A capital investment approach to price formulae/ determination

I.J. Lambrechts and J.J. Doppegieter
Department of Business Economics, University of Stellenbosch

In an analysis of ten widely used price-control formulae it was shown that the formulae took into consideration a variety of different stipulations such as the calculation of funds employed, the definition of profit and the profitability rate allowed. Furthermore it is maintained that the commonly used intuitive and/or conventional methods of evaluation are subject to various shortcomings. Therefore, it can be inferred that it is virtually impossible to compare different price formulae in isolation. To overcome this problem a simulation model, based on certain assumptions, has been developed. The model compares and evaluates the adequacy of various price formulae over time (dynamically) in different ways, i.e. several ratios and criteria are calculated with the internal rate of return being the primary one. In the remaining three articles, the simulation model will be applied to the two formulae presented in this article.
S. Afr. J. Bus. Mgmt. 1985, 16: 35 – 39

Deur die tien mees algemene formules vir prysbeheer te analiseer, toon die skrywers dat die formules 'n verskeidenheid van verskillende bepalings in aanmerking neem soos die berekening van totale fondse, die definiëring van wins en die graad van winsgewendheid toegelaat. Verder word dit gestel dat die algemene gebruik van intuitiewe en/of konvensionele metodes van evaluasie aan verskeie tekortkominge blootgestel is. Daarom word aanvaar dat dit bykans onmoontlik is om verskillende prysformules in isolasie te vergelyk. Om hierdie probleem te oorkom, is 'n simulasiemodel, gebaseer op verskeie aannames, ontwikkel. Die model vergelyk en evalueer die aanvaarbaarheid van verskeie prysformules oor tyd (dinamies) op verskillende maniere, te wete verskeie verhoudings en kriteria word bereken — met die klem op die interne rendabiliteit. In drie artikels (in opvolgende uitgawes) sal die simulasiemodel toegepas word op twee van die formules wat in hierdie artikel bespreek word.
S.-Afr. Tydskr. Bedryfsl. 1985, 16: 35 – 39

I.J. Lambrechts* and J.J. Doppegieter
Department of Business Economics, University of Stellenbosch, Stellenbosch, 7600 Republic of South Africa
*To whom correspondence should be addressed

Accepted August 1984

Introduction

A price formula/policy can be described in different ways. Some formulae are described in simple terms, e.g. 15% before interest and tax on capital employed, while other formulae are described in a more sophisticated way by specific definition of the profit element with more explicit detail on capital determination. Price formulae are common in price-controlled and non-price-controlled industries/undertakings. In the latter case the objective of a price formula could be either to test the adequacy of a price or to determine the selling price.

Price control was first introduced in South Africa during the Second World War when circumstances were favourable for industry and commerce to charge unjustifiably high prices for available goods. After the war, price control was retained for certain commodities. In 1963 the prices of only about 18 commodities were still subject to price control but since 1964 price control has been extended to various other commodities. In 1964 *The Price Control Act*, No. 25 of 1964 was passed by Parliament. This Act was amended in 1967. The Act provides *inter alia* for the appointment of a Price Controller who is empowered to fix maximum prices or charges.

Prescribed prices are not only determined in terms of the Price Control Act. Examples of prescribed prices in terms of other Acts are electricity tariffs (The Electricity Act of 1958), railway tariffs (The Republic of South Africa Constitution Act, No. 32 of 1961) and certain agricultural products (in terms of different Acts) marketed through Control Boards.

In analysing the methods of price calculations applied in terms of the different Acts referred to above, it is evident that the applied formulae differ for virtually every product/service. Even the formulae applied in terms of the Price Control Act differ substantially from one another.

It appears as if the original formula could have been the same but that concessions/changes were implemented over time to accommodate requests subsequently made by different industries and companies.

The objective of this article is *firstly* to compare certain pricing formulae. *Secondly*, after the differences between the formulae have been pointed out, an attempt will be made to develop an approach to quantify the differences in terms of a single denominator. It should be stressed that the underlying sentiment of this article is not the continuation of price control. The authors are fully aware of the undertaking of the Prime Minister at the Carlton and the Good Hope Conferences that market forces will be allowed to act as a greater regulator of economic activities than in the past. In fact, quite a number of products/industries have been exempted from price control since these conferences. The

approach developed in this article is, however, applicable to all pricing formulae/policies. It could be applied for example in respect of the parastatals, e.g. Escom, South African Transport Services, the Post Office, and the Agricultural Control Boards where price control is still applicable, as well as in the case of private companies where definite pricing formulae/policies are spelled out.

