The Construction of an Anticipatory Model for the Strategic Management Decision Making Process at the Firm Level[1]

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Abstract

This paper analyzes the effect of productivity on profitability at the firm level through the construction of an anticipatory framework/model, based on Gold's model. It is a Total Productivity Measurement (TPM) model, which directly measures and relates productivity with long-term profitability (defined as the Shareholder Value Added-SVA) and uses dynamic productivity ratios and their effects on profitability in value terms. The proposed model could support management at the business unit level in their strategic decision making process (the formulation and evaluation of proposed future strategies), and the evaluation of current strategies (the performance measurement and improvement process), and could close the gap between strategy development and its implementation.

Keywords: productivity, profitability, strategic management, performance measurement and improvement, anticipatory systems.

1. Introduction

The overall welfare, and the ultimate productivity of the whole organization, are affected by strategic planning, policy formation and goal setting. Most strategic plans

[1] International Journal of Computing Anticipatory Systems, volume 9, 2001, CHAOS, University of Liege, Belgium, pp. 127-142.

reflect technological, economic, political and social prospects (Dessler, 1986). Strategic plans have corresponding management control activities of formulating personnel practices, capital planning and developing new products.

From a productivity standpoint, the control function (the evaluation of the outcomes of the implemented strategy and the firm's performance measurement) enables managers to obtain and use resources effectively and efficiently, to achieve the organizations' objectives. In this way, productivity increases are linked to business strategies and to action (Skinner, 1985).

Productivity measurement and improvement are strategic issues. Well formulated plans for managing productivity that clearly specify time periods required to achieve continuing, long-term improvements are vital to organizational success. (Smith, 1990).

Productivity and profitability are important concepts and measures describing the performance and successfulness of an organisation

There are many models in the literature for analyzing the effects of different factors on the costs and profitability of a firm. Most of them with a short run horizon, as for example variance analysis with sales activity, and price recovery and productivity, and some of them with long run horizon, as for example the total-factor productivity measurement (TFPM) and the total productivity measurement (TPM) models and the NPV and IRR models. (Kaplan and Atkinson 1989 : 321-350; Horngren et al, 1994 : 753-782 or Pineda 1990 : 2). However, very few of these models are used in the strategic decision making process, as planning, forecasting (or better scenarios constructing) and control (performance evaluation and improvement) management tools.

This study proposes the construction of an anticipatory framework/model to support the strategic management decision making process.

An anticipatory system is a system containing a predictive model of itself and/or of its environment, which allows it to state at an instant in accord with the model's predictions pertaining to a later instant (Rosen, 1985: 341).

All decisions that are taken within an organization are based on the results of the anticipation and in this way they provide the system with a degree of intelligence. In our situation of the specific (case) firm, the proposed anticipatory system is feeding the predictive model with all the necessary future input data (i.e., price and volume changes of capital, labour, materials, and general expenses) that top management of the organisation believes will direct the firm towards the future increase of its market value (i.e., its profitability in terms of the SVA concept). The predictive model then, after the processing of this data, produces specific future outcomes (i.e., SVA results). These results are taken into consideration by management in the development of their future strategic decisions, according to a decision rule: If the specific future outcome is a positive SVA result, that is if it increases the total market value of the firm, then the proposed strategy is accepted by top management and this strategy will be finally implemented. If, however, the specific future outcome is a negative SVA result, then top management rejects the proposed future strategy and feeds the predictive model with new future input data (i.e., a new formulated strategic alternative) until the resulted outcomes turn out to give a positive SVA:

