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An Analytical Approach for Making Management Decisions Concerning Corporate Restructuring

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Internal corporate restructuring activities, such as downsizing, sale or termination of a business line, facility closure, consolidation, or relocation, often occur as part of managerial strategies intended to improve efficiency, control costs, and adapt to an ever-changing business environment. Such actions frequently result in fundamental changes in a business's organization, its strategies, its systems, and its operations. They can unsettle a business and often significantly affect current and future earnings and cash flows. In this paper we propose a novel decision-making model through the use of the dynamic programming technique to illustrate how management can determine the optimal timing and appropriate restructuring actions that maximize the benefits of a restructuring program. Copyright © 2006 John Wiley & Sons, Ltd.

INTRODUCTION

Restructuring has become increasingly common during the past decade. In order to adjust to the ever-changing business environment, restructuring is one option that may improve company performance. Restructuring plans take many forms, such as exiting a line of business, closing, consolidating or relocating a facility; though can be a broad company-wide reorganization that impinges upon the nature and focus of operations. Restructuring plans present a great challenge to companies. Difficult decisions must be made concerning appropriate workforce size and skill requirements, plant capacity and location, and possible production focus shifts. These decisions affect business strategies, operations, organizational functions and existing management structures.

On the accounting side, restructuring activities may be costly, and significantly affect company earnings, cash flows and future economic performance. Short-term earnings are likely to fall. Since the estimation of restructuring charge and the timing of its recognition are somewhat subjective, it is possible for managers to manipulate a restructuring charge schedule to show a better overall earnings picture (e.g. Francis *et al.*, 1996; Moehrle, 2002). Therefore, the timing, measurement and disclosure practices of such charges are emerging as important and sometimes controversial areas in accounting practice. This has drawn the attention of regulatory bodies, investment communities and academic researchers.

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Prior studies on this topic have focused on examining the characteristics of firms that undertake restructuring activities (e.g. John *et al.*, 1992; Berger and Ofek, 1995), the causes of restructuring initiatives (e.g. Bethel and Liebeskind, 1993; Gibbs, 1993; Berger and Ofek, 1999), and the wealth and performance effects of restructuring events (e.g. Brickley and Van Drunen, 1990; Chaney *et al.*, 2000; Kross *et al.*, 2000; Poon *et al.* 2001). Few studies have built on these insights to the point of developing and discussing robust restructuring strategies. For example, when is the *right* time to reorganize the company? What is the goal of the restructuring? What specific activities should be in the restructuring plan? How much time will it take to implement the restructuring program? Will it be a one-time event, or a multi-stage program? In this study, we will explore these strategy-related questions analytically, from the perspective of managers and decision makers. We present a decision-making model and apply dynamic programming skills to conceptually illustrate how to implement an effective restructuring plan that maximizes the probability of achieving management goals.

To address the topic systematically, the subsequent sections are organized to logically develop this model and discuss its use. The next two sections examine the key business forces, which underlie restructuring decisions, as found in the existing literature. In these two sections, we identify the relevant variables that may apply to the decision-making process during the planning and implementation stages of a restructuring plan, including state variables that provide fundamental information for managerial decision-making, as well as decision variables that characterize alternatives. We follow up with a section that presents primary objectives of restructuring and measures of restructuring effects. Penultimate section formulates a quantitative decision-making model of the overall process, including necessary variables and parameters. Finally, the future research directions are outlined in the last section.

THE CHARACTERIZATION OF STATE VARIABLES

Among factors that may influence a restructuring decision, agency conflicts play an important role. The agency theory states that mangers have incentives to expand firms beyond the optimal size to maximize their own utility, even when growth and diversification are not in the best interest of shareholders (e.g. Jensen, 1986; Jensen and Murphy, 1990; Lang and Stulz, 1994; Berger and Ofek, 1995). Denis *et al.* (1997) and Berger and Ofek (1999) find that corporate control events, such as management turnover, outside shareholder pressure, changes in a management compensation plan, or financial distress, frequently precede corporate refocusing programs. This suggests that frequently, restructurings are taking place to reduce those agency conflicts. Empirical findings show that restructurings are often initiated to correct past inefficient expansion and diversification executed under either internal or external pressures. Several studies (e.g. Bethel and Liebeskind, 1993; Gibbs, 1993; Kang and Shivdasani, 1997) present evidence that corporate restructurings are likely to be triggered by the presence of free cash flow, limited investment opportunities, weak governance structure, and takeover threats[1]. Therefore, these factors are indicators of agency conflicts and should be included as relevant state variables.

Another important factor that influences the decision to restructure is the company's operating performance. Although restructuring can be involuntarily driven by external forces, to reduce agency conflicts, often it is undertaken voluntarily, to deal with poor performance. Restructurings became a more common response to poor operating performance when the frequency of corporate takeover activities fell considerably during the early 1990s (Kang and Shivdasani, 1997; Denis and Kruse, 2000). Therefore, operating performance prior to a restructuring is also an important state variable that will influence managers' decisions.

A change in business environment is another factor that can affect management's restructuring strategies. Restructuring may occur as a response to major changes in the business climate and/or surroundings, such as technological or product innovations, changes in tax laws, deregulations, and/or foreign competition. Those changes may be only specific to one industry, but can be economy-wide. Another environmental factor is the 'bandwagon' effect, which refers to managers' tendency to mimic the actions of other managers (e.g. Bethel and Liebeskind, 1993). In addition,

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excess capacity within an industry can force firms to exit particular activities (e.g. Jensen, 1993). Excess capacity may be caused by oversupply, demand reduction, or technological changes. Therefore, prominent changes in the business environment should be included as a state variable in our analysis as well.

THE CHARACTERIZATION OF RESTRUCTURING DECISION-MARKING PROCESS

When management is considering restructuring as an option to enhance a firm's efficiency, profitability, and competitiveness, certain questions are typically asked. When will be the right time to embark on a restructuring? Will it be a one-time shot, or be followed by subsequent restructuring(s)? What specific corporate problems or challenges will be addressed by restructuring activities?

