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An Optimization Function on Depreciation of Assets

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A B S T R A C T

Depreciation is a measure of the durability of a fixed asset and refers to the ongoing decline in the quality, quantity, or value of an asset. In fact, over time, the efficiency of fixed assets that are constantly used in business will decrease. Therefore, depreciation can be considered as a kind of price reduction that will still occur even if the goods are properly stored and used properly. For example, no matter how well you maintain your property and take all necessary steps to maintain it properly, over time, you will see water pipes, appliances, etc. wear out. Note, of course, that depreciation does not mean erosion and destruction of an asset. Sometimes the costs of depreciating assets are repeated many times in the production process. In this paper, we intend to present an optimization formula for a specific type of capital depreciation by presenting a mathematical model. Suppose the distance between two cities in a desert is a miles. On one side of the desert is a refinery and on the other side is an industrial factory that requires fuel produced by the refinery for production. N liters of fuel must be sent to this factory. A fuel carrier car is supposed to transport the fuel required by the industrial factory from the refinery. The capacity of this car is z liters. Also, suppose this car consumes one liter of fuel per mile. Assume that $f(z, N, a)$ is equal to the maximum amount of fuel delivered by this vehicle to the industrial factory, then, when $R = N + z - z\left\lceil \frac{N}{z} \right\rceil$:

$$f(a,N,z) = \begin{cases} 0 & \text{if } N < a \\ N & \text{if } a = 0 \\ N - a\left(2\left\lceil \frac{N}{z} \right\rceil - 1\right) & \text{if } (2\left\lceil \frac{N}{z} \right\rceil - 1) \le R \\ f(z, N-R, a - \frac{R}{2\left\lceil \frac{N}{z} \right\rceil - 1}) & \text{elsewhere} \end{cases}$$

1. Introduction

In accountancy, depreciation refers to two aspects of the same concept: first, the actual decrease of fair value of an asset, such as the decrease in value of factory equipment each year as it is used and wear, and second, the allocation in accounting statements of the original cost of the assets to periods in which the assets are used

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(depreciation with the matching principle). Depreciation is thus the decrease in the value of assets and the method used to reallocate, or "write down" the cost of a tangible asset (such as equipment) over its useful life span. Businesses depreciate long-term assets for both accounting and tax purposes. The decrease in value of the asset affects the balance sheet of a business or entity, and the method of depreciating the asset, accounting-wise, affects the net income, and thus the income statement that they report. Generally, the cost is allocated as depreciation expense among the periods in which the asset is expected to be used. In fact, depreciation is a measure of the durability of a fixed asset and refers to the ongoing decline in the quality, quantity, or value of an asset. Then, over time, the efficiency of fixed assets that are constantly used in business will decrease. Therefore, depreciation can be considered as a kind of price reduction that will still occur even if the goods are properly stored and used properly. For example, no matter how well you maintain your property and take all necessary steps to maintain it properly, over time, you will see water pipes, appliances, etc. wear out. Note, of course, that depreciation does not mean erosion and destruction of an asset. Sometimes the costs of depreciating assets are repeated many times in the production process.