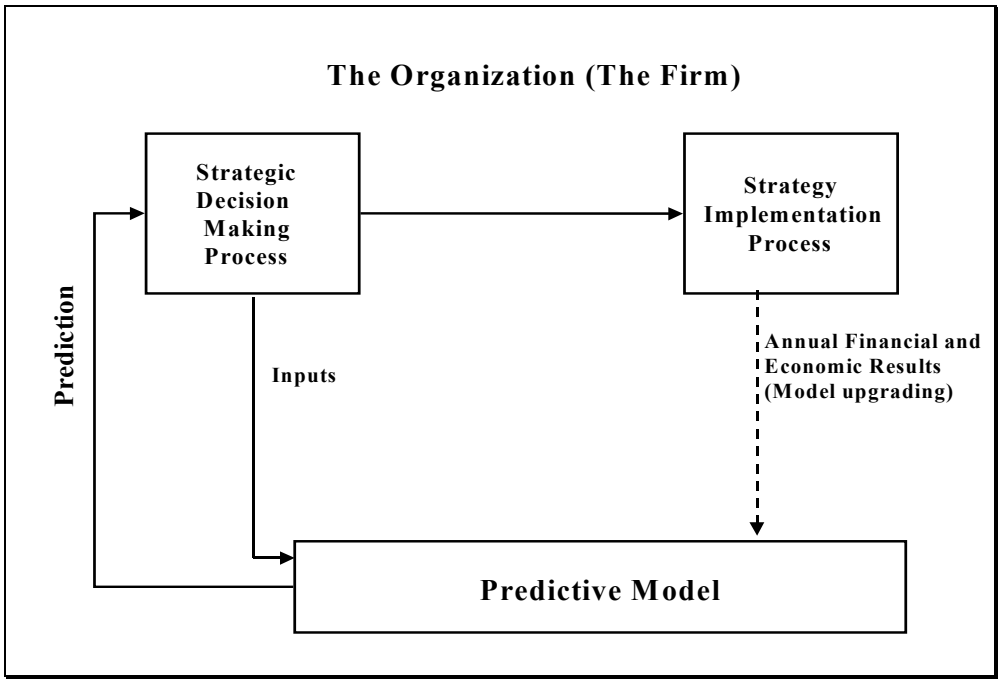

Figure 1: The Anticipatory System of an Organization.

The aims are:

a) To create a framework/model to support strategic management and control through productivity and profitability measurement and improvements. This framework could close the gap between strategy development and its implementation.

b) To evaluate the model's worth to the executive managers of a selected case firm, first, in terms of its operability (explaining past behaviour of the firm as well as its predictive power) and second, in terms of its capability to enable the firm's executives to understand better the relationship between productivity improvements and the resulted profitability at the firm level.

Above aims are achieved by creating a tool for producing information about the effects of productivity improvements on long-term profitability, at the firm level. This information base both, (a) supports the strategic management decision making process, especially on the evaluation of proposed alternative strategic options, and (b) simultaneously, creates a performance measurement system capable of evaluating the firm's implemented strategies.

2. Background

Strategic management and performance measurement can help the organization's ability to compete and survive, depending on how these two systems are developed and utilized.

No subsystem is more important than planning when it comes to continuous performance improvement. Strategic planning is not done very well in Europe and USA (Sink and Tuttle, 1989). Strategic plans often do not lead to commitment, hence there is a significant variance between the plan and expectations and actual implementation.

Performance measurement, in order to have validity, must derive from the strategy of the organisation. A valid collection of strategy driven performance measures will enable a continuous feedback of customer needs, competitive costs, responsiveness, and other critical indicators of world class performance (Campi, 1993). The linkage between performance measures, strategies and objectives is a critical management imperative.

There is plenty of literature describing the most important objectives and targets that firms should employ in their long-range strategic planning process as well as in their performance measurement and improvement process:

Profitability was the first and the most important proposed measure that firms should adopt as their major long term objective in their strategic planning process and their performance measurement and improvement process. A good review of these profitability measures can be found in many books (Argenti, 1980: 36–57 and 191–207), (Horrigan, 1968: 284 – 294), (Van Horne, 1980: 7-11 and 711-740), (Kaplan 1984: 390 – 418), and (Brealey and Myers, 1996: 303 – 313).

They could be divided into two main categories: (a) Profitability which is determined by accounting numbers and methods, as for example, return on investment (ROI), return on capital employed (ROCE), returns on net assets (RONA), return on sales, return per employee etc., and (b) Profitability which is determined by discounted cash flow analysis (DCF) as for example, return on shareholders capital (ROSC) or else the Internal Rate of Return (IRR) of the company's cash flows by which the benefit (income) is exactly as great as the sacrifice (expenses), or, most recently (Rappaport, 1986 and 1998), the shareholders value added (SVA) which is the net present value (NPV) of the company's annual inflows (incomes) minus the outflows (investments and net working capital expenses).

During the past decade CEOs have talked consistently about the dominant business objective (Rappaport, 1992: 84-90) of **establishing sustaining competitive advantage** through the increase of productivity and profitability (mainly in terms of creating shareholders value).

Productivity, the value of output produced by the value (costs) of all resources used, is the foundation for creating competitive advantage (cost leadership or differentiation with a premium price, or both) in the market place. A business creates competitive advantage when the long – term value of its output or sales is greater than its total costs, including its cost of capital. This advantage can be achieved by providing superior value (better quality, better after sales service etc) or lower prices, or both (Rappaport, 1998: 69-73).

Furthermore, it is, mainly, long-term productivity increases that create excess cash flows (long-term profitability), which is used for the sustaining of, or the creation of

new, competitive advantage, through new investment in the company's resources (tangible or physical, intangible, and organisational capabilities). Sustainability of the competitive advantage is far more important than the competitive advantage itself (Day and Reibstein, 1997: 52).

It is also productivity that the stock market reacts to when pricing a company's share. Embedded in all shares is an implied long-term expectation about a company's productivity that is, its ability to create value in excess of the cost producing it. When the stock market prices a company's shares according to a belief that the company will be able to create value over the long-term, it is attributing to a company's long-term productivity a sustainable competitive advantage. In this way, **productivity is the hinge on which both competitive advantage and shareholder value hangs.**

Industry attractiveness analysis, the assessment of a business unit's position within its industry segment, and the auditing of its resources (core competencies and capabilities), are the building blocks for identifying competitive advantage and its sources. **Estimating the long - term productivity and profitability (shareholder value added) potential of strategies will signal the absence or presence of competitive advantage** (Rappaport, 1998).

