Value Model of Used Equipment: Market Trap for Gain

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Abstract. There is a belief that the acquisition of new industrial equipment is less profitable than the purchase of used equipment. The ground for this effect may be found in rather significant decline of the price of industrial equipment after the first years of acquisition. Well known that the car price falls down by 20% - 30% during the first year of ownership. For industrial equipment, the price does not fall so fast, but this effect is observed too. The article considers the profitability of purchasing of used equipment in the framework of Preserved Value Approach. The findings suggest that used equipment is indeed usually priced below its value. This effect provides the buyer of used equipment with an additional benefit, the value of which depends on the actual interest rate of the buyer. Moreover, the buyer may choose a strategy for extending the period of value-added use beyond the limits of economic life. In this case, the purchase of used equipment becomes especially profitable. The reason for this effect seems to be the existence of some “market punishment” for the owner, who acquired industrial equipment but is not able to use it effectively.

1. Introduction

The market for machinery and equipment is a rather complex and heterogeneous system. This market is divided into two segments - the market for new machinery and equipment, or the primary market, and the market for used machinery and equipment, or the secondary market. The buyer is always faced with an important question - is the new equipment more profitable to purchase for production purposes, or used. The shares of market where new and used equipment are vending depends on the type of equipment. For industrial equipment, the share of the secondary market can reach up to 20%. For example, in Russia the sales of used cars exceed the sales of new cars three times in average. According to data of Association of European manufacturers and AUTOSTAT Analytic Agency, 1.8 million new cars and 5.7 million second-hand cars were sold in Russia in 2018 [1, 2].

A buyer who chooses between purchasing the new or similar used equipment is usually guided by his own opinionated understanding of current and future benefits. The purpose of this article is to substantiate the opinion on when and how get the profit form acquiring or selling the used machinery and equipment. The focus of the article is the transport industry where huge and expensive assets are the specific feature. The transport industry is very important in Far East of Russia and, especially, in the Primorsky Region with about 12%-15% share in regional production.
2. Task statement

Being in process of expanding or maintaining production capacity, the company is faced with the question of covering the expenses caused by the acquisition of equipment. Management may follow one of the next possible strategies, either always acquire new and better equipment, or optimize costs finding a balance between costs and expected revenues. Implementing the strategy cost-revenue balance, the management of the organization sooner or later has to choose between the acquiring of new or used equipment. There are quite a few handbooks that recommends prices for used equipment depending on age and economic life. However, none of these handbooks answers the question of how profitable or unprofitable to acquire used equipment. The answer to this question is not obvious really if suitable methodology is not given. To find reasonable solution, this article proposes to apply the specific approach to cost estimation as a methodological basis. This approach was described in articles [3,4] and referenced as “Preserved Value Approach”. Below is a brief explanation of the approach.

Fig. 1 shows the systematization of generally accepted approaches to property valuation where the “Preserved Value Approach” in two versions - “Discontinuity Method” and “Steady Expectations Method” is added.

Preserved value approach for the asset valuation acts within the concept of time value of money. The core idea of the approach is the assumption that used asset and the same asset when it was new are the mutually exclusive alternatives. That means the used asset and the same asset when it was new must be equivalent in terms of economic benefit to the owner during the service life. After purchase the asset may generate different cash flow due to different intensions of initial and new owners. From time domain, the Preserved Value Approach shows it’s specifics comparing to other well-known approaches (see Fig. 2) because it combines the information about the asset from its past and the assumptions concerning the asset future.

For the purposes of given article, the Steady Expectations Method of Preserved Value Approach will be used for validation of possible benefits from purchasing of used equipment. If buyer of used asset supposes to utilize in the same way as initial owner, i.e. no changes to cash flow and life, and interest rate is fixed during asset life, the equipment value $AV$ may be calculated from the next formula:

$$AV = C_0 \cdot \frac{(1+i)^n - (1+i)^m}{(1+i)^n - 1}$$  \hspace{1cm} (1)
where $C_0$ – equipment first cost, $i$ – interest rate $n$ – total count of periods of time of equipment life or service life, $m$ – equipment age, or number of period of time when the equipment is valued.

In assessor experience the handbook presenting reference valuation information is the common practice. We can see the similar approach in most of assessor handbooks, between them may be mentioned very reputable publications [5-10]. The book that formed the basis for the Table 1 is [10]. Table 1 shows the most relevant to transportation enterprise objects and their service life. Normal service life of assets of transportation enterprise covers range from 5 years for motor vehicles to 20 years for deep sea transportation objects like deep-sea vessels.
Table 1. Typical service life of general equipment.

| #  | Description                          | Typical Service Life, yrs |
|----|--------------------------------------|---------------------------|
| 1  | Auto & Other Motor Vehicle           | 5                         |
| 2  | Buses                                | 8                         |
| 3  | Communication Equipment              | 8                         |
| 4  | Deep Sea Transportation               | 20                        |
| 5  | Machinery and Equipment              | 14                        |
| 6  | Professional and scientific instruments | 12                      |
| 7  | Railroad Cars                        | 12                        |
| 8  | Truck and Bus Bodies                 | 12                        |
| 9  | Vessels, Push, Tug, Tow              | 15                        |
| 10 | Warehouse - General                  | 10                        |

Depending on service life, the typical percent good factors are introduced as estimation of the ability of asset to fulfill its general function. Good factors serve as the coefficients applied to the initial cost of the object to find out the “fair” market value. Typical percent good factors from [8] at 6.75% rate of return are given in Table 2.