Accounting is an art of recording, classifying and summarizing in an informative and measured manner in the form of currency, on transactions or financial events of the firm and the interpretation of the results. The overall purpose of accounting is to provide information that can be used in decision making. Financial accounting is a process that ends in preparing financial statements concerning the company as a whole for use by both internal and external parties ([8]). The financial statement is an information that describes the condition of a company, which then it will be an information that describes the performance of a company ([5]). Fixed assets are tangible assets or property of a company, with relatively high economic value, used for operational activities to produce goods and services with a period of usage periods expected over one year period ([4]). Fixed assets are assets with properties that cannot be converted into cash in the operating cycle of a company ([10]). Understanding depreciation according to Statement of Financial Accounting Standards (PSAK) No. 16 (2011: 15): "Depreciation is the allocation of the cost of a fixed asset over its economic life in a systematic and rational manner." According to [11] over time the use of a fixed asset, at the same time fixed assets will begin to decrease in ability or begin experiencing obsolescence (obsolescence) to create goods and services. The decrease in fixed assets capability is referred to as depreciation. Depreciation generally occurs when a fixed asset is used and is a burden for the period in which the asset is utilized. Depreciation is made because the useful life and potential of the assets are saturated. The amount of depreciation is the cost of an asset, or any other amount that replaces the cost, less the residual value. Depreciation is the systematic allocation of the amount of depreciable assets over its useful life. In financial accounting, depreciation of property and equipment is calculated monthly and for tax purposes depreciation is calculated only once at the end of the reporting year ([16]). Thus, depreciation of property and equipment may be characterized as: the gradual transfer of fixed assets under the influence of the wear process on the cost or cost of the current period ([13]). In this regard, you can also read references [1,9, 14, 15].

Calculation of depreciation fixed assets according to financial accounting standards using five methods: the straight-line method, declining balance method, sum of the years digit method, service hours method, and the unit of productions method. While according to taxation rules just only use two methods: the straight-line method and the declining balance method. The differences in the use of depreciation methods according to financial accounting standards and tax rules will result in fiscal correction. According to the depreciation expense is deductible expense for purpose of calculating income tax. Recently in [6], authors determined the application of methods of depreciation fixed assets according to financial accounting standards and tax laws as well as impact on taxable income PT. Massindo Sinar Pratama Manado. The analytical method used is descriptive qualitative analysis method. The results showed the application of the method of calculation of depreciation PT. Massindo Sinar Pratama Manado in accordance with the provisions of the tax, but an error in the calculation of depreciation that increase the value of the company taxable income. PT. Massindo Sinar Pratama Manado should be more careful and referring to the tax rules in calculating the value of depreciation due to give effect to net profit before tax (taxable income) of the company, so that it will also to give effect to income tax to be paid by the company.

One of the important issues in macroeconomics is the calculation of GDP. In calculating GDP, the issue of capital depreciation is very important and effective. Each product produced in the economy goes through several stages in order to become the final product. Bread, for example, as a final product that is consumed directly, goes through stages such as the production of wheat and flour. It is clear that in complex industrial products the number of conversion or processing steps is more. However, in estimating GDP, the value of the final product (bread) should be used, because the value of flour is implicit in it, as the value of wheat is implicitly present in flour. Gross domestic product (GDP) is a monetary measure of the market value of all the final goods and services produced in a specific time period. Total GDP can also be broken down into the contribution of each industry or sector of the economy. The history of the concept of GDP should be distinguished from the history of changes in many ways of estimating it. The value added by firms is relatively easy to calculate from their accounts, but the value added by the public sector, by financial industries, and by intangible asset creation is more complex. These activities are increasingly important in developed economies, and the international conventions governing their estimation and their inclusion or exclusion in GDP regularly change in an attempt to keep up with industrial advances. In the words of one academic economist, "The actual number for GDP is, therefore, the product of a vast patchwork of statistics and a complicated set of processes carried out on the raw data to fit them to the conceptual framework.

Even GDP needs to keep it real. When we calculate GDP using today's prices, we are creating a measure called nominal GDP. However, prices can change even if output doesn't change. Because of that, our measure of output might get distorted by something like inflation. We account for this using real GDP, which is a measure of GDP that has been adjusted for the price level. In this way, real GDP is a truer measure of output in an economy. However, there is a slight problem with the method above. Calculating real GDP by weighting final goods and services by their prices in a base year can lead to an overstatement of real GDP growth because the prices of some goods decrease over time. Therefore, this method overstates growth in real GDP because it makes it seem like goods make up a bigger share of spending than they really do. Figures **1** and **2** are examples of countries ranking based on GDP.