In the literature there are many different approaches for analyzing the relationship between productivity and profitability. Usually the relationship between productivity and profitability at firm level is described by models. Most of these models are total-factor productivity measurement (**TFPM**) - total productivity measurement (**TPM)** models or models, which are based on managerial control ratios (MCR).

Pineda (1990) has dealt with the **TFPM-TPM** models rather broadly. TFPM-TPM, according to him (Pineda 1990: 13), directly measures and relates productivity with profitability and uses dynamic productivity ratios and their effects on profitability in dollars.

He (Pineda, 1990: 2) has found 13 different TFPM-TPM models, which divided in three categories :

a) the Productivity Indices (PI) Models,
b) the Profitability = Productivity + Price Recovery (PPPR) Models and
c) the Econometric Models.

Two models are of great importance in the measurement of productivity (partial and total) and its relation to profitability, at the firm level: the **Gold's** model (Gold, 1973) and the **APQC** model (Pineda, 1990; Sumanth, 1984). **Gold's** model is more appropriate for long-run decisions (strategic decisions), whereas the **APQC** model is a "resource allocation accounting model", which enhances conventional cost accounting practice. It leads to a correction of efficiency variance, through the price recovery effect, which is of great significance to managerial perception of short-run controllable profit.

3. The Construction of the Model

In the present section we shall (a) expand Gold's model in two directions, so as to make it an "open" model in the sense that we shall describe below, and (b) improve the Gold's model by connecting it to the Shareholders Value Analysis.

(A) The first proposed expansion concerns the number of partial productivity measures. Gold proposed three direct inputs for productivity measurement: labour, materials and capital. Their productivity measurement ratios are: (a) Output/Labour, (b) Output/Materials and (c) Capacity/Fixed Investment, taking as capacity the firm's maximum available production volume and fixed investment as measuring capital input through depreciation charges or replacement costs.

We propose the replacement of this input (fixed capital) with the following two:

- Output/ Capital charges (i.e. depreciation[2] and interest charges of long and short-term loans), which will measure the partial productivity of total capital, and
- Output/General Expenses, which will measure the partial productivity of "General Expenses".

By doing this, the model is improved in two grounds:

1. It gives a measure of productivity changes of total general expenses and total capital expenditure, and, thus, more information to managers, and
2. It gives a better indication of the firm's unit cost, because now all costs are included in the model.

(B) The second proposed expansion concerns the number of financial ratios used in the Gold's model. In the proposed framework there is the ability of using as many financial ratios as the firm's management team consider important for the control of current (implemented) strategies.

(C) The improvement of Gold's model has to do with its connection to profitability, and more specifically to ROI. We shall change this accounting profitability measure with the new concept of Shareholder Value – Added (SVA), which produces better results for strategic evaluation and performance measurement purposes.

By means of the above, productivity analysis has been transformed to cover:

a) Changes in the level of each category of input requirements per unit of output, including materials, capital, salaried personnel and direct labour (wage earners) and finally general expenses;
b) Changes in the proportions in which inputs are combined, both in order to take account of substitutions (e.g. buying more highly fabricated components instead of making them, or replacing labour with machinery) and also in order to differentiate between changes in the productivity of major as over against minor inputs; and
c) Variations in all components of this 'network of productivity relationships' as viewed simultaneously by managers capable of adjusting relationship among them in the interest of improving aggregate performance relative to specified criteria.

These factors have been incorporated in the following proposed model (Theriou, 2000):

[2] We assume that the company follows a straight-line depreciation method for book keeping purposes.