The capital investment approach to price formulae/determination will be discussed in a series of four articles. In this *first article* an outline is given of different formulae, the general approach is analysed and the formulae to be used as illustration are described. In the *second article* three financial aspects of industries/companies where price control applies or where price formulae are applicable will be evaluated, i.e. profitability, provision for inflation, and financial structure. The *third article* deals with a quantification of the specific differences between pricing formulae in terms of the internal rate of return. In the *fourth article* the sensitivity of apparently important external parameters (inputs) is tested.

In presenting this series on price determination the authors tend to solve the problems in evaluating price formulae. These shortcomings follow mainly from the difficulty in comparing different formulae, differences in applying the accounting rate of return, the arbitrary definition of profit and capital employed and the absence of a meaningful approach to evaluate techniques (based on cash flow) combined with a computer simulation model. The adequacy of formulae could therefore be evaluated in terms of cash flow, business and financial risk, inflationary effects, growth requirements, and financial strategies and policies.

Comparison of price control formulae

Price control in terms of the Price Control Act was mainly exercised by controlling the profitability of an industry or company. The crucial components in determining profitability are the calculation of *funds employed, the definition of profit, the profitability rate allowed, the accounting period* used for price determination and the divisor to determine the price adjustment per unit of product. The main problem underlying a comparison of the formulae is the combination of different practices/approaches in respect of each of these crucial components. These differences will now be discussed briefly.

In total ten different pricing formulae have been analysed. The differences in the formulae are clear from the following summary which shows the different practices under each variable:

Funds employed

(i) Average funds employed and year-end balances.
(ii) Depreciated fixed assets at book value, conservative market value and depreciated fixed assets at replacement value.
(iii) Work under construction included and work under construction excluded.
(iv) Cash balances allowed and disallowed.
(v) Trade creditors not deducted from funds employed and trade creditors and other interest-free loans deducted.
(vi) Actual current assets employed allowed and normal (according to formulae) current assets allowed.

Definition of profit

(i) Profit before deducting interest and tax but excluding investment income and non-recurring income and expenditure; and profit before interest but after tax excluding investment income and non-recurring income and expenditure.
(ii) Additional depreciation allowed fully and additional depreciation only allowed partially.
(iii) Additional depreciation calculated on different values, i.e.
- Actual replacement values.
- Revaluations, adjusted with the production price index.
- Insurance valuations.
- Subjective valuations.

(iv) In some cases the fact that additional depreciation is not deductible for tax purposes is taken into account and the amount allowed is increased to provide for this.
(v) Stock profits deducted and stock profits included.

Profitability allowed

The profitability allowed fluctuates widely, mostly between 8,5 and 17%. The magnitude of these percentages is, however, irrelevant because of the differences regarding funds employed and profit levels. In certain cases a higher profitability level is allowed provided the increases are the result of productivity improvements. In other cases productivity is not taken into account explicitly. Sometimes the allowed profitability is expressed on a before-tax basis and in other cases on an after-tax basis.

Accounting period

Historical figures are used as a basis for price control as well as estimated figures. Combinations are also used, e.g. nine months actual plus three months budgeted figures. Audited statements are required in certain instances.

Divisor to determine the price adjustment per unit

Sales volume of previous years or the higher of the previous year's sales and expected sales subject to a normal capacity, minimum actual production figure of previous year and the average of the production figure for the previous year and for the following year.

From the above summary it is clear that a very large number of price formulae are possible, consisting of an item under each of the above five headings. The following is an example of such a formula (combination): 15% of funds employed (average of total funds including current liabilities and work under construction based on depreciated book values). The profit is before interest and tax, after additional depreciation and excluding stock adjustments. The forecast period is used as a basis as well as the estimated sales volume.