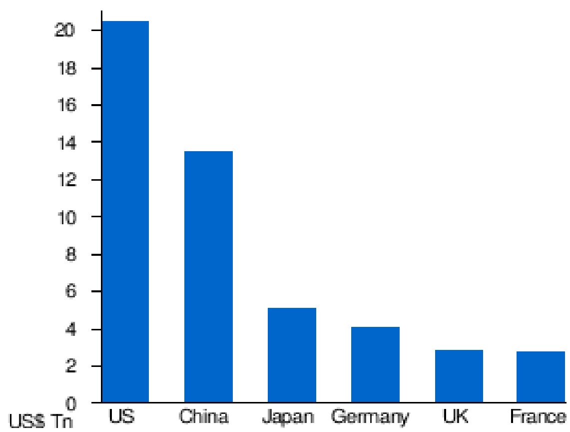

Figure 1. Gdp ranking

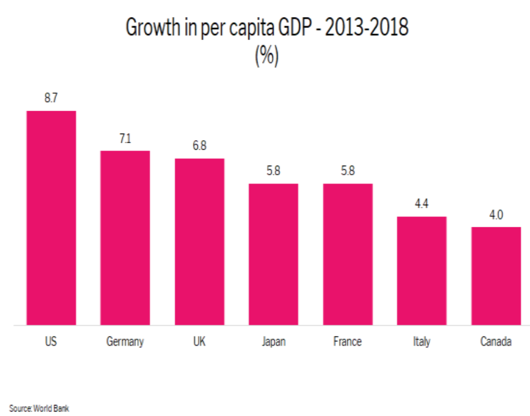

Figure 2. Growth in per capita Gdp

Value added reflects the value generated by producing goods and services, and is measured as the value of output minus the value of intermediate consumption. Value added also represents the income available for the contributions of labour and capital to the production process. Value added by activity shows the value added created by the various industries (such as agriculture, industry, utilities, and other service activities). The indicator presents value added for an activity, as a percentage of total value added.

In fact, GDP is the sum of value added at every stage of production (the intermediate stages) for all final goods and services produced within a region in a given period of time. In other words, GDP is the wealth created by industry activity. Incomes generated by production are referred to as Value Added at each stage of production, where Value Added is defined as total Output (also known as value of production) less the value of Intermediate Inputs into the production process. This can be calculated either by subtracting input costs from the final Output of each Industry or by summing each Industry’s payments made the components of Value Added (VA): Labor Income (LI), Other Property Income (OPI), and Taxes on Production and Imports (TOPI).

All the discussions that have been discussed so far about GDP have a big drawback. In fact, in a large economy, you can’t calculate the efficiency of the economy. Two economies may have the same GDP but they may have different Efficiency. Therefore, the issue of calculating the cost of production is one of the important issues in macroeconomic issues. In fact, a country's GDP may be dependent on the sale of raw materials. In fact, the cost of production and the sale of raw materials are two important factors. What we are going to do in this article is to calculate amount of production cost. Let us use mathematical modeling to express our problem in mathematical language. One of the important issues in economic factors is the topic of the repeating costs. In other words, it is important for us to know what has been our real profit after several stages of investing in a project.

To make the discussion clearer, let us give a simple example. Suppose there is a fuel refinery on one side of the desert, also suppose there is a city on the other side of this desert that needs the fuel produced by this refinery. Now, suppose a fuel truck has to deliver refinery fuel to the city. Also, assume that there are only fuel depots on the route of this car. Therefore, this car has to consume some fuel. Thus the car must travel this route back and forth many times, while trying to travel the shortest distance. In fact, the question is that how many steps this process will take? Also, finally how much fuel is consumed by the car as a cost of production and how much fuel has reached the city as a return on investment. After this introduction, in the next section, we will solve the (this) problem using optimization tools. For more information on the economic issues raised in this article, we refer readers to [2, 3, 7, 12].