Timing

As discussed earlier, the decision to restructure can be driven by many factors, and is often a tough one to make. Ideally, managers should anticipate a crisis and act preemptively, before being overtaken by the event. Prior studies show that greater value can be created when a restructuring is done preemptively rather than under the threat of financial distress or hostile takeover (e.g. Donaldson, 1994; Gilson, 2001). However, it is often quite difficult to persuade corporate stakeholders to restructure at an *early* stage, in the absence of a serious crisis. The negative effect of a restructuring charge on the firm's operating income also affects the timing decision. Moreover, managers may be reluctant to admit past mistakes, and choose not to restructure (e.g. Boot, 1992). Another factor is that labor laws and union rules make it costly for firms to lay off employees. Finally, organizational restructuring might be hard to implement if employees resist the change. These barriers show the need to develop a rational decision model that determines the optimal timing for implementing a restructuring plan.

Restructuring Frequency and Activities

Additional restructuring activities may take place as part of a multi-phase restructuring plan, as firms continue to address pressing financial and operational problems, or as new crises/opportunities emerge. Atiase *et al.* (2004) find that firms with multiple restructurings are more likely to improve their earnings and cash flows in the post-restructuring period, which suggests there is a link between restructuring frequency and a change in future operating performance. However, repetitive restructuring charges may have negative implications, especially across a short horizon. The findings of Adut *et al.* (2003) show that compensation committees consider recurring restructuring activities within a short time frame as less deserving, and so do not completely shield CEO cash compensation from the adverse effect of subsequent restructuring charges on earnings. These empirical findings therefore show that the determination of optimal restructuring frequency is essential to managerial decision-making.

Restructuring activities typically include, but are not limited to, the following: workforce reduction, downsizing, asset sales, closures or consolidation of facilities, business relocation, eliminating unprofitable operations, changes in management structure, or fundamental reorganizations that affect the nature and focus of operations. Different restructuring activities can have a sequence of interacting intermediate and long-term effects, which in turn may yield a mixed outcome. For example, a system upgrade, use of advanced technology, or the streamlining of operations can cause reduction of personnel and improve worker productivity, but lower employee morale. Financially, workforce reduction entails short-term cash outlay for severance and other costs of employee termination benefits, but helps to limit personnel expenditure in future years. In addition, previous studies present evidence that asset divestitures or refocusing programs are value-increasing because they eliminate negative impact of the divested asset on the remaining assets (e.g. Comment and Jarrell, 1995; John and Ofek, 1995). However, plant closings are generally viewed negatively by the markets (Blackwell *et al.*, 1990), especially for financially weak firms (Gombola and Tsetsekos, 1992). The ultimate effect of a set of restructuring activities depends on whether the benefits brought by the synergized activities outweigh the costs incurred.

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THE OBJECTIVES OF CORPORATE RESTRUCTURINGS AND THEIR EFFECTS

Corporate restructurings can aspire to a variety of goals, such as making the firm more cost competitive, abandoning a flawed corporate strategy, exiting negative cash flow segments, and/or increasing the firm's market value. The impact of a restructuring can be measured by changes in a firm's stock market performance during the post-restructuring period. The restructuring is often an ongoing dynamic process. Investors will continually revise their expectations about the effect of restructuring on a firm's value and future profitability as they receive new information. The firm's long-term stock performance, after the market and industry adjustment, will show if shareholders' wealth has been enhanced by the restructuring efforts.

Changes in operating performance during the period following a restructuring provide another perspective to assess the long-term impact of a restructuring plan. Several studies examine this issue and find that restructurings do not lead to significant improvements in future operating performance in three to five years immediately following the restructurings (e.g. Brickley and Van Drunen, 1990; Lopez *et al.*, 2001). The insignificant results can be caused by mixing 'good' restructurings with 'bad' ones, thus averaging out the effects of restructurings. Atiase *et al.* (2004) revisit this issue and show that post-restructuring performance changes are positive for firms with losses. They argue that it is because 'firms with losses in the restructuring year may face a more difficult operating environment than firms with gains, and may therefore be more likely than firms with gains to use restructuring to address operating weakness. (pp. 508–509)' Denis and Kruse (2000) and Kang and Shivdasani (1997) present similar findings, that firms which restructured after they had a substantial performance decline improved their operating performance substantially in the three years following the restructuring.

MODEL DEVELOPMENT

When restructuring is considered, the first question might be, 'Is it workable?' As discussed in the previous section, the answer may depend on many factors, and is not always a clear-cut 'yes' or 'no'. Accordingly, a more complex, yet more pragmatic, question arises, 'When and how should restructuring take place?' Clearly, this answer will depend strongly upon the specifics of each case and the information utilized by decision-makers. An analytical model is presented here which describes the process of decision-making in regard to restructuring activities. In the model, it is assumed that a company can control the form and timing of restructuring. In addition, restructuring charges are assumed to properly reflect the actual restructuring costs (so here, we do not consider the use of accounting to manipulate restructuring charges in order to meet a certain earnings goal).

Elements and notation of the model

One of management's major responsibilities is planning, which is to establish enterprise-wide objectives and propose ways of accomplishing them within a specified time frame. Within the context of restructuring, managers seek a strategy to determine the best timing, and detail the steps, so that the plan may be accomplished within the given window. For the purpose of our analytical model, the maximal likelihood of achieving a successful post-restructuring performance (relative to corporate targets) within this time window is clearly an objective that is consistent with most managers' primary business goals.

As mentioned in the second section, state variables represent factors or information used by managers in their decision-making process. For each period, these variables also provide information on how likely it is that the goal can be achieved in the future. Values of the state variables may probabilistically change over time. This uncertainty can be described using transition probabilities between the states in different periods. Therefore, within each period, managers will review current operating and financial states, and estimate how business conditions will evolve, to determine the best business plan on a rolling basis. Take Eastman Kodak as an example. This company has been adversely impacted by not adapting itself fast enough into the digital imaging market, which took over the traditional film imaging business at an unexpectedly explosive rate. Kodak has undergone a series of restructuring programs since 1992 to reposition itself in the photographic equipment and supplies industry

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and to realign its worldwide operations towards its 'digitally oriented growth strategy'. Below is an excerpt from the management discussion in this company's 2004 annual report, which discusses its 2004–2006 restructuring program.

