Disassembling the Replacement Analysis in Capital Budgeting: A Teaching Note

Cris de la Torre, Ph. D., J. D.*
Professor of Finance
Kenneth W. Monfort College of Business
University of Northern Colorado
Campus Box 128
Greeley, Colorado 80639
970-351-1240
cris.delatorre@unco.edu

Amber Lemmon
Graduate Student
Texas Tech University
Lubbock, Texas

Rutilio Martinez, Ph. D.
Professor of Business Statistics and International Business
Kenneth W. Monfort College of Business
University of Northern Colorado
Campus Box 128
Greeley, CO 80639
970-351-1106
Rutilio.Martinez@unco.edu

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*Contact Author

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Abstract

When teaching capital budgeting, specifically the analysis with regard to replacement projects, there comes a point when the instructor has to explain why the market value of the old machine is recognized, as is the continued depreciation on the old machine. Typically, the response is, "Well we want to capture the true effect of replacing the old machine and its true impact." This paper disassembles the analysis into the sale of the old machine and the purchase of the new project separately to help clarify the process to students.

KEY WORDS: Capital Budgeting, Replacement Projects.

The discovery of a mathematical law to describe the price of a stock option in terms of the price of the underlying stock is an example of a conservation law in finance. Robert Shiller[1]

I. Introduction

When teaching capital budgeting, eventually the material in the course focuses on replacing an existing project. The old project has a market value, along with existing depreciation. The next step is to show the incremental effects of adding a new project to an existing set of cash-flows. Textbooks[2] tend to recognize the impact of selling the old machine and yet still show the subtraction of the old depreciation as an incremental impact on a yearly basis. Frequently, students will ask how both can exist—doesn't the sale preclude the existence of the depreciation? One way to explain this conundrum is to argue, unsatisfactorily at times, that you are capturing the "true impact" of the replacement and that both do exist. Once pressed on this issue, typically the instructor is left lacking a satisfactory explanation.

This article presents a different approach by analyzing the old machine and the new machine separately, similar to the net advantage of leasing (NAL).[3] Not surprising, the two answers will equal the same of that of the combined analysis. This is akin to Shiller's above referenced conservation laws, and/or Modigliani and Miller's 1958 irrelevancy theorem, meaning that value is not created from financing, but from the cash-flows. So to, this analysis can help reinforce the idea that a replacement decision is nothing more than two separate NPV's combined.

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[1] *Finance and the Good Society*, p.132 (2012). In physics we have the *Law of Conservation of Matter and Energy* which says that matter and energy can neither be created nor destroyed. In finance the conservation law would be as follows: value cannot be created or destroyed via transactions or financing—meaning that value lies with underlying cash-flows and not the financing surrounding the assets. In terms of a balance sheet, it is the assets that create value, not the liabilities.

[2] *See* Brigham, *Intermediate Financial Management* (2003), Appendix 11-B.

[3] The NAL calculates the NPV of leasing and of purchasing an asset separately and then nets the two.

From a pedagogical standpoint, students get a better understanding that recognizing the sale of the old machine and the recognition of the old depreciation is consistent with an incremental after-tax cash-flow analysis. Several excel spreadsheets are included to help explain the process and make it clear to students that when taken separately, the analysis is correct to include both.

II. The Problem

Assume that an existing widget machine has the following properties:

Table 1: Inputs

	Old Machine	*New Machine*
Purchase Price	$400,000 (**5 years ago**)	$600,000
Market Value	$80,000	$600,000
Book Value	$200,000	$600,000
Salvage Value	$0 (**5 years from now**)	$70,000 (**10 years from now**)
Age	5	0
Original Life	10	10
Yearly capacity	45,000 units	55,000 units
Sales Price	$8/unit	$8/units
Yearly expenses	$55,000	$75,000
Training expenses	not applicable	$30,000
Inventory	$40,000	$50,000
Tax rate	40%	40%
Discount rate	10%	10%

A traditional replacement chain analysis would be as follows:

Initial

($600,000)	purchase price
$80,000	market value
$48,000	tax gain on sale (200,000 -80,000) *.4 = $48,000
($18,000)	after-tax training
($10,000)	Δworking capital
($500,000)	initial outlay

Intermediate

old dep = $400,000/10 = $40,000
new dep = $600,000/10 = $60,000

Note: Straight line depreciation is used throughout for simplicity. Salvage value of zero is assumed when calculating the annual depreciation.