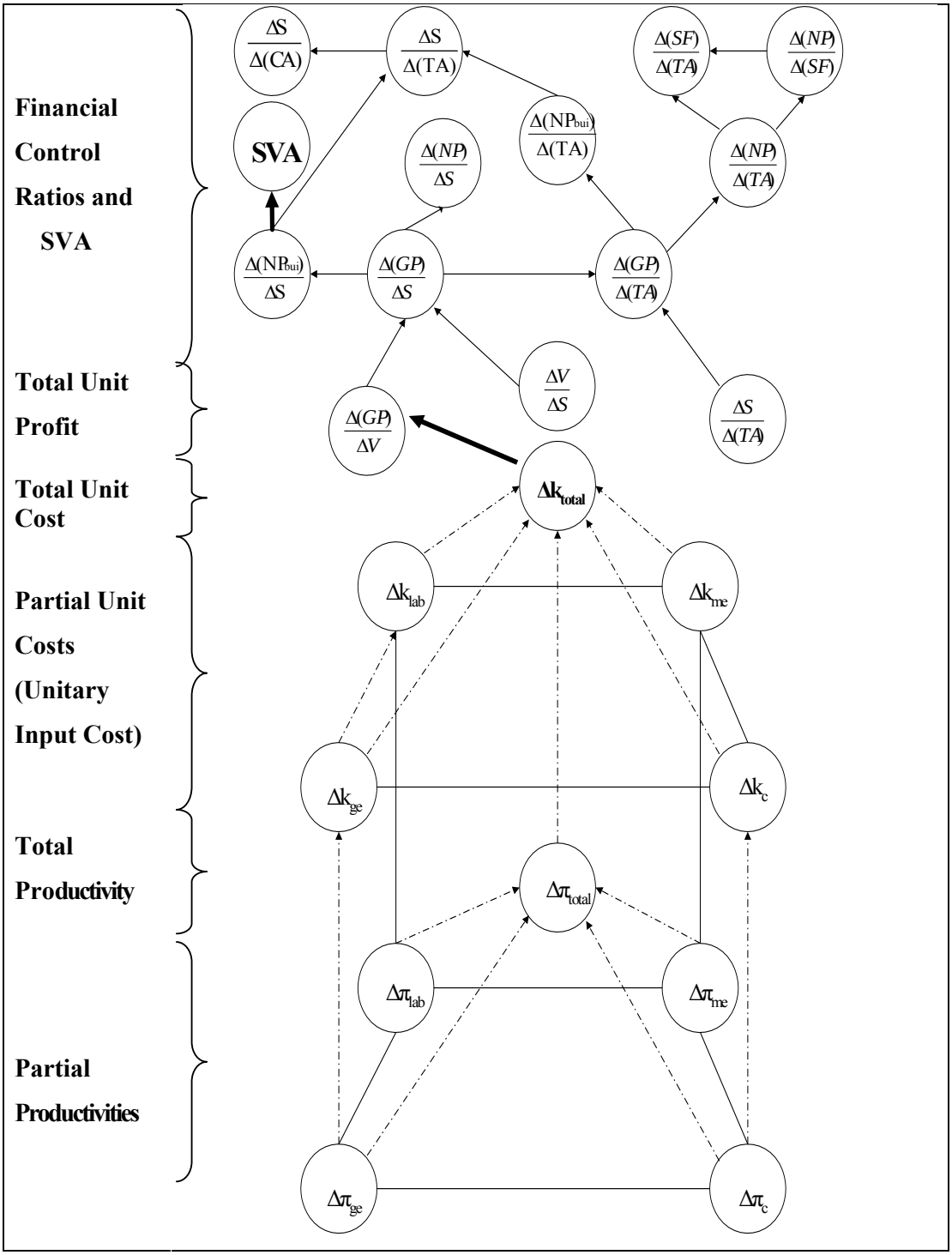

Figure 2.: The framework of 'Productivity – Profitability' of a firm

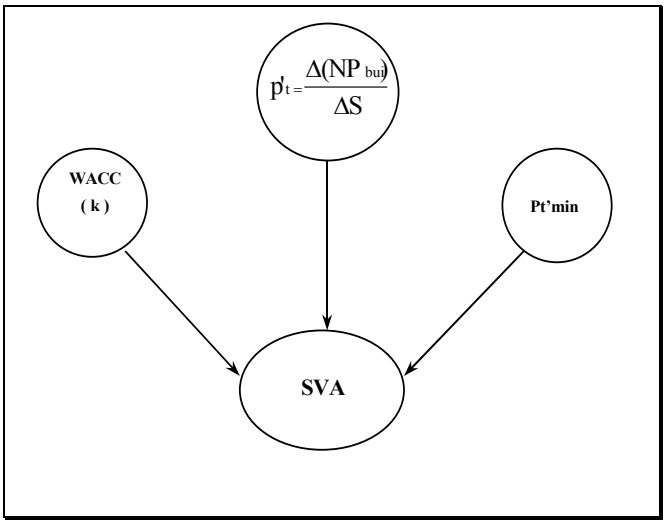

Figure: 3.: The Shareholder Value Added model

List of Symbols

V	:	Total Production Volume
π	:	Productivities (π_{lab}: partial productivity of labour, π_{me}: partial prod. of materials and energy, π_c: partial prod. of capital, π_{ge}: partial prod. of gen. expenses, and π_{total}: total productivity).
k	:	Unit cost (k_{lab}: unit labour cost, k_{me}: unit cost of materials and energy, k_c: unit cost of capital, k_{ge}: unit cost of gen. expenses, and k_{total}: firm's total unitary cost).
q_j	:	Price of Input j
Q_j	:	Volume of Input j
S	:	Sales Value
GP	:	Gross Profit
NP	:	Net Profit
TA	:	Total Assets
NP_{bui}	:	Net Profit before Unorganic Income and Financing Expenses, or else Earnings Before Interest and Taxes-EBIT.
SF	:	Shareholders Funds
SVA	:	Shareholder Value Added: $SVA_t = \frac{(p_t' - p_{t\,min}')(1 - T_t)\Delta S_t}{k(1+k)^{t-1}}$
WACC (or k)	:	Weighted Average Cost of Capital : k= [(EC/TC)*k_e + (BC/TC)*k_b), where: EC: Equity capital, BC: Borrowed capital, TC: Total capital, k_e: cost of equity capital, and k_b: cost of borrowed capital.