> 'Currently, the Company is being adversely impacted by the progressing digital substitution. As the Company continues to adjust its operating model in light of changing business conditions, it is probable that ongoing cost reduction activities will be required from time to time. In accordance with this, the Company periodically announces planned restructuring programs, which often consist of a number of restructuring initiatives.' (Eastman Kodak 2004 10-K)

This indicates that ongoing decision-making to ensure a safe transition through changing business conditions plays a crucial role in restructuring planning. The transition probability may be one essential element to model the changes in business conditions. In practice, these probabilities can be estimated by the analysis of historical data, expected changes in business conditions, managers' experience, or other appropriate means. They will be assumed within our decision model, because the actual estimation is on a case-by-case basis and requires inside information.To start, we divide the time window into N periods. In each period, management decides whether or not restructuring should be taken. The following notation is used to associate the restructuring decision process described above with analytical modeling:

$\mathbf{x}_k$ = the set of state variables for period k ($k = 1, 2, \ldots, N$),

a_j = the numerical variable representing the restructuring activities in period j ('$*$' is used when a_j cannot be specified, that is, no restructuring takes place in period j),

$\bar{P}(\mathbf{x}_k)$ = the probability that, given $\mathbf{x}_k$ for period k, the company reaches its target by the end of period k.

In addition, since a restructuring event generally will have an effect on both the current period as well as several subsequent periods, we assume that the expected number of these periods is t. That is, previous restructuring decisions made within last $t-1$ periods, $a_{k-t+1}, a_{k-t+2}, \ldots, a_{k-1}$ will affect the determination of a_k for the current period k, and these decisions $(a_{k-t+1}, a_{k-t+2}, \ldots, a_k)$ will impact the state transition from $\mathbf{x}_k$ to $\mathbf{x}_{k+1}$. Thus, we define

$P_{k,k+1}(\mathbf{x}_{k+1}|\mathbf{x}_k, a_{k-t+1}, a_{k-t+2}, \ldots, a_k)$ = the probability that $\mathbf{x}_k$ transits to $\mathbf{x}_{k+1}$, given the previous restructuring activities that occurred in previous $t-1$ periods and the activity in the current period.

This addresses the transition probability between the current state for period k and next state for period $k+1$, which depends on the activities $a_{k-t+1}, a_{k-t+2}, \ldots, a_k$ conducted in the previous periods. This also implies that a_{k-t+1} in period $k-t+1$ has influence on the following t state transitions: $\mathbf{x}_{k-t+1} \rightarrow \mathbf{x}_{k-t+2}$, $\mathbf{x}_{k-t+2} \rightarrow \mathbf{x}_{k-t+3}, \ldots,$ and $\mathbf{x}_{\mathrm{k}} \rightarrow \mathbf{x}_{k+1}$.

A Decision Model

Recall that, given the future N periods, managers develop (or revise if needed) a restructuring plan from period to period (or over time). Consider one particular period. The plan should be able to show the optimal decision for this period, given all relevant factors. In addition, this plan should address possible conditions for the future periods and show the decisions in response to them. The probabilities associated with the changes between current and future conditions might need to be re-estimated within each period to continuously provide managers with updated information for decision-making, and to further align operations with management goals. The purpose is to maximize the probability of successfully reaching the company's target(s) by the end of N periods. Here we use an indicator variable, I_k, which equals 1 if the target has been achieved (i.e. a success) in periods 1, 2,..., $k-1$, and zero otherwise. When determining a_k in period k, the current state ($\mathbf{x}_k$), whether or not success has been achieved (I_k), and the prior restructuring activities $(a_{k-t+1}, a_{k-t+2}, \ldots, a_{k-1})$ that may have influence on the present period, are the relevant information for decision-making. We define $V_k(\mathbf{x}_k, I_k, a_{k-t+1}, a_{k-t+2}, \ldots, a_{k-1})$ = the maximal probability that, given the information of $\mathbf{x}_k, I_k, a_{k-t+1}, a_{k-t+2}, \ldots$ and a_{k-1} in period k, the company will have success some time by the end of N periods.

Clearly, in period k, if the management determines that the target has been reached ($I_k = 1$), the probability that we have success by the end of N periods is one, because it has already occurred.

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That is,

$$V_k(\mathbf{x}_k, 1, a_{k-t+1}, a_{k-t+2}, \ldots, a_{k-1}) = 1$$

for any $\mathbf{x}_k, a_{k-t}, a_{k-t+1}, \ldots,$ and a_{k-1}.

In this case, it is clear that restructuring would not need to be considered ($a_k = *$). If the target has not been reached ($I_k = 0$), we have two options: no restructuring, or determining restructuring activities a_k. However, for each decision, we need to consider all possible state transitions and the likelihood of achieving the objective for each transition. Then, the probabilities of obtaining a success for each decision are calculated, and the best decision will create the greatest chance for the company to reach its corporate target. The above concept can be addressed mathematically according to the principle of optimality as follows. If we choose no restructuring in the current period, $V_k \times (\mathbf{x}_k, 0, a_{k-t+1}, a_{k-t+2}, \ldots, a_{k-1})$ will be