2. Main result

What we are looking at in this article is, in fact, the issue of capital depreciation in a production process. What is ultimately a production process cannot necessarily be considered as a return on investment. Our initial capital in the production process may be depreciated due to various factors. And the higher the depreciation, the less profit we will have from the production process.

Here we have tried to turn the problem of capital depreciation into a purely mathematical problem.

In fact, by abstracting the type of problem, we intend to obtain a mathematical model for calculating the optimal points of capital depreciation. To make this discussion more understandable, it is better to explain a little more.

In the production process, you may have to repeat certain sequences many times in order to sustain the production process. Sometimes you have to spend a lot of money to support only a small part of the production process. Sometimes these costs are sequential. Now if you have a choice in this sequence chain, finding the optimal path will be important for you. The issue we are going to discuss in this section has a purely mathematical approach to this process.

As we said in our introduction, an investor may invest a lot of money in the production process of a product but the production process can be so consuming that in the end due to the repetition of some costs, production is not economical at all. A simple example of this is GDP.

Sometimes the production process in the country is so complicated that the value of the primary resources consumed by that country is greater than the value of the final products. One of the important factors in calculating the cost of production is the costs that are repeated in the production process. We try to turn this problem into a mathematical process such that it can be calculated.

Theorem 1: Suppose the distance between two cities in a desert is a miles. On one side of the desert is a refinery and on the other side is an industrial factory that requires fuel produced by the refinery for production. N liters of fuel must be sent to this factory. A fuel carrier car is supposed to transport the fuel required by the industrial factory from the refinery. The capacity of this car is z liters. Also, suppose this car consumes one liter of fuel per mile. Assume that $f(z, N, a)$ is equal to the maximum amount of fuel delivered by this vehicle to the industrial factory, then

$$f(a,N,z)=\begin{cases}0 & \text{if } N<a\\ N & \text{if } a=0\\ N-a\left(2\left\lceil\frac{N}{z}\right\rceil-1\right) & \text{if } (2\left\lceil\frac{N}{z}\right\rceil-1)\le R\\ f(z,N-R,a-\frac{R}{2\left\lceil\frac{N}{z}\right\rceil-1}) & \text{elsewhere}\end{cases}$$

when $R=N+z-z\left\lceil\frac{N}{z}\right\rceil$.

Proof. Note that the car route can be divided into (some) sections which is (are) determined by the bypass points of the car. The car will pass through each of these parts an odd numbers of times. In fact, we can assume that there is no fuel left in any of the points. Because we can move the remaining fuel to any point with several reciprocating movements between these points. Optimal distance is equal to $\frac{1}{2}R$, if $R\le z$, otherwise is equal to $\frac{1}{2}z$.

Because this car can move the remaining fuel previous bypass points completely, it will never need to go back to the previous parts after going through one of these parts. So it's enough to just look at some cases that all remaining fuel is transferred from one point to the next.

To make the discussion more intuitive, suppose that the discussion space is a two-dimensional Cartesian space. This space has points in the form of orderly pair (N,a). This means that each piece of the moving path can be considered as a line segment between two points on this page (For example, between (N,a) and (N',a')).

This means that at the starting point, the total volume of fuel remaining is equal to N liters and remaining distance to carry all remaining fuel equals to a miles. Now after passing the next piece on the way the total volume of fuel remaining is equal to N' liters and remaining distance to carry all remaining fuel equals to a'miles.