Table 2. Typical percent good factors for machinery and equipment.

| Service Life, yrs | Age, yrs | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  |
|-------------------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 5                 |          | 81  | 62  | 45  | 29  | 18  | 10  | 5   | 1   |     |     |     |     |     |     |     |     |
| 8                 |          | 89  | 78  | 67  | 56  | 45  | 35  | 26  | 19  | 14  | 10  | 6   | 3   |     |     |     |     |
| 10                |          | 92  | 83  | 75  | 66  | 57  | 49  | 41  | 33  | 26  | 20  | 16  | 12  | 9   | 6   | 4   | 1   |
| 12                |          | 94  | 87  | 80  | 73  | 66  | 59  | 52  | 45  | 38  | 32  | 26  | 22  | 17  | 14  | 11  | 9   |
| 14                |          | 95  | 89  | 84  | 78  | 72  | 66  | 60  | 54  | 48  | 43  | 37  | 32  | 27  | 23  | 19  | 16  |
| 15                |          | 95  | 90  | 85  | 80  | 75  | 69  | 64  | 58  | 53  | 47  | 42  | 37  | 32  | 27  | 23  | 19  |
| 20                | 97       | 94  | 91  | 87  | 84  | 80  | 76  | 72  | 69  | 65  | 61  | 57  | 52  | 48  | 44  | 40  |     |

End of service life does not mention the end of life of the asset. Typically, for the assets with relatively short service life their operating life may be longer by approximately 25% and over. As we can see from Table 2, the value corresponding to the end of service life for short-life assets is framed by about 18%. For the long serving assets, like vessels or deep-sea vessels, life may be prolonged by 50% and over. For example, for deep-sea vessels with 20 years service life the operating life may be expanded up to 32 years with relatively slow falling of percent good factor.

Methodology of solution of placed in this article problem contains the next few steps.

1. For the given service life the values of asset $AV$, in percents of initial value, are calculated for the sequence of ages of the given asset. That means the formula (1) has to be transformed to the form (2):

$$ AF = \frac{(1+i)^n - (1+i)^m}{(1+i)^n - 1}$$

where $AF$ is the asset residual factor that is equivalent to the percent good factor by meaning.
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where $AF$ is the asset residual factor that is equivalent to the percent good factor by meaning.

2. Each $AF$ is comparing to the corresponding percent good factor. Positive difference between buyer $AF$ and percent good factor is understood as market gain, and the negative one as market loss.

3. It is supposed, that at some age of asset the market gain achieves the maximum. That means the purchase of asset at best age gives the most benefit to buyer.

3. Strategy of acquiring

Let's consider the tractor unit with expected service life is five years. What is the optimal age for the purchase of given asset? The trap is that the assessors handbooks recommends the percent good factors for the relatively low rate of return. This data finally became the market standard and rather never call questions. But buyer with highly profitable business may gain extra benefits. Next calculation will be completed for three interest rates 10%, 20%, and 25% yearly.

Fig. 3 shows the calculation of market gains and losses for the “standard” market value based on low rate of return. Calculation in Fig 3. is formed as follows. String “Age” shows the age of asset. Next string shows the percent good factors corresponding to age as given in Table 2. Cell A3 contains the length of service life of asset. Subtable B4-F6 shows asset residual factors calculated from equation (2). Each string in B4-F6 corresponds to possible buyer interest rate given in cells A4-A6. Subtable B7-F9 contains the remainders between percentage good factors from string B2-F2 and asset residual factors from subtable B4-F6. For easier understanding Fig. 4 shows how the first two columns of the spreadsheet at Fig. 3 were filled.

As we can see there is the difference between the percent good factor from standard table and asset residual factor that is calculated basing on buyer profitability. The difference is positive during first three years and after goes down and changes to negative. Fig. 5 represents the data from Fig. 3 in more convenient graph view.

![Figure 3](image1.png)

**Figure 3.** Calculation of market gain for asset with 5 years service life.

![Figure 4](image2.png)

**Figure 4.** Formulas filling the spreadsheet at Fig. 3.
As follows from Fig. 5, there is a maximal benefit that may be gained from the difference between common market value and asset value in use which figured out from simple version of Preserved Value Approach. Maximal benefit will be gained if asset is acquired at the age of two years.