$$\begin{aligned}
&\sum_{\mathbf{x}_{k+1}} P_{k,k+1}(\mathbf{x}_{k+1}|\mathbf{x}_k, a_{k-t+1}, a_{k-t+2}, \ldots, *) \\
&\quad \times (1 - \bar{P}(\mathbf{x}_{k+1})) \\
&\quad \times V_{k+1}(\mathbf{x}_{k+1}, 0, a_{k-t+2}, a_{k-t+3}, \ldots, *) \\
&\quad + \sum_{\mathbf{x}_{k+1}} P_{k,k+1}(\mathbf{x}_{k+1}|\mathbf{x}_k, a_{k-t+1}, a_{k-t+2}, \ldots, *) \\
&\quad \times \bar{P}(\mathbf{x}_{k+1}) \times V_{k+1}(\mathbf{x}_{k+1}, 1, a_{k-t+2}, a_{k-t+3}, \ldots, *) \\
&= \sum_{\mathbf{x}_{k+1}} P_{k,k+1}(\mathbf{x}_{k+1}|\mathbf{x}_k, a_{k-t+1}, a_{k-t+2}, \ldots, *) \\
&\quad \times (1 - \bar{P}(\mathbf{x}_{k+1})) \\
&\quad \times V_{k+1}(\mathbf{x}_{k+1}, 0, a_{k-t+2}, a_{k-t+3}, \ldots, *) \\
&\quad + \sum_{\mathbf{x}_{k+1}} P_{k,k+1}(\mathbf{x}_{k+1}|\mathbf{x}_k, a_{k-t+1}, a_{k-t+2}, \ldots, *) \\
&\quad \times \bar{P}(\mathbf{x}_{k+1})
\end{aligned}$$

or if restructuring is adopted, we need to decide the appropriate restructuring activities a_k. Thus, $V_k(\mathbf{x}_k, 0, a_{k-t+1}, a_{k-t+2}, \ldots, a_{k-1})$ will be

$$\max_{a_k} \left\{ \begin{array}{l}
\sum\limits_{\mathbf{x}_{k+1}} P_{k,k+1}(\mathbf{x}_{k+1}|\mathbf{x}_k, a_{k-t+1}, a_{k-t+2}, \ldots, a_k) \\
\quad \times (1 - \bar{P}(\mathbf{x}_{k+1})) \\
\quad \times V_{k+1}(\mathbf{x}_{k+1}, 0, a_{k-t+2}, a_{k-t+3}, \ldots, a_k) \\
\quad + \sum\limits_{\mathbf{x}_{k+1}} P_{k,k+1}(\mathbf{x}_{k+1}|\mathbf{x}_k, a_{k-t+1}, a_{k-t+2}, \ldots, a_k) \\
\quad \times \bar{P}(\mathbf{x}_{k+1}) \\
\quad \times V_{k+1}(\mathbf{x}_{k+1}, 1, a_{k-t+2}, a_{k-t+3}, \ldots, a_k)
\end{array} \right\}$$

$$= \max_{a_k} \left\{ \begin{array}{l}
\sum\limits_{\mathbf{x}_{k+1}} P_{k,k+1}(\mathbf{x}_{k+1}|\mathbf{x}_k, a_{k-t+1}, a_{k-t+2}, \ldots, a_k) \\
\quad \times (1 - \bar{P}(\mathbf{x}_{k+1})) \\
\quad \times V_{k+1}(\mathbf{x}_{k+1}, 0, a_{k-t+2}, a_{k-t+3}, \ldots, a_k) \\
\quad + \sum\limits_{\mathbf{x}_{k+1}} P_{k,k+1}(\mathbf{x}_{k+1}|\mathbf{x}_k, a_{k-t+1}, a_{k-t+2}, \ldots, a_k) \\
\quad \times \bar{P}(\mathbf{x}_{k+1}).
\end{array} \right\}$$

Therefore,

$$\begin{aligned}
&V_k(\mathbf{x}_k, 0, a_{k-t}, a_{k-t+1}, \ldots, a_{k-1}) \\
&= \max \left\{ \begin{array}{l}
\sum\limits_{\mathbf{x}_{k+1}} P_{k,k+1}(\mathbf{x}_{k+1}|\mathbf{x}_k, a_{k-t+1}, a_{k-t+2}, \ldots, *) \\
\quad \times (1 - \bar{P}(\mathbf{x}_{k+1})) \\
\quad \times V_{k+1}(\mathbf{x}_{k+1}, 0, a_{k-t+2}, a_{k-t+3}, \ldots, *) \\
\quad + \sum\limits_{\mathbf{x}_{k+1}} P_{k,k+1}(\mathbf{x}_{k+1}|\mathbf{x}_k, a_{k-t+1}, a_{k-t+2}, \ldots, *) \\
\quad \times \bar{P}(\mathbf{x}_{k+1}) \\
\max\limits_{a_k} \left\{ \begin{array}{l}
\sum\limits_{\mathbf{x}_{k+1}} P_{k,k+1}(\mathbf{x}_{k+1}|\mathbf{x}_k, \\
\quad a_{k-t+1}, a_{k-t+2}, \ldots, a_k) \\
\quad \times (1 - \bar{P}(\mathbf{x}_{k+1})) \\
\quad \times V_{k+1}(\mathbf{x}_{k+1}, 0, a_{k-t+2}, \\
\quad\quad a_{k-t+3}, \ldots, a_k) \\
\quad + \sum\limits_{\mathbf{x}_{k+1}} P_{k,k+1}(\mathbf{x}_{k+1}|\mathbf{x}_k, \\
\quad a_{k-t+1}, a_{k-t+2}, \ldots, a_k) \\
\quad \times \bar{P}(\mathbf{x}_{k+1}).
\end{array} \right\}
\end{array} \right\}
\end{aligned}$$

The decision for period k is the option (if success has not been achieved) that provide $V_k \times (\mathbf{x}_k, 0, a_{k-t+1}, a_{k-t+2}, \ldots, a_{k-1})$.