p'_t : Incremental operating profit margin on incremental sales (Δ in earnings before interest and tax-EBIT or NP_{bui} divided by Δ in Sales, in period t):

$p'_{t\,min.}$: The break-even operating return on sales or the minimum pre-tax operating profit margin on incremental sales needed to create value for shareholders:

$$p'_{t\,min} = \frac{(f_t + w_t)k}{(1-T)(1+k)}$$ where:

f_t: capital expenditure(CE) minus depreciation(D) per dollar of sales increase, (CE-D) / ΔS,

w_t: cash required for net working capital (WC) per dollar of sales increase:

$$w_t = \frac{\Delta CA_t - \Delta CL_t}{\Delta S_t}$$

T: Cash Income tax rate

CA : Current Assets

CL : Current Liabilities

As we realise, the appraisal of new investments (innovations) from the economic point of view, which is critical for managerial purpose, cannot be restricted to predominantly physical input – output relationships. Specifically, management can not evaluate the net benefits of a past innovation solely on the basis of data specifying resulting adjustments in each of the eight components of the network of productivity relationships. Nor can management choose between alternative innovations on the basis solely of estimated effects on each of these eight components. Estimates of such relationships are critical elements in appraising their economic implications, but the analysis must be extended to include the latter if it is to serve as a sound basis for managerial decisions. And a first step in this direction would involve exploring the cost effects of changes in unit input requirements and factor proportions by superimposing the 'structure of costs' on to the 'network of productivity relationships'.

The effect of changes in output per man-hour on unit wage costs depends, of course, on concomitant changes in wage rates. Similarly, the effect of changes in unit material requirements on unit material cost depends on accompanying changes in the price of such materials. And the effect of changes in the productivity of capital on the cost of such capital per unit of output, depends on the annual rate of changes of all charges on such capital. What is being emphasised in this proposed framework, however, is the necessity of considering interactions between productivity adjustments and factor prices instead of continuing to make the simplifying assumptions that the latter remain unchanged.

In turn, the effect of a change in unit wage costs on total unit costs depends on the proportion of total costs accounted for by wages as well as on concomitant changes in other unit costs weighted by their respective shares of total costs. For example, if wages account for less than one-fifth of total costs, a 5 per cent decrease in unit wage costs would tend to reduce total unit costs by only 1 per cent. But total unit costs are more likely to increase than decrease if the innovation engendering the decline in unit wage

costs involved increases in unit material and unit capital costs, which together account for more than three times the wage share of total costs in many manufacturing industries.

Integration of the productivity network and cost structure models relates changes in 'apparent' input productivities $\Delta\pi_j$ (and factor proportions) through factor prices (Δq_j) to each of the unit costs; and it also relates changes in individual unit costs (Δk_j) through cost proportions (ΔK_{ji} / ΔK_j) to total unit costs (Δk_{total}). Hence it identifies the additional kinds of information required to evaluate the prospective effects on total unit costs of given patterns of past (or anticipated) changes in the network of productivity relationships.

Finally, managerial decisions in private industry obviously can not be based on minimising total unit cost either, in view of the over – riding importance of long term profitability. Accordingly, the 'productivity network' and 'the structure of costs' must be further integrated with some model of the determinants of changes in *profitability*, such as the 'financial control ratios' and the SVA.

Above figures 2 and 3, show, how these financial ratios and the SVA may be integrated with the network of 'productivity relationships' and with the 'structure of cost relationship' to provide a unified framework for systematically exploring the complex of interactions linking changes in productivity and factor prices to unit costs and to the other determinants of changes in long-term profitability (the SVA). Figure 2 can be read from the bottom up.

Completing the description of the proposed framework, it will be very useful to see how this framework could be used by a firm's management team, as the organizational tool for planning, decision making and performance evaluation, in their strategic formulation and evaluation processes.

3.1. Value Driver Assessment

Hundreds of factors influence the value of any business and, faced with the task of managing them, many executives find it difficult to set priorities.

Business value depends, according to the SVA analysis, on seven financial "**macro value drivers": sales growth, operating profit margin, incremental fixed capital investment, incremental working capital investment, cash tax rate, cost of capital (WACC), and value growth duration.** While these drivers are critical in determining the value of any business, they are too broad to be useful for many strategic and operating decisions. To be useful, managers must establish for each business the **"micro value drivers"** that influence the seven financial macro value drivers.

Our proposed model contains both, the seven financial macro value drivers as well as all the necessary micro value drivers that affect the macro drivers. **Figures 4 and 5** present the linkage between micro and macro value drivers.

