

# Dynamic programming: resource allocation

[Finance](#)



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Executive Summary Dynamic programming has evolved as one of the most widely and effective techniques in the field of optimisation. The technique has been used extensively by business managers around the world to solve complex problems. Because of its simplicity, the technique has been gaining popularity. This report analyses the benefits and limitations of dynamic programming and at the same time it explains the technique with the help of an example.

Introduction Managing business has become far more complex and because of this reason several techniques and methods have been introduced with the ability to solve different kinds of complex problems (Polak, & Rogers, & Sweeney, 2010). As businesses have faced several issues and complexities, one of the major benefits that businesses and entrepreneurs have seen over the recent years is the use of different programs and techniques that could assist them in analysing the situation better and help them in decision making (Ben-Ameur, Breton, & Francois, 2006). With the advancement in the field of optimisation, dynamic programming has emerged as one of the most powerful methods that business managers use to analyse and solve discrete problems and this technique can give much effective results in comparison to other techniques and methods (Young, 1998). This report analyses the benefits and limitations of dynamic programming method as well as it explains the concept of dynamic programming with the help of an example.

Benefits of Dynamic Programming The main benefits of dynamic programming are as follows: One of the major benefits of using dynamic programming is its simplicity and

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this is one of the reasons why the method has been used extensively.

Complicated algorithmic problems can be solved using dynamic programming; therefore in complex situations dynamic programming is used (Elton, & Gruber, 1971). Remarkable growth has been observed to solve sequential decision problems because of dynamic programming and because of research in the field of dynamic programming, advancement has been made in econometrics. The results or efficiency of dynamic programming is relatively high in comparison to other methods. Limitations of Dynamic Programming One of the major limitations of dynamic programming is that it is used only for linear orders and the characters cannot be rearranged (Mao, & Sarndal, 1966). In addition to this, the other major limitation of using dynamic programming is that in dynamic programming, it is important to write code that are able to evaluate the sub-problems in the most effective manner. In order to calculate and solve a problem using dynamic programming, formulating a good solution method is one of the challenges faced. In dynamic programming, the user has to make sub-problems and then analyse how the sub-problems would be calculated and then decide the order of these sub-problems. The other drawback of dynamic programming is that with the usage of 'The Principle of Optimality and Polynomial Break up' there are only few distinct sub-problems in a good dynamic programming (Bhowmik, 2010). EXAMPLE: The technique of dynamic programming is beneficial for the finance organisations in order to manage their portfolios in more effective and efficient manner. This can be explained more thoroughly with the help of an example. For instance, the finance company has to make a portfolio in such a way that the output or revenue is maximised. The company has two different options, either to invest in a particular types of

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bonds, stocks, or in t-bills. The total fund available for investment is 10 million. The following table summarise the return of all options along with the cost associated with them. Apart from this, the table also presents the limit for investing in any particular type of securities in order to minimise the risk associated with it. Security Cost per security (M) Return per security (000) Maximum Limit Bonds 5 90 2 T-bills 2 30 5 Stocks 2 50 3

With the help of the dynamic programming problem formulation, solution, and analysis the company will be able to invest the available fund in optimal way. The objective function in this case is to maximise the overall return of the investment. The global decision is to decide how much securities of each type should be bought. As, there are three possible options so there are three sub decisions i. e. every sub decision will tell about the number of particular type of securities which should be purchased. Hence, the example provided has three different stages and each decision will be made in sequence. According to the assumptions the three stages are: Stage 1: Stocks Stage 2: Bonds Stage 3: T-bills  $x_n$  = the input which is available in the starting of the stage  $n$   $d_n$  = the decision which is taken at the stage  $n$  The detailed analysis (see appendix), provides the optimal solution in which the available fund of 10 million should be spend on the purchase of 2 units of T-bills and 3 units of Stocks in order to maximise the overall return on investment which will be 210, 000. Conclusion Dynamic programming has become an important part of today's decision making process. Because the technique can be used easily to solve complex problems therefore it has been gaining popularity over the years. There are few limitations of this technique; however the benefits of dynamic programming could overcome its limitations. Appendix Stage 1:  $d_1$   $x_1$  0 1 2 3  $d_1^*$   $f_1(x_1)$   $x_0$  0 0 0 0 0 1 0 0

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0 1 2 0 50 1 30 2 3 0 50 1 30 1 4 0 50 100 2 60 0 5 0 50 100 2 100 1 6 0 50  
 100 150 3 150 0 7 0 50 100 150 3 150 1 8 0 50 100 150 3 150 2 9 0 50 100  
 150 3 150 3 10 0 50 100 150 3 150 4 Stage 2:  $d_2 \times 2$  0 1 2  $d_2^* f_2(x_2)$   $x_1$  0 0  
 0 0 0 0 0 1 0 0 1 2 50 0 50 2 3 50 0 50 3 4 100 0 100 4 5 100 100 0 100 5 6  
 150 100 0 150 6 7 150 150 0 150 7 8 150 150 0 150 8 9 150 190 1 190 4 10  
 150 190 180 1 190 5 Stage 3:  $d_3 \times 3$  0 1 2 3 4 5  $d_3^* f_3(x_3)$   $x_2$  10 190 180  
 210 190 170 150 2 210 6 Optimal Solution: Stage 3:  $x_3 = 10$ ,  $d_3^* = 2$ ,  $x_2 =$   
 $x_3 - 2d_3^* = 10 - 4 = 6$  Stage 2:  $x_2 = 6$ ,  $d_2^* = 0$ ,  $x_1 = x_2 - 5d_2^* = 6 - 0 = 6$   
 Stage 1:  $x_1 = 6$ ,  $d_1^* = 3$ ,  $x_0 = x_1 - 2d_1^* = 6 - 6 = 0$  The finance company  
 should make purchases in the following order Stage 1: two t-bills by paying 4  
 million Stage 2: zero bonds Stage 3: three stocks by paying 6 million Total  
 Investment = 4 + 0 + 6 = 10 million Total return =  $(2 * 30,000) + (3 * 50,$   
 000) = 210,000 Reference List Ben-Ameur, H, Breton, M, & Francois, P,  
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