The above recursive formulation finds the optimal solution for period k through backward calculations from the end of period N. The boundary condition for the above recursive formulation is

$$V_{N+1}(\mathbf{x}_{N+1}, 1, a_{N-t+2}, a_{N-t+3}, \ldots, a_N) = 1,$$
$$V_{N+1}(\mathbf{x}_{N+1}, 0, a_{N-t+2}, a_{N-t+3}, \ldots, a_N) = 0.$$

The above second equation states that, in the end of N periods, if the performance target has not been reached ($I_{N+1} = 0$), it is impossible for the managers' goal (having success within the N-period time window) to be attained. Thus, the maximal probability of having success within the future N periods $V_1(\mathbf{x}_1, 0, a_{2-t}, a_{3-t}, \ldots, a_0)$ ($k = 1$), where $a_{2-t}, \ldots$, and a_0 stand for the restructuring activities that have been taking place prior to the planning time window, and the corresponding restructuring decision for the present time can be solved by the above recursive equation. Note that, at the beginning of period

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one, a_{2-t}, a_{1-t},... and a_0 should be known, and $\bar{P}(\mathbf{x}_k)$ and $P_{k,k+1}(\mathbf{x}_{k+1}|\mathbf{x}_k, a_{k-t+1}, a_{k-t+2}, \ldots, a_k)$ for $k = 1, \ldots, N$ and each $\mathbf{x}_k$ and $\mathbf{x}_{k+1}$ need to be estimated. Furthermore, the appropriate decisions in the future and the corresponding maximal probabilities of reaching the target by the end of N periods (i.e. $V_k(\mathbf{x}_k, 0, a_{k-t+1}, a_{k-t+2}, \ldots, a_{k-1})$ for $k = 2, \ldots, N$) may be obtained as well by the recursive equation. Since we cannot know what the future states will be, the model calculates these maximal probabilities for each one of all possible future state conditions. Coupled with the possible transitions from the current state, these probabilities are used to determine the current optimal restructuring decision so that the probability of achieving the objective is maximized at the present time.

The proposed method provides managers with a rational tool for making the best restructuring decision. Within each period, we may re-define the length of the future horizon that is being planned, letting current period be period one, and then re-estimate all the relevant probabilities (e.g. $P_{k,k+1} \times (\mathbf{x}_{k+1}|\mathbf{x}_k, a_{k-t+1}, a_{k-t+2}, \ldots, a_k)$ and $\bar{P}(\mathbf{x}_k)$ for all k) to take into account the factor of evolution over time. Then, using the information of the current state variables and previous restructuring events, we can apply this method, along with the boundary condition, to find the best restructuring decision for the current period, if the corporate objective has yet to be achieved.

An Numerical Example

A simple example is presented here which illustrates the use of the analytical technique outlined above for restructuring decision-making. Suppose that, in year 1, a company considers conducting restructuring activities in the next three years so as to achieve the goal of 20% growth in return on equity (ROE) (i.e. success) by the end of the fourth year ($N + 1 = 4$). The management seeks to determine when and how restructuring(s) should be taken within next three years, if needed. Assume that this is the first time in its history the firm has considered restructuring (or, any prior restructuring activities are too remote to have any tangible effects on the operating performance in the starting period). Management considers the profitability of its business (in a profit or loss position, coded as 1 or 0) as the state of the company (in a more generalized case, the state can be defined as a set of variables or factors such as those discussed in the second section). In addition, downsizing (e.g. personnel reduction and facility closures) and change in management structure are considered to be two alternative restructuring activities (denoted by $a_k = 1$ and 0, respectively, for $k = 1, 2, 3$). It is estimated that 70% of 'profit' firms may achieve 20% growth of *ROE* in one year ($\bar{P}(1) = 0.70$ for $k = 1, 2, 3$), whereas only 5% of 'loss' firms can get to this goal ($\bar{P}(0) = 0.05$ for $k = 1, 2, 3$). Furthermore, assume that a particular restructuring event has a *significant* impact on the firm's operating performance only up to two years after the restructuring (i.e. $t = 2$), because its effect is likely to be attenuated by other events in a longer term. We make this assumption to keep the illustration straightforward, even though a particular restructuring event may have an impact beyond two years (as prior studies have shown). Here, $t = 2$ implies that the transition probabilities from the state $\mathbf{x}_k$ to the future state $\mathbf{x}_{k+1}$ between period k and $k+1$ will depend on the restructuring activities in periods k and k-1 (a_k and a_{k-1}). Additionally, we assume this company is operating in a stable business environment, where the transition probabilities between two given states of any two consecutive periods are assumed to be constant for the future three periods. That is, $P_{k,k+1}(\mathbf{x}_{k+1}|\mathbf{x}_k, a_{k-1}, a_k)$ for $k = 1, 2, 3$ are the same, if ($\mathbf{x}_{k+1}$, $\mathbf{x}_k$, a_{k-1}, a_k) are the same for $k = 1, 2, 3$. The simplifications made above will not affect the technical validity of the proposed model. Assume that the management estimates the following $P_{k,k+1}(\mathbf{x}_{k+1}|\mathbf{x}_k, a_{k-1}, a_k)$, as shown in tables (or probability matrix) below, which applies for $k = 1, 2, 3$:

	$\mathbf{x}_{k+1}$		$\mathbf{x}_{k+1}$		$\mathbf{x}_{k+1}$	
$\mathbf{x}_k$	1	0	1	0	1	0
1	0.70	0.30	0.60	0.40	0.50	0.50
0	0.20	0.80	0.10	0.90	0.10	0.90
	$(a_{k-1}, a_k) = (*, *)$		$(a_{k-1}, a_k) = (*, 0)$		$(a_{k-1}, a_k) = (*, 1)$	

	$\mathbf{x}_{k+1}$		$\mathbf{x}_{k+1}$		$\mathbf{x}_{k+1}$	
$\mathbf{x}_k$	1	0	1	0	1	0
1	0.75	0.25	0.60	0.40	0.70	0.30
0	0.30	0.70	0.20	0.80	0.10	0.90
	$(a_{k-1}, a_k) = (0, *)$		$(a_{k-1}, a_k) = (0, 0)$		$(a_{k-1}, a_k) = (0, 1)$	

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	$\mathbf{x}_{k+1}$		$\mathbf{x}_{k+1}$		$\mathbf{x}_{k+1}$	
$\mathbf{x}_k$	1	0	1	0	1	0
1	0.75	0.25	0.80	0.20	0.70	0.30
0	0.30	0.70	0.20	0.80	0.35	0.65
	$(a_{k-1}, a_k) = (1, *)$		$(a_{k-1}, a_k) = (1, 0)$		$(a_{k-1}, a_k) = (1, 1)$	

The tables show that, for example, if the state of the firm is currently 'profit' and it has not done restructuring in both last year and this year, the probability that this firm will stay profitable next year is 0.70. If the state of the firm is currently 'loss' and it did not restructure last year but did 'downsizing' this year, the probability that the state of this firm will change to 'profit' next year is 0.10.