Important pointis that if we leave aside the issue of fuel consumption, the fuel carrier must move the route back and forth $2\left\lceil\frac{N}{z}\right\rceil-1$ times to be able to get all the fuel to the end of the road. It means that to cross the distance of two points between (N,a) and (N',a') , the fuel carrier consumes $(2\left\lceil\frac{N}{z}\right\rceil-1)(a-a')$ liters of fuel. Consequently, the slope of the line between (N,a) and (N',a') is equal to $\frac{1}{2\left\lceil\frac{N}{z}\right\rceil-1}$. This means that decreasing the value of $\left\lceil\frac{N}{z}\right\rceil$ will increase the slope of the tangent line. Increasing of the slope of the connecting line will reduce the amount of fuel consumed by the car in one part of the route. Therefore, the optimum state occurs when the value of $\left\lceil\frac{N}{z}\right\rceil$ decreases. This will happen when N is a multiple of z. Using induction, it can be proved that other answers will not be better than this answer. Therefore,

$$f(a,N,z)=\begin{cases}0 & \text{if } N<a\\ N & \text{if } a=0\\ N-a\left(2\left\lceil\frac{N}{z}\right\rceil-1\right) & \text{if } (2\left\lceil\frac{N}{z}\right\rceil-1)\le R\\ f(z,N-R,a-\frac{R}{2\left\lceil\frac{N}{z}\right\rceil-1}) & \text{elsewhere}\end{cases}$$

when $R=N+z-z\left\lceil\frac{N}{z}\right\rceil$, as we claim.

In above, we claim that the car can move the remaining fuel previous bypass points completely, it will never need to go back to the previous parts after going through one of these parts. Here we are going to explain a little bit about proving this claim (to explain about this claim).Suppose we have three points X,Y,Z along the way. Such that X has the shortest distance to the starting point and Z has the longet (longest) distance to the starting point. These are the points that the car uses to get around. To fully proof the above claim, we must prove that there is a path that the car can arrive at point Z such that returning to the point X is not necessary. In fact, between two consecutive points we can do so many reciprocating movements until all the remaining fuel in the previous point is transferred to the next point. Of course, you can take longer steps to optimize your movement. But there will be no problem in the whole discussion. Because you can go back and forth between the points along the way, such that you need not to go back to point X. □

3. Numerical Example

Consider the distance between two cities in a desert is 2000 miles. On one side of the desert is a refinery and on the other side is an industrial factory that requires fuel produced by the refinery for production. 6000 liters of fuel must be sent to this factory. A fuel carrier car transports the fuel required by the industrial factory from the refinery. The capacity of this car is 2000 liters. Also, suppose this car consumes 2 liters of fuel per mile. How much fuel is consumed by the car and how much fuel has reached the city?

Based on Theorem 1, we must calculate $f(2000,6000,2000)$.

$$f(2000,6000,2000) = f\left(2000,4000,\frac{4}{5}(2000)\right) = f\left(2000,2000,\frac{7}{15}(2000)\right) = \frac{8}{15}(2000) = 1066.66 \text{ liters}$$

Thus, 1066.66 liters is the maximum amount of fuel that will be transported by car to the destination city.

4. Conclusions

What we studied in this article was, in fact, a kind of pure mathematical modeling for a financial problem. In the world of financial finance today, the issue of productivity is a very important issue. It is very influential in terms of productivity in the production process of capital depreciation. Sometimes there are so many repetitive and sequential costs in the production process that it becomes very difficult to calculate the production profit. Especially today, very complex service markets are formed in the global financial markets. In markets where production is service-oriented and no priced commodity is produced, calculating the profit of an investor becomes very complicated. For example, some intra-city Internet shipping companies have emerged today. These companies deal with a wide range of drivers with light vehicles. There are a variety of costs involved in these companies, if these companies intend to own the used cars, due to the very high volume of traffic of these cars and various costs such as car depreciation, driver insurance,…, the question is, has such an investment been profitable at all?

Sometimes, if we can turn a general economic problem into an abstract mathematical problem, we will largely avoid duplicate calculations. In fact, our main discussion in this paper was to turn the problem of depreciation in the production process into a purely mathematical problem. By converting the cost of depreciation into a purely mathematical problem, we were able to design a function that calculates sequential costs in a production process. In addition, by finding a function for serial costs in the production process, we were able to identify the optimal points.

Conflict of interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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