It is clear that the wide variation in price formulae makes it virtually impossible to compare the final result of each. Such a comparison is essential to judge the adequacy of the formula applicable to each industry/undertaking in the light of its inherent business and financial risk. An approach to judge specific formulae will be discussed and illustrated in the next section by using the formulae as discussed in the next section (formulae A and B). Formula A will be discussed in detail and formula B briefly by pointing out the differences between formulae A and B.

Approach to evaluate a price formula

Price formula A

Funds employed

The amount of funds employed is equal to average funds, with fixed assets at depreciated book value including work under construction, plus additional cash and including actual current assets (the stock evaluation method applied by the

industry is therefore accepted). Trade investments and goodwill are excluded. The amount of trade creditors is not deducted from funds employed.

Profit levels

The profit figures used to determine prices consist of profit before interest and tax but excluding investment income and non-recurring income and expenditure. Additional depreciation based on revalued assets is allowed fully and no provision is made to compensate for the non-deductibility of additional depreciation for tax purposes.

Profitability

A percentage (before interest and tax) is based on funds employed with productivity not taken into account explicitly.

Accounting period

The present year's figures are used; in the case of funds employed the average figure of the present and past year is used.

Divisor

No divisor is used in the capital investment approach because of the assumption that no time lag exists and that the allowed profitability is fully attained. In the actual situation different divisors are used depending on utilization/sales volume and the allowed profitability is usually not attained.

Price formula B

The most important differences between price formula A and price formula B are the following:

(i) Fixed assets are valued at depreciated replacement cost and work under construction is excluded.
(ii) No profit from additional cash is included in the profit definition.
(iii) Provision is made to compensate for the non-deductability of additional depreciation for tax purposes.
(iv) A profitability rate before interest but *after* tax is used to calculate the allowed profit levels.

General assumptions

Several assumptions are made, the most important being:

(i) The amount of original fixed assets is equal to the original cost price thereof.
(ii) Replacement of fixed assets is on a continuous basis.
(iii) Full capacity utilization exists at the beginning. Expansion occurs continuously with increasing volumes.
(iv) The maximum period of evaluating the formula is equal to the average lifetime of fixed assets.
(v) No time lag exists with the result that a shortfall of the allowed profitability is fully recovered the next year.

Description of model

Introduction

Our approach is based on the development of a computer model, which simulates the balance sheet (assets and liabilities) and the relevant items of the income statement. On the basis of reasonable assumptions, basic relationships between the financial variables are expressed algebraically. The assumptions are based partly on the above-mentioned general assumptions and partly on predictions of certain external factors. The algebraic relationships are constructed in such a way that later experimentation will be possible. In this way efficiency and flexibility is preserved and the model thereby enables the analyst *inter alia* to test the sensitivity of each specific parameter.

The main classification of items included in the model is as follows:

- Asset items
- Profit items
- Capital items
- Analysis section.

There is an interrelationship between the above-mentioned items, e.g. the total assets form the basis for the profit items which subsequently influence the capital items (via undistributed profits). All these items have an effect on the analysis section.

Asset items

Fixed assets. Fixed assets form an ideal complex with the result that continuous replacement takes place and no provision for under-recovery of depreciation is necessary. The ideal complex is not distorted as a result of technological improvements and, because expansion of fixed assets takes place continuously, there is a fairly constant utilization of capacity. All fixed assets are depreciated on a straight-line basis. The ratio of fixed assets to total assets is supplied as an external input which forms the basis for the calculation of the initial values of fixed and current assets. The amount for fixed assets for the subsequent years is calculated as follows:

Fixed assets of previous year + expansion investment + replacement investment − depreciation.

Expansion investment is related to the growth in sales and specific increases of capital expenditure. *Replacement investment* is also influenced by nominal growth (price increases) as well as the average lifetime of fixed assets, which is an external input.

The fixed assets are depreciated on a straight-line basis, based on the fixed assets of the previous year plus 50% of the expansion and replacement investment of the specific year.

Current assets. The initial value of current assets is an external input. The values for the subsequent years are a function of real and nominal growth (specific price increases).

Profit items

The profit items are calculated prior to the capital items because the amount of undistributed profits has an influence on capital requirements. The first profit item is profit before interest and tax (for formula A and after tax for formula B) which is obtained by multiplying the allowed rates of profitability (an external input) with either average or total assets (an external input is required to indicate whether average or total assets should be used).