Now, we may use the recursive formulation to develop the restructuring strategy for the next three years to maximize the probability of success. For year $k = N + 1 = 4$, we have

$$V_4(\mathbf{x}_4, 1, a_3) = 1,$$
$$V_4(\mathbf{x}_4, 0, a_3) = 0.$$

for $\mathbf{x}_4 = 0$ and 1, and $a_3 = *$, 0 and 1. This above states that, the probability of success is one if the target of *ROE* growth has been achieved within four years ($I_4 = 1$). On the other hand, by our definition the probability of management achieving its goal is zero if the *ROE* growth has not been attained by the end of next three years ($I_4 = 0$). In this case, no decision needs to be made since year 4 is out of the planning window (years 1, 2 and 3).

For $k = 3$, since $V_4(\mathbf{x}_4, 1, a_3) = 1$ and $V_4(\mathbf{x}_4, 0, a_3) = 0$ hold for $\mathbf{x}_4 = 0$ and 1, and $a_3 = *$, 0, and 1, we need to choose a_3 from $*$, 0 and 1 using the following if the corporate target has not been achieved ($I_3 = 0$):

$$V_3(\mathbf{x}_3, 0, a_2) = \max\left\{ \sum_{\mathbf{x}_4} P_{3,4}(\mathbf{x}_4|\mathbf{x}_3, a_2, *) \times \bar{P}(\mathbf{x}_4), \sum_{\mathbf{x}_4} P_{3,4}(\mathbf{x}_4|\mathbf{x}_3, a_2, 0) \times \bar{P}(\mathbf{x}_4), \sum_{\mathbf{x}_4} P_{3,4}(\mathbf{x}_4|\mathbf{x}_3, a_2, 1) \times \bar{P}(\mathbf{x}_4) \right\}.$$

For example, for a 'profit' firm that failed to achieve success in period 3 and did not do restructuring last period, the following can be obtained using the above equation,

$$V_3(1, 0, *) = \max\left\{ \begin{array}{c} a_3 = * : P_{3,4}(1|1, *, *) \\ \times \bar{P}(1) + P(0|1, *, *) \times \bar{P}(0) \\ a_3 = 0 : P_{3,4}(1|1, *, 0) \\ \times \bar{P}(1) + P(0|1, *, 0) \times \bar{P}(0) \\ a_3 = 1 : P_{3,4}(1|1, *, 1) \\ \times \bar{P}(1) + P(0|1, *, 1) \times \bar{P}(0) \end{array} \right\}$$

$$= \max\left\{ \begin{array}{l} 0.70 \times 0.70 + 0.30 \times 0.05 \\ 0.60 \times 0.70 + 0.40 \times 0.05 \\ 0.50 \times 0.70 + 0.50 \times 0.05 \end{array} \right\}$$

$$= 0.51 \text{ (choosing} a_3 = *)$$

That is, a restructuring action is not needed in period 3 and the company can achieve the goal of *ROE* growth in period 4 with the highest probability of 0.51. Similarly, we can have $V_3(1, 0, 0) = 0.54$ with $a_3 = *$, $V_3(1, 0, 1) = 0.57$ with $a_3 = 0$, $V_3(0, 0, *) = 0.18$ with $a_3 = *$, $V_3(0, 0, 0) = 0.25$ with $a_3 = *$, and $V_3(0, 0, 1) = 0.28$ with $a_3 = 1$, which describe what decisions should be made under different circumstances and the corresponding maximal probabilities of reaching the target by period 4. Also, we have $V_3(\mathbf{x}_3, 1, a_2) = 1$ for any $\mathbf{x}_3$ and a_2. In this case, no restructuring is needed ($a_3 = *$) since the *ROE* goal has been attained in or by year 3 (i.e. $I_3 = 1$).

For $k = 2$, for a 'profit' firm that failed to achieve the goal ($I_2 = 0$), if the company did not do restructuring in the last period, the following can be obtained:

$$V_2(1, 0, *) = \max\left\{ \begin{array}{l} P_{2,3}(1|1, *, *) \times (1 - \bar{P}(1)) \times V_3(1, 0, *) \\ \quad + P_{2,3}(0|1, *, *) \times (1 - \bar{P}(0)) \times V_3(0, 0, *) \\ \quad + P_{2,3}(1|1, *, *) \times \bar{P}(1) \\ \quad + P_{2,3}(0|1, *, *) \times \bar{P}(0) \\ P_{2,3}(1|1, *, 0) \times (1 - \bar{P}(1)) \times V_3(1, 0, 0) \\ \quad + P_{2,3}(0|1, *, 0) \times (1 - \bar{P}(0)) \times V_3(0, 0, 0) \\ \quad + P_{2,3}(1|1, *, 0) \times \bar{P}(1) \\ \quad + P_{2,3}(0|1, *, 0) \times \bar{P}(0) \\ P_{2,3}(1|1, *, 1) \times (1 - \bar{P}(1)) \times V_3(1, 0, 1) \\ \quad + P_{2,3}(0|1, *, *) \times (1 - \bar{P}(0)) \times V_3(0, 0, 1) \\ \quad + P_{2,3}(1|1, *, 1) \times \bar{P}(1) \\ \quad + P_{2,3}(0|1, *, 1) \times \bar{P}(0) \end{array} \right\}$$

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$$= \max \left\{ \begin{array}{c} 0.70 \times 0.30 \times 0.51 + 0.30 \times 0.95 \\ \times 0.18 + 0.70 \times 0.70 + 0.30 \times 0.05 \\ 0.60 \times 0.30 \times 0.54 + 0.4 \times 0.95 \\ \times 0.25 + 0.60 \times 0.70 + 0.40 \times 0.05 \\ 0.50 \times 0.30 \times 0.57 + 0.50 \times 0.95 \\ \times 0.28 + 0.50 \times 0.70 + 0.50 \times 0.05 \end{array} \right\}$$

$= 0.66$ (choosing $a_2 = *$).