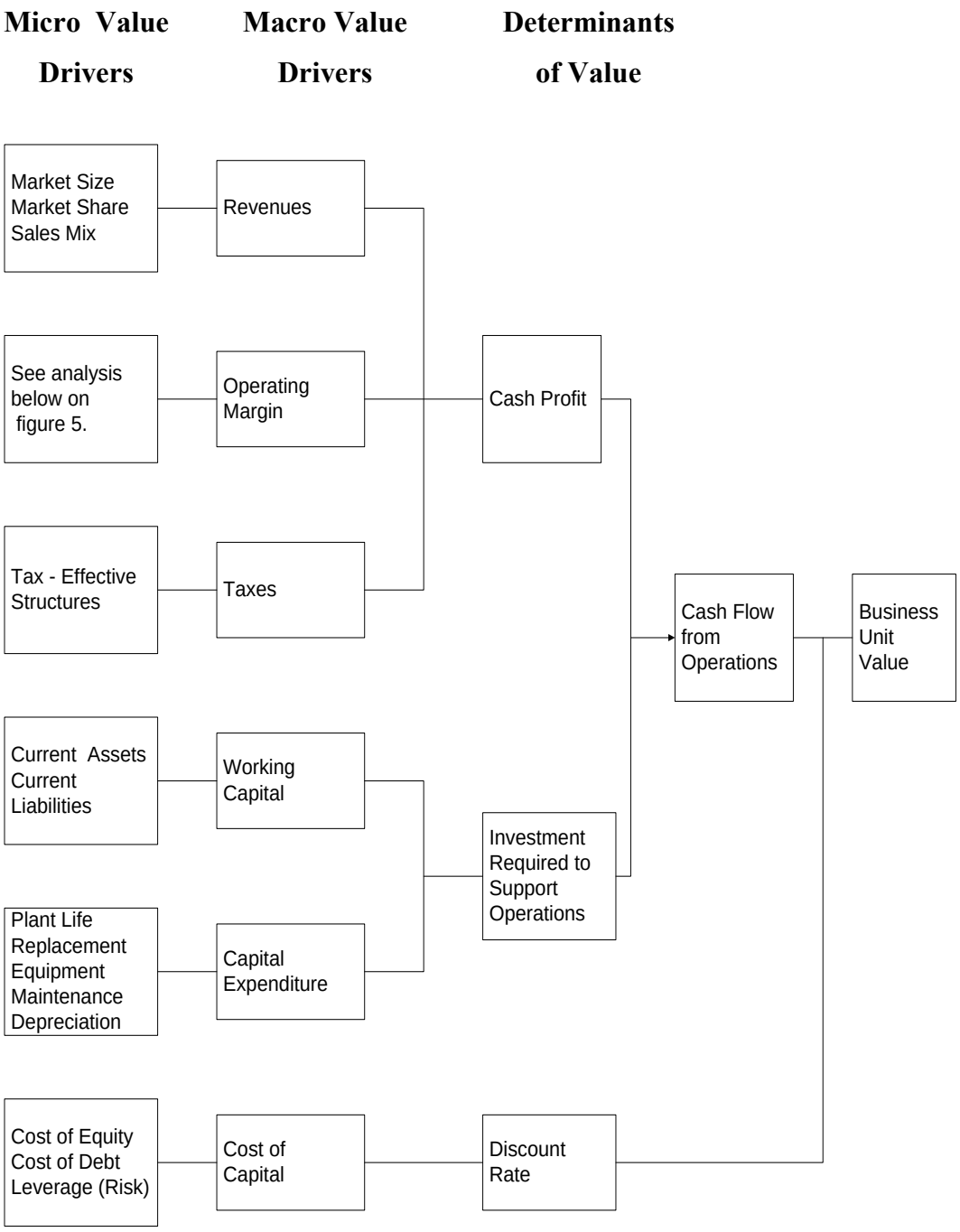

Figure 4: Micro and Macro Value Drivers

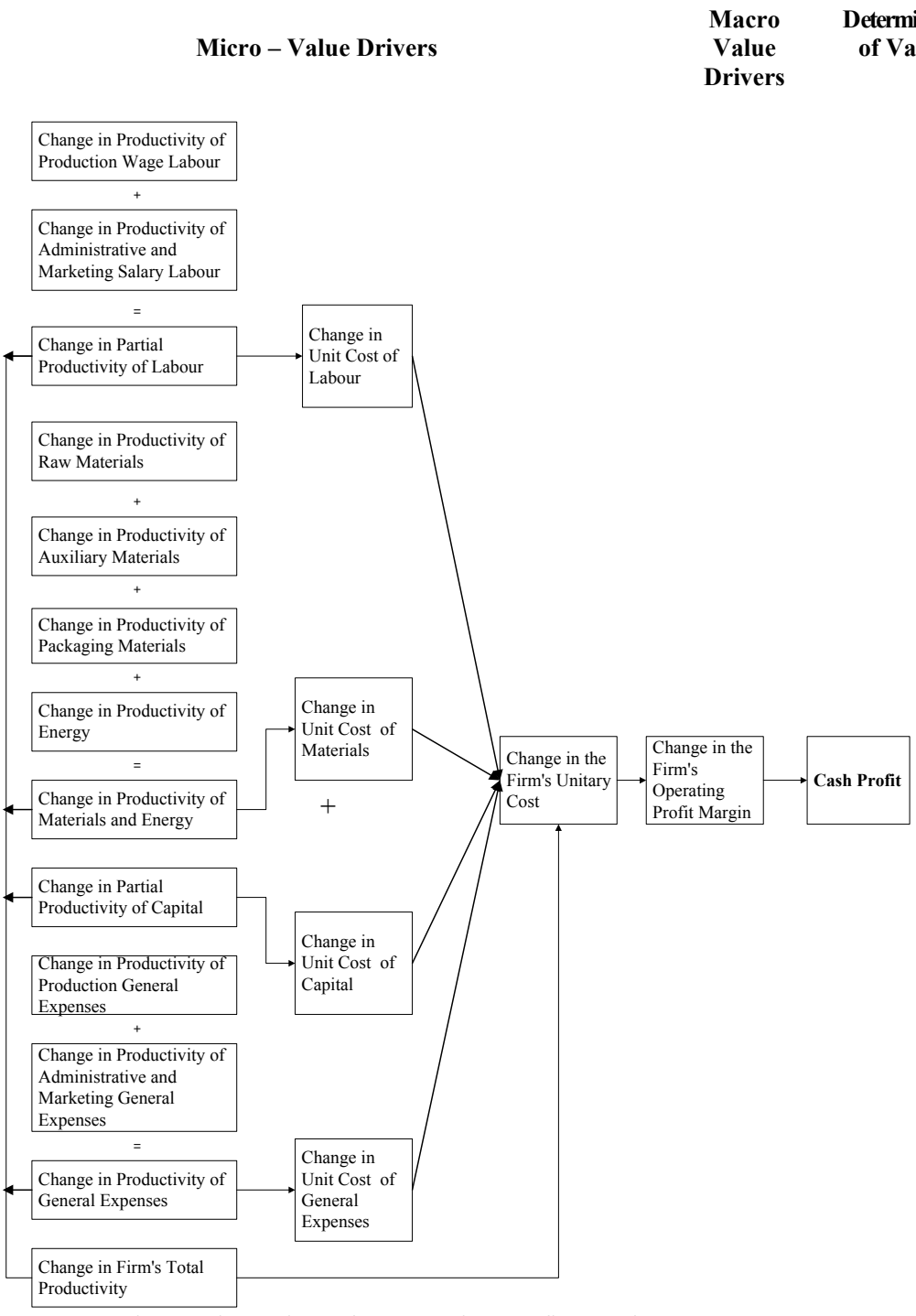

Figure 5 : Micro Value Drivers for Operating Profit Margins

4. The Construction of the Tool

On the basis of the proposed model, a tool has been constructed for analyzing the usefulness of the proposed model to the top management team of a selected case firm as far as the formation and evaluation process of alternative strategic options is concerned, as well as the performance measurement of the whole firm. This tool was made with Microsoft Excel and tested with actual data taken from the case firm, a cigarette manufacturer (Theriou, 2000).

The results of the tested firm were very promising for the following reasons:

1. They proved the relationship between productivity and long-term profitability (SVA) and how the first affects the second at the plant level:
   a) Changes in productivity, $\Delta\pi_t$, and input prices, Δq_t, are the only two determinants of the firm's changes in unit cost, k_t, because $\Delta k_t = \frac{\Delta q_t}{\Delta \pi_t}$.