Δ dep	= \$20,000
Δ Rev = 10,000 units × \$8	= \$80,000
Δ Costs = \$75,000- \$55,000	= \$20,000

$\Delta CFAT_{1-5}$ = (\$80,000 - \$20,000 -\$20,000) (1-.40) + \$20,000
= \$44,000

ΔRev	= 440,000 - 0	= \$440,000
ΔC	= 75,000 - 0	= \$75,000
Δ Dep	= 60,000 - 0	= \$60,000

$\Delta CFAT_{6-10}$ = (\$440,000 - \$75,000 - \$60,000)(1-.40) + \$60,000
= \$243,000

Terminal

70,000(1-.4) = 42,000 + 50,000 (ΔWC) = 92,000

0	1	2	3	4	5	6	7	8	9	10
↓ (500k)	↑ 44k	↑ 44k	↑ 44k	↑ 44k	↑ 44k	↑ 243k	↑ 243k	↑ 243k	↑ 243k	↑ 243k + 92k = 335k

$NPV_{@10\%}$ = \$274,233
IRR = 17.52%

(Table 2 and 3 here)

III. Disassembling the Cash-Flows

A. The Old Machine:

If we take the old machine and consider disposing the asset at the present time, the cash-flows as follows:

Initial

(\$80,000)	market value
<u>(\$48,000)</u>	tax consequences of the sale (200,000 -80,000) *.4 = \$48,000
(\$128,000)	*This represents the lost opportunity of not selling the machine.*

Intermediate

Rev	= 45,000 units × \$8	= \$360,000
Costs	=	= \$55,000
Dep	= \$400,000/10	= \$40,000

$\Delta CFAT_{1\text{-}5}$ = ($360,000 - 55,000 -40,000) (1-.40) + 40,000 = $199,000

Terminal

$40,000 (*Recovery of working capital*)

	199k	199k	199k	199k	199k+40k
0 ↓	↑	↑	↑	↑	↑
(128k)	1	2	3	4	5

$NPV_{@10\%}$ = $651,203.42
IRR = 154.46%

(Table 4 here)

The analysis shows that the old machine still provides a healthy proportion of the total benefits. Furthermore, the initial costs are the foregone opportunity costs of <u>not</u> selling the machine at the present time. [4] Students can see how the sale of the old machine is actually an opportunity cost and does not impact the depreciation at all. Thus the depreciation that is recognized in the analysis is correct.

B. The New Machine:

If we take the new machine and consider disposing the asset at the present time, we could look at the cash-flows as follows:

Initial

($600,000)	purchase price
($18,000)	after-tax training
<u>$14,836.85</u>	Δworking capital
($603,163.15)	

Intermediate

Rev	= 55,000 units × 8	= $440,000
Costs		= $75,000
Dep	= 600,000/10	= $60,000

[4] The analysis in some ways invokes the abandonment value as discussed in Robichek & Van Horne (1967).

$\Delta CFAT_{1\text{-}10}$ = (\$440,000 - 75,000 -60,000) (1-.40) + 60,000 = \$243,000

Terminal

70,000(1-.4) = 42,000 + 50,000 (*Recovery of working capital*) = \$92,000

0	1	2	3	4	5	6	7	8	9	10
(603.163k)	243k	243k	243k	243k	243k	243k	243k	243k	243k	243k + 92k = 335k

$NPV_{@10\%}$ = \$925,436.64

IRR = 39.01%

(Table 5 here)

The initial change in working capital is the combination of the an additional \$10,000 (negative) needed to run the new machine and the benefit of not having to expend the \$40,000 at the present time, but rather in five-years. The present value of the \$40,000 is computed as a benefit. Thus the net is equal to the \$14,836.85. This is hardest concept to explain because it requires the student to place themselves at time zero and realize that the \$40,000 did not have to be expended at the present time because it exists at the present time in the form of inventory that exists due to the old machine.

C. Recognizing working capital

Also, it is important to note that if the working capital is completely ignored, from the computation of the individual NPVs, the same net NPV would be computed but individual NPV of the new machine and of the old machine would be overstated. Looking at Table 6 above while the net NPV will remain the same (column c), the individual components that make up the old and new, as a percentage of the net NPV of the replacement analysis are not the same. This is important because ‘ ‘ ‘ ‘

Table 6: Comparison of Value using Working Capital and not using Working Capital as a Percentage of Net NPV

	NPV of old Machine (a)	*NPV of New Machine (b)*	*Net NPV (c)*	*Net NPV % of Old NPV (d)*	*Net NPV % of New NPV (d)*
Using ΔWC	$651,203.42	$925,436.64	$274,233	*42.9%*	*29.6%*
Not Using ΔWC	$626,366.57	$900,599.79	$274,233	*43.8%*	*31.41%*

IV. Conclusions

Too often analyzing replacement projects in capital budgeting, leads to confusion when it comes to recognizing the sale of the old machine while also using the depreciation at the same time. This paper separates or disassembles the analysis into the continuation of the old machine, and the adoption of the new machine. This allows the student to appreciate how the individual components correctly capture the true value of the decision.

References:

Mauer, D., & Ott, S. (1995). Investment under Uncertainty: The Case of Replacement Investment Decisions. *The Journal of Financial and Quantitative Analysis, 30*(4), 581-605. doi:1. Retrieved from http://0-www.jstor.org.source.unco.edu/stable/2331278 doi:1

Robichek, A., & Van Horne, J. (1967). Abandonment Value and Capital Budgeting. *The Journal of Finance, 22*(4), 577-589. doi:1. Retrieved from http://0-www.jstor.org.source.unco.edu/stable/2326002 doi:1

Shiller, Robert (2012). *Finance and the Good Society*.