Additional depreciation is calculated after revaluing fixed assets by using specific price increase rates which are supplied as external inputs. The additional depreciation is the difference between replacement and historical cost depreciation. This additional depreciation is before tax and as a result is subject to tax.

fluctuating cash levels which differ from year-end levels), is a very difficult item to define, and is relatively small in magnitude. It is expressed as a percentage (fixed) of profit before interest and tax.

The income derived from investments is relevant only if surplus cash results after all financing requirements have been satisfied (the investment rate of surplus cash is an external input).

The interest paid is calculated by multiplying the average interest rate (an external input) with the average interest-bearing loan capital for a specific year. The level of the interest expense has an effect on the amount of average interest-bearing loan capital.

Taxation is calculated after taking into account investment and initial allowances (external inputs) on all fixed assets in the first year and new investments afterwards. The effect of initial allowances on the depreciation allowed for tax purposes is fully accounted for. If there is an accumulated tax loss it should first be eliminated before tax is payable.

Since the dividend policy of a company or an industry is determined by various factors, an equation is constructed which preserves flexibility and can be changed according to the specific situation. The maximum amount of dividends is limited to the profit after tax. Provision is made for different dividend formulae which can be tested for sensitivity on the final results.

Capital items

The initial structure is supplied as an external input consisting of equity capital and loan capital, where a differentiation is made between long- and short-term interest-bearing capital as well as short-term non-interest-bearing loan capital. In subsequent years the amount of total assets is compared to the equity capital of the previous year *plus* undistributed profit for the specific year with long-term loans of the previous years being reduced to provide for redemption based on an average redemption period. If there is a shortfall in funds it is raised in the following assumed sequence:

(i) New equity capital is raised equal to a percentage (external input) of new expansion investments (fixed assets plus the increase in current assets).

(ii) If there is still a shortfall in funds, additional loan capital is raised. The different types of loan capital are in the same ratio as in the initial capital structure. If there is a surplus of funds it results in surplus cash with investment income, which also has an effect on interest payable.

Analysis of model and description of capital investments approach to price formulae

The result of a specific price formula on a company/industry can be evaluated by means of (amongst others) a *profitability analysis,* an *evaluation of the sufficiency of inflation allowances granted* and an analysis of the financial structure. These aspects will now be discussed in more detail.

Profitability analysis

The profitability rate used in a price formula does not give an indication of the actual (effective) profitability earned by an industry even if it is assumed that no time-lag exists. Differences between the actual (effective) profitability and the allowed (planned) profitability rate result because of certain 'allowances', e.g. additional depreciation, profit from additional cash, and other differences in the formulae, such as the definition of profits (before tax or after tax; based on historical or replacement costs) and funds employed (creditors deducted or not, based on historical or replacement costs). Other factors which result in important differences are the testing period and whether or not the price is calculated on historical results with certain adjustments on projected figures. The differences in price formulae create the need for a uniform variable to evaluate the sufficiency of a specific formula.

The conventional profitability (accounting rate of return) based on annual financial statements is subject to certain shortcomings of which the most important are: It ignores the *time value of money* and therefore it is difficult to compare different alternatives; as applied in most of the formulae it is only a *one-year measure;* and its value is to a large extent the result of *accounting figures* which tend to vary according to the assumptions made (Lambrechts, 1979).

To overcome these problems a more meaningful criterion has been developed, namely the internal rate of return (discounted cash-flow rate of return) which takes into account the *time value* of money; provides for the *automatic recovery* of investments made; takes into account the *full period* which is analysed; and is *based on cash flows* compared to profits and asset values which do not vary according to the assumptions or accounting methods applied. It enables the analyst to make meaningful comparisons between price formulae because it is a common denominator.

The internal rate of return is, however, also subject to certain shortcomings. Owing to the nature of the simulation model some of these shortcomings do however not apply. The possibility of no internal rate of return or multiple internal rates of return does not exist because the simulation model describes a conventional flow of funds, i.e. an initial investment followed by inflows which exceed subsequent investments. Therefore no problem arises with comparisons between different pricing formulae because of equal initial investments and periods over which the formulae are evaluated. The implicit assumption that all cash inflows are re-invested at a rate which equals the calculated internal rate is however still applicable. This is the only theoretical shortcoming the analyst should be aware of (Lambrechts, 1979).