   b) Changes in unit cost, Δk_t, which is also equal to changes in the firm's total cost, ΔK_t,, divided by the firm's production volume ΔV (i.e. $k_t = \frac{\Delta K_t}{\Delta V}$), is one of the three major determinants of the changes in the firm's average (unit) gross and net operating profit, $\frac{\Delta GP}{\Delta V}$, $\frac{\Delta GP}{\Delta S}$ and $\frac{\Delta NP_{bui}}{\Delta S}$ or $\frac{NP}{\Delta S}$. The other two major determinants are (a) the changes in the firm's sales average price, $\frac{\Delta S}{\Delta V}$, and (b) the changes in the firm's stock difference' cost or value (we assume that stock difference' cost, $K_{ST,}$ and stock difference value $D_{ST,}$ are equal: $K_{ST} = D_{ST}$). This explains the fact that sometimes companies can increase productivity but decrease their profitability, because the respective productivity increase is smaller than the corresponding increases in input prices or the corresponding sales price or /and sales volume or stock difference increases are smaller than the cost increases.
2. It has been shown how the proposed productivity measurement model can be connected to the Shareholder Value Added (SVA) model, through the determination of net operating profit (N_{bui}) or EBIT (earnings before interest and tax), divided by incremental sales, ΔS, ($p'_t = \frac{\Delta(NP_{bui})}{\Delta S}$).