That is, management does not need to conduct restructuring and the company can achieve the goal of *ROE* growth in the future periods with the maximal probability 0.66. Similarly, we can have $V_2(1,0,0) = 0.70$ with $a_2 = 1$, $V_2(1,0,1) = 0.75$ with $a_2 = 0$, $V_2(0,0,*) = 0.37$ with $a_2 = 1$, $V_2(0,0,0) = 0.41$ with $a_2 = *$, and $V_2(0,0,1) = 0.51$ with $a_2 = 1$. These describe what decisions should be made under different circumstances. Also, we have $V_2(\mathbf{x}_2, 1, a_1) = 1$ for any $\mathbf{x}_2$ and a_1. In this case, no restructuring is needed ($a_2 = *$) since the *ROE* goal has been attained in or by year 2 (i.e. $I_2 = 1$).

Finally, we solve for $V_1(1,0,*)$ if the company is 'profit' in year 1 and $V_1(0,0,*)$ if the company is 'loss' in year 1 (here $a_0 = *$ because it is assumed that the company did not conduct restructuring within past two years). Using the same skills, we have

$$V_1(1,0,*) = 0.75 \text{ with } a_1 = *,$$
$$V_1(0,0,*) = 0.57 \text{ with } a_1 = 1.$$

Therefore, in year 1, if the state of the company is 'profit', the best decision is 'no restructuring', which provides the maximal probability of success of 0.75. If the company is in 'loss' position, the best decision is 'downsizing', which provides the maximal probability of success of 0.57.

The above numerical results are summarized in Figures 1 and 2, which show the best restructuring plan at year 1, in order to reach the business target within the 3-year window (i.e. succeed by year 4).

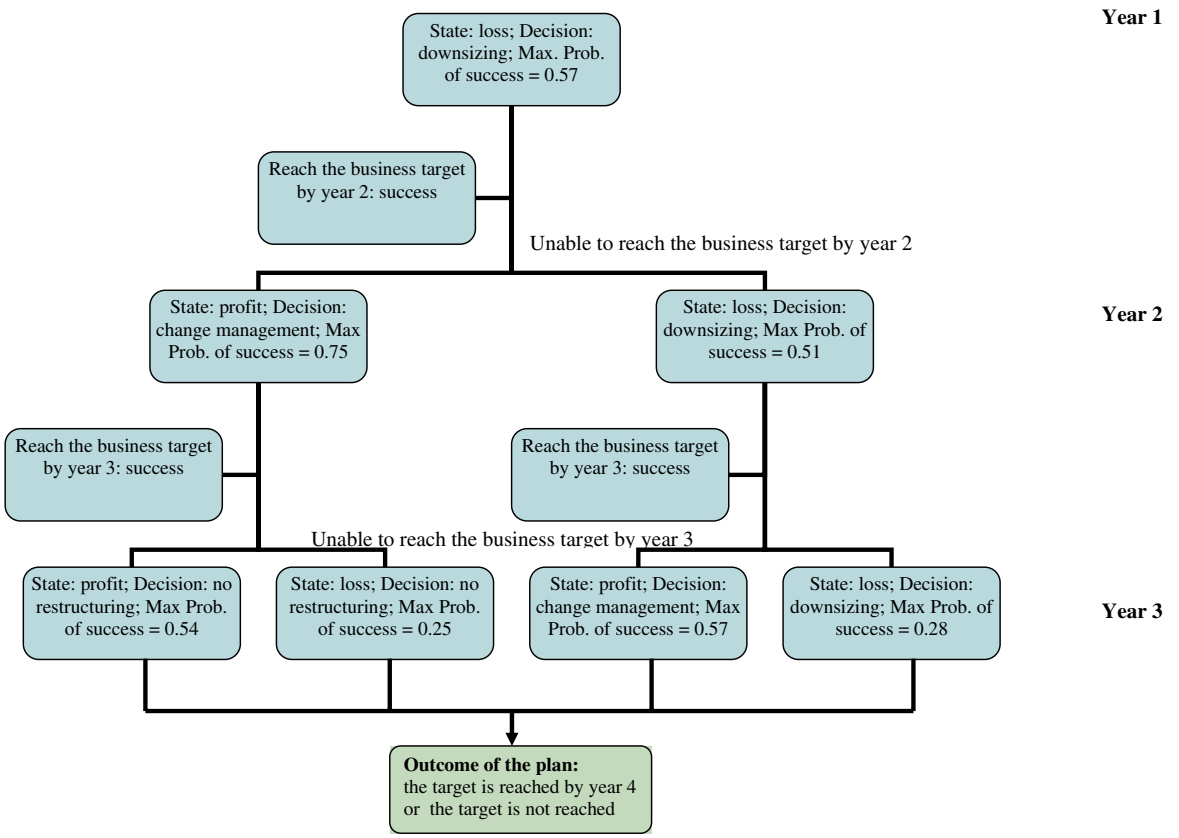

Figure 1. An example of a restructuring plan established for a loss firm at year 1, in order to reach the business target within the 3-year window (i.e. succeed by year 4).