The internal rate of return is calculated by solving for r in the following equation:

$$\sum_{t=0}^{n} \frac{I_t}{(1+r)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+r)^t} - \frac{R_n}{(1+r)^t} = 0$$

where n = lifetime over which the formulae is evaluated; I_t = investment amount in period t, which consists of total assets in period nil, expansion investments, replacements investments and increases in current assets; C_t = cash inflow in period t, which consists of profit after tax plus interest paid $\times$ (1 – effective tax rate) plus depreciation; and R_n = residual value consisting of total assets and surplus cash at the end of the evaluation period.

Please note that, in the calculation of C_t, interest (on an after-tax basis) is added to profit after tax because the effect of the interest (also after tax) is included in the cost of capital with which the internal rate of return is compared.

The internal rate of return can be used in different ways. *Firstly,* it can be used to evaluate the *adequacy* of a price formula. If it exceeds the critical rate of return (cost of capital) of the specific industry, a satisfactory rate of return is earned. It should be remembered that the calculated internal rate of return is a real return because provision is fully made for higher replacement costs, and it should consequently be compared with the real cost of capital. *Secondly,* it can be used to *compare* different price formulae. The internal rate of return is therefore a criterion which tends to point out differences between price formulae. It is a common denominator which eliminates all differences between price formulae. It should however be taken into account that the magnitude of the internal rate of return for different price formulae only gives an indication of their 'attractiveness'. *Thirdly,* a sensitivity analysis can be done on the various external variables (inputs) to test their effect on the internal

rate of return, and to establish their relative importance.

The analysis section also makes provision for the calculation of the accounting profitability after tax (based on average capital). This enables the analyst to compare the magnitude of the allowed profitability rate (which is also an accounting profitability) with the accounting profitability achieved per period, and the trend thereof. Furthermore, the relationship between the accounting profitability, the internal rate of return and the effect of changes in variable inputs on this relationship can also be determined.

Evaluation of inflation allowances

To analyse the extent of the inflation compensation provided for in a price formula, the ratio of depreciation allowed to replacement investments is calculated. If depreciation is based on replacement values, two components are included, i.e. normal depreciation which is net after tax and the additional depreciation which is not tax deductable. The cash flow from the additional depreciation is, therefore, equal to additional depreciation multiplied by (1 – effective tax rate). The ratio of depreciation allowed to replacement investments is calculated on an annual basis and a cumulative basis. If this ratio equals or exceeds one, adequate provision is made for replacement of fixed assets.

Provision should however also be made for that portion of replacement investments financed by means of loan capital.

Financial structure

If a price formula is satisfactory to an industry/company it should not result in a drastic deterioration of the equity capital to loan capital ratio, especially if the assumption is made that no new share capital is raised. Another method to test the financial risk of a capital structure is to calculate the interest-coverage ratio based on profit and cash flow. If this ratio deteriorates over time the reason should be in the formulation of the price formula. The coverage *ratio* based on profit is profit before interest and tax to interest paid. Based on cash flow the ratio is profit before interest and tax *plus* depreciation *plus/minus* changes in working capital (excluding interest bearing loan capital) to interest paid.

Summary

In an analysis of ten widely used price-control formulae it was shown that the formulae took into consideration a variety of different stipulations such as the calculation of funds employed, the definition of profit, and the profitability rate allowed. Furthermore it is maintained that the commonly used intuitive and/or conventional methods of evaluation are subject to various shortcomings. Therefore, it can be inferred that it is virtually impossible to compare different price formulae in isolation.

To overcome this problem a simulation model, based on certain assumptions, has been developed. The model compares and evaluates the adequacy of various price formulae over time (dynamically) in different ways, i.e. several ratios and criteria are calculated with the internal rate of return being the primary one.

In the remaining three articles, the simulation model will be applied to the two formulae presented in this article.

Reference

Lambrechts, I.J. 1979. *Die Investeringsbesluit*. Pretoria: HAUM, pp.107 – 109.