   The other two determinants of SVA is the weighted average cost of capital (WACC) and the threshold operating profit margin, $p'_{t.min}$.
3. They proved the usefulness of the tool to managers of the case firm, because:
   a) The proposed tool is very suitable for evaluating future alternative strategies by predicting accurately the resulted effect of each strategic option to the firm's shareholder value added. The tool can provide explicit predictions as to how the system (the firm) is likely to behave in the future under given conditions. Three major methods of analysis may be used for the purpose of its predictive use: the

method of sensitivity analysis, the method of deterministic appraisal (use of different scenarios), and the method of risk simulation.

b) It could also help executives, in the strategy formation and formulation process, through their better understanding of the micro and macro value drivers' movements. Furthermore, the better understanding of value drivers would give management a deeper insight about the company's core competencies and capabilities and their future maintenance or sustainability.
c) It could be adopted as a powerful tool for the performance measurement and improvement system of any manufacturing firm at the firm level, and
d) It could be used for the evaluation of proposed investment that lead to both productivity and profitability increases.

4.1. Testing of the Model With the use of Neural Networks (NN).

In our proposed anticipatory model we have used mathematical equations for the estimation of the future results of the case firm. We also tried to test the anticipatory power of this model with the use of two neural network software packages (SNNS and Braincel). For this purpose we constructed two neural networks. One for the estimation (prediction) of the total productivity and the other for the estimation of profitability (shareholder value added – SVA) of the case firm. The first neural network consisted of 53 inputs (the quantities and prices of all factors of production and all final products produced), one hidden layer and one output (the actual total productivity results of the firm). The second network consisted of eight inputs (EBIT, total sales value, new investments, depreciation, current assets and liabilities, income tax rate, and weighted average cost of capital), one hidden layer and one output (the actual SVA results of the firm). Both networks were fed with two sets of financial data concerning the actual inputs and outputs of the firm: The first set was used for the training of the networks and included the years 1985-1994 (ten patterns). The second set was used for the testing of the networks and included the remaining years 1995-1996 (two patterns). The predicted results of the first network, for the two years 1995-1996, were very promising with an accuracy of around 95% :

Table 1: Comparison of actual results of the firm with those predicted by the NN.

Years	Actual Results of the firm	Predicted results (53x25x1)	Predicted results (53x40x1)	Predicted results (53x35x1)
1995:	**0.832**	0.876	**0.874**	**0.871**
1996:	**0.725**	0.763	**0.730**	**0.717**

However, the results of the second network were totally inaccurate. This is probably due to the following reasons:

- Very few patterns for the training of the network. This was the reason given by one of the used software packages, named Braincel, which stated that the patterns for the training of the network, taking into consideration the number of inputs and outputs,

should be around fifty. This could be correct, because when we included the same patterns (years 1985-1994) twice in the training of the network, the forecasted results changed dramatically and the forecasted **trend** of the firm's profitability from 1995 to 1996 was in the right direction.

- Not very good preprocessing and normalization of the data, due to many negative numbers of the most variables, inputs and output (e.g. EBIT, working capital changes, interest rate and tax rate changes, and SVA changes), as well as to the limited period of time of the two researchers (we devoted about seventy working hours for the preprocessing and normalization of the data of the second network).

5. Conclusion

This study developed and tested an anticipatory model of productivity-profitability changes at the firm level. By tracing the pattern of events over a period of time and by recording the level of various performance criteria (productivity and SVA), managers, through the use of the proposed tool, could link these criteria with all variables (controllable and uncontrollable) in the system (the firm), so that conclusions can be drawn about the effectiveness or otherwise of past managerial decisions. It is on the basis of an adequate understanding of past behaviour that managers can then attempt to make predictions about the future and about the possible consequences of certain alternative actions (strategies) that may be taken. In this way the model is quite appropriate for the formulation and evaluation of the past or future strategies to be made. In the context of managerial control of an enterprise, the proposed productivity-profitability model and its analytic power allows measures of performance to be ascertained and cost and profitability relationships to be understood, so as to lead to the improvement of both criteria of productivity and profitability (SVA). Having constructed the model, based on historical data to explain past behaviour of the system and its performance criteria, management could turn to the predictive use of the model, and pose questions about the expected response of the system to certain changes that may occur. The model may help to give indications, or to provide explicit predictions, as to how the system is likely to behave in the future under given conditions.

Finally, the model gives the companies the capacity for "strategic learning and feedback" : with the proposed framework at the center of its management system, a company can monitor short term results of productivity and profitability movements (and its corresponding micro and macro value drivers movements) and evaluate strategy in the light of recent performance. They could determine which actions will drive them toward their targets, identify the measures they will apply to those drivers and establish the short run milestones that will mark their progress along the strategic paths they have selected. By helping to define the key "value drivers" of shareholders value added growth and by committing to targets for each of them, the division' s managers eventually will become comfortable with the BOD or CEO' s goals. In this way the gap between strategy development and implementation closes.

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