The calculations above are given for the case if the strategy of buyer is preserving of initial service life. Let’s see what happens if the buyer will change the strategy. Changed strategy presumes that acquired asset will service extended life. As follows from Table 2, the common practice allows extension of the service life for up to 50%. For example, the asset with five years service life saves the 18% good factor at the end of service life. The end of economic life for this asset appears after eight years when asset good factor falls to 1% according to common practice.

If buyer of used asset decides to expand its life, calculation of market gain may be made as shown at Fig. 6. Graph representation of the difference between percent good factor and asset residual factor is presented at Fig. 7.

![Figure 5](image1.png)

**Figure 5.** Graph representation of the difference between percent good factor and asset residual factor, as portion of initial cost at different interest rates for asset with 5 years service life.

![Figure 6](image2.png)

**Figure 6.** Calculation of market gain – strategy of extended life.

| Age | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|     | 10,00% | 0.91 | 0.82 | 0.71 | 0.59 | 0.47 | 0.33 | 0.17 |
|     | 20,00% | 0.94 | 0.87 | 0.78 | 0.67 | 0.55 | 0.44 | 0.22 |
|     | 25,00% | 0.95 | 0.89 | 0.81 | 0.71 | 0.59 | 0.43 | 0.24 |
| Gain 10% | 0.1026 | 0.1964 | 0.2906 | 0.3942 | 0.2881 | 0.2293 | 0.1204 | -0.0100 |
| Gain 20% | 0.1294 | 0.2467 | 0.3294 | 0.3846 | 0.3690 | 0.2982 | 0.1672 | -0.0100 |
| Gain 25% | 0.1396 | 0.2666 | 0.3579 | 0.4194 | 0.4064 | 0.3326 | 0.1903 | -0.0100 |

![Figure 7](image3.png)

**Figure 7.** Graph representation of difference between percent good factor and asset residual factor – strategy of expanded life, as portion of initial cost at different interest rates.
The second strategy forms the maximal gain at the fourth year of economic life for the asset with five years service life. That means the most profitable policy for buyer is to acquire the asset with five years service life at the age of four years with intention to exploit this asset during next four years until its economic life ends up.

Fig. 8-9 show the representations of difference between percent good factor and asset residual factor for assets with 14 and 20 years service life. As follows from Fig. 5, 7, 8 and 9, the optimal age for buying of used asset is between half to two-thirds of service life if buyer pursues the strategy of normal service life. If buyer accepts the strategy of extended life of asset, the optimal age for acquiring of asset moves to the end of normal service life or even over. Optimal moment for buying of asset is also depends on interest rate and is shifting in direction to the end of economic life with higher interest rate. And, the benefit from buying of used asset is increasing with extending of economic life. For example, asset with 20 years of service life being extended to 32 years of economic life may provide to the buyer the benefit in amount of 68% of its initial cost if acquired at the age of 21 to 23 years and company interest rate is equal to 25% yearly.

## Figure 8
Graph representation of difference between percent good factor and asset residual factor for asset with 14 years service life, as portion of initial cost at different interest rates.

## Figure 9
Graph representation of difference between percent good factor and asset residual factor for asset with 20 years service life, as portion of initial cost at different interest rates.

### 4. Conclusion
There is a belief that machinery and equipment earns more profit if they are bought slightly used. This belief has no rational explanation if the “Preserved Value Approach” is not engaged. Under Preserved Value Approach as the method of cost estimation the next result may be formulated.

1. Preserved Value Approach provides the explanation why the used machinery and equipment is more profitable than new one if the buyer owns the highly profitable business. Acquiring new machinery and equipment the buyer pays the market price that is equal to the value in use. On the other hand, purchase of the used equipment and machinery brings to buyer the value significantly higher than market price based on relatively low rate of return.

2. The best age for acquiring of used machinery and equipment depends on service life, total economic life, and difference between company interest rate and base rate of return.

3. Buyer may use one of two different strategies:
   - strategy of normal life that means the machinery and equipment will be used during its normal service life;
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strategy of extended life that means the machinery and equipment will be used during extended service life until being completely exhausted.

4. Strategy of normal life usually results in the recommendation to acquire the used asset at the age of from half to two-thirds on service life and gain modest benefit. Strategy of extended life presumes the significant extension of normal service life and results in recommendation to acquire the asset at the end of normal service life.

5. The exact recommendation of the age when the asset should be purchased must be calculated thoroughly basing on real market value, presumed economic life and company interest rate.

6. The most interesting question is why the used equipment is more profitable than the new one. There is a possible right answer. Once the asset was bought but owner wasn’t able to use it in proper order, and find it nonproductive. Nonproductive asset had declined the general profitability of business and owner was forced to sell the bad asset at relatively low price. The market price below the normal level is a kind of “punishment” for poor business solution.

5. References

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