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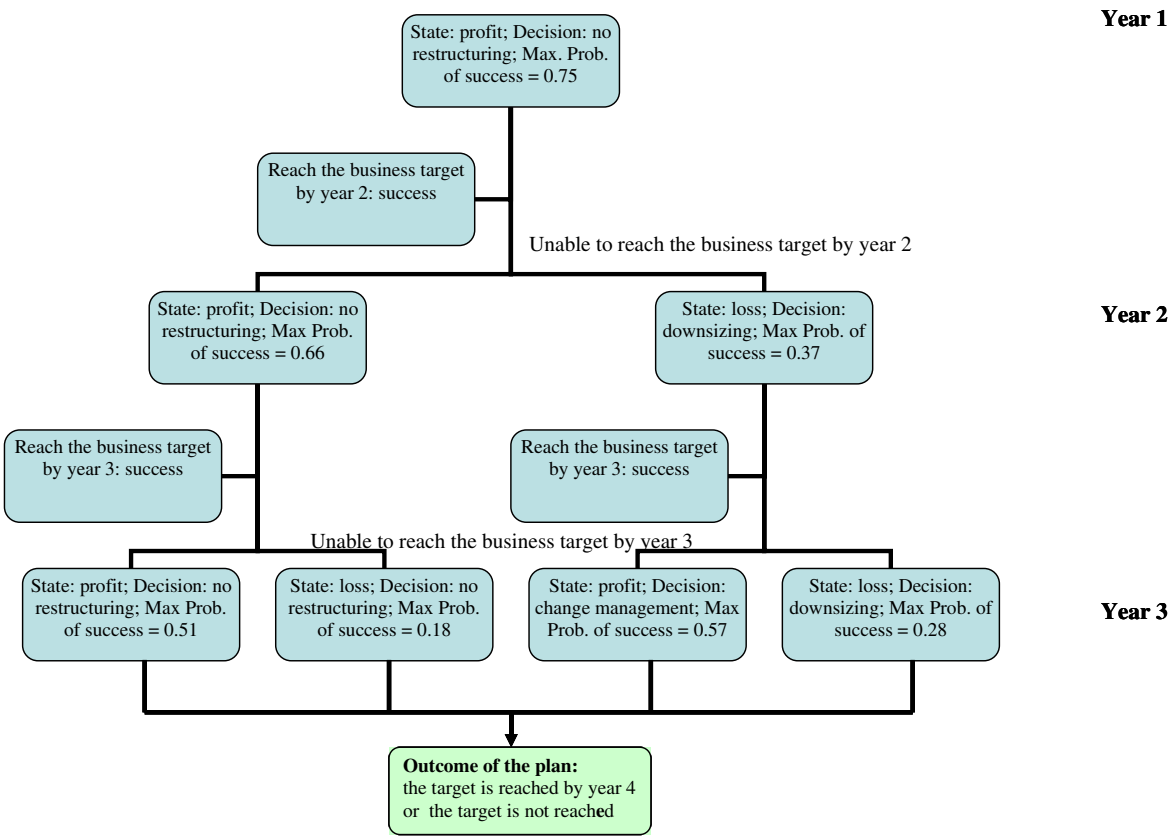

Figure 2. An example of a restructuring plan established for a profit firm at year 1, in order to reach the business target within the 3-year window (i.e. succeed by year 4).

This plan also contains the optimal decisions for each possible state that might occur in year 2 and year 3, based upon the parameters estimated at year 1. If, in years 2 and 3, these estimations are still held and the ending point of the planning window is not re-defined, this restructuring plan set up at year 1 will be good for all three years. However, in reality the situation may be more complicated and require modification of the plan when new information is received. For example, suppose that the company is a 'profit' firm at year 1. At year 2, the state of the company is 'loss', and managers decide to extend the planning window to the end of year 5 and update relevant parameter estimations from year 1. In this case, we can apply the proposed method and revise the plan at year 2 by setting year 2 as period 1 and letting $N = 4$. Then, a new plan will be established that might suggest a different decision at year 2 from 'downsizing', as was suggested in the plan of year 1 (see Figure 2).

Compared to our proposed approach, it may seem to be simpler for managers to evaluate the probabilities anew at the beginning of each period with respect to the likelihood of achieving their objective(s) with or without restructuring, given their knowledge of what has passed in the preceding period(s), and then to choose a plan they expect to yield the highest probability. However, under this approach, the calculated probability of achieving the objective is based on past restructuring events and their outcome, due to decisions which may or may not be optimal. In contrast, our proposed approach uses the backward procedure to maximize the probability of success, considering all possible state transitions and scenarios for the future periods, and the optimal sequences for restructuring decisions in response to each of them. According to the principle of optimality, the solution for the current period is optimal, and thus can beat the above simple approach.

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CONCLUSION

We have evaluated important managerial issues relating to the causes and consequences of corporate restructuring, utilizing a mathematical model which incorporates analytical techniques. The logic behind decision-making of timing and restructuring activities is presented by using the technique of dynamic programming. The objective in the model, maximizing the likelihood of reaching business goal(s), is a reasonable one for management. Nevertheless, corporate goal setting depends on the firm's business environment and the interests of its different stakeholders. Also, the parameters and variables presented in the model (e.g. state variables, decision variables, and measures of performance), as well as the division of periods, should be defined based on the practical needs of the firm in order to properly facilitate decision-making.

This paper is a first attempt at developing a model, which incorporates analytical skills within the decision-making process that governs restructuring. Once the variables and parameters are well defined, the concept behind the model could be generally applied to the development of related strategies. Moreover, this analytical work can enhance the use of decision support systems. In the future, we hope to build on the insights and the findings of significant factors associated with firms' market and operating performance so as to further enhance the application of the analytical modeling to the development of restructuring strategy.

NOTES

1. Manne (1965) finds that the threat of takeover could mitigate the agency problem by forcing the management to refocus so as to improve efficiency. Several other papers document the relationship between takeover threats and restructurings. See, for example, Bhagat *et al*. (1990), Bhide (1990), and Berger and Ofek (1999) for evidence of restructuring following successful takeover; Dann and DeAngelo (1988) for evidence on defensive asset restructurings; and Denis *et al*. (1997) and Berger and Ofek (1999) for evidence on the influence of external control pressures on corporate refocusing activity.

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