ADDENDUM TO MULTIPLE FACTORS FOR A NEW INTERNAL RATE OF RETURN ANALYSIS METHOD. THE CASE OF ACQUISITION OF PRODUCTIVE FIXED ASSETS

XXI CONGRESO INTERNACIONAL DE CONTADURÍA ADMINISTRACIÓN E INFORMÁTICA

Área de investigación: Finanzas

Juan Carlos García-Piña Rosete
Universidad Complutense de Madrid
España
juancarlos.gpr@gmail.com

ANFECA
Asociación Nacional de Facultades y Escuelas de Contaduría y Administración
alafec

Addendum to multiple factors for a new internal rate of return analysis method. The case of acquisition of productive fixed assets

Resumen

Ampliación de trabajo previo que explora las deficiencias del método de análisis de la Tasa Interna de Retorno para Decisiones Corporativas de Inversión. Se incluyen trabajos previos donde autores distintos han investigado los beneficios de adaptar la fórmula de la Tasa Interna de Retorno para obtener resultados más eficientes correspondientes a los diferentes procesos de toma de decisión en específico de los sectores financieros y de bienes raíces. Sin embargo, hay un vacío de análisis relativo a los sectores de manufactura y productivos. El propósito es proyectar la necesidad de adicionar factores al método actual teniendo como objetivo la eficiencia del proceso de Toma de Decisiones. Los factores sujetos al análisis son los siguientes: inflación, ingresos marginales y eficiencia relativa a maquinaria productiva. La adición de dichos factores en una fórmula combinada agregaría valor y certeza al análisis; de este modo, proveería decisiones eficientes a los corporativos que intentan engrandecer o expandirse internacionalmente.

Amplification of previous work that explores the shortcomings from the Internal Rate of Return analytical method for Corporate Investment Decisions. The inclusion of previous studies where different authors have researched the benefits of adapting the internal rate of return formula corresponding to different decision-making processes specifically those deemed to financial sectors and real estate where more efficient results are obtained. However, there is a lack of analysis on the manufacturing and productive sectors. The purpose is to project the necessity to add factors to the current method aiming process efficiency for Decision Making. The factors subject to analysis are: inflation, marginal revenue and efficiency on production machinery. The addition of these factors on a combined formula would add value and certainty to the analysis; thus, providing efficient corporate decisions for those companies attempting to grow or expand operations internationally.

Palabras clave / Key terms: Tasa interna de retorno; toma de decisiones de inversión; inflación; ingresos marginales; eficiencia. Internal rate of return; investment decision making; inflation; marginal returns; project efficiency.

I. Introduction

The most widely accepted as theoretically accurate analysis methods for Investment Decision Making Processes have been for over eight decades the Net Present Value (NPV), and the Internal Rate of Return (IRR). The NPV results in a monetary value for prospective Investments' probable future cash flow at the present time of the analysis by discounting the future inflows of cash at the prevailing market interest rate. The IRR results in a discount rate as a derivative of the NPV, by allocating that the investment amount must equal the sum of the probable cash inflows resulting in zero. Each method is selected based on what the financial analyst is seeking for, whether is the monetary value or the discount rate. Due to this fact, it is required to take a further comparison to ascertain the correspondent results derived from each method.

For the most part, the discount rate rendered by the IRR is quite appropriate for most decisions, since its result is the return rate expected to obtain by the project at hand. This method has strong relevance for several industries; specifically in the financial, real estate, and other productive industries. Unfortunately, this method has been analyzed by several researchers as being limited at its present form. The concurrent research by authors like Magni, and Trifonov have opted for the addition of factors to the IRR model; subsequently, their proposal is to develop alternative methods such as the Modified Internal Rate of Return, Incremental Internal Rate of Return, and the Average Internal Rate of Return as more effective methods. (Magni, Aggregate Return on Investment and Investment Decisions: A new Perspective, 2010) (Trifonov, Yashin, Koshelev, & Makarov, 2011)

The above mentioned proposals have advocated for the inclusion of marginal returns within the Internal Rate of Return Method, their proposals have proven that the inclusion of such factor does provide different results, deemed as relatively more accurate to the real expectancy of net returns throughout the project's prospective future years of operations.

The present paper will attempt to circumscribe its effort in establishing a background allocation for missing factors such as Inflation, Marginal Returns, and Productive Equipment Efficiency. For this purpose, a projected purchase of new machinery from a metallurgical corporation would be analyzed empirically from its projection and the results up to the fifth year of operations.

II. Theoretical framework

The Internal Rate of Return (IRR) and the Net Present Value (NPV) models are the most widely used set of analysis for investment decisions in corporations. Both methods were introduced by Irving Fisher, an American neoclassical economist, on its 1930's book entitled "The Theory of Interest". Fisher explained the role that interests play in long-term investments, where time is the leading factor to assign the profit value in the present moment of the analysis. (Fisher, 1930) The reason for their widespread usage is the practical implications, and by offering relative measures of worth, also commonly required by investors. The reasons for a relative measure of worth is often seen that a percentage return is easily understood and is felt as an intuitive measure by most investors. (Evans & Forbes, 1993)

As stated, the Internal Rate of Return offers a relative percentage measure of worth obtained from the Net Present Value method application of monetary value. The Internal Rate of Return model has been defined by Fisher as the moment where the Net Present Value of a specific project's cash flow equals zero. (Fisher, 1930) For an investor to select an evaluated option, the selected choice must be equal or exceed a desired return, which must be superior to the corporation's cost of capital funding, in order for such corporation to report a profit from its intended investment project.

This method has prevailed applicable for over 86 years, now seen as to possess several flaws, which are going to be discussed in this paper. Friedrich A. Lutz has stated that Fisher's method did not consider the existence of variable interest rates, but fixed interest rates. (Lutz, 1968) This consideration occurs for the majority of the developed nations, while in some under developed or developing nations, variable interest rates are a constant. This paper's considerations relate to the existence of factors such as inflation, marginal returns, and in specific cases of productive fixed assets' efficiency have not being considered.

Inflation has concurrent relevance, due to the fact that currently prices do change, in the past it was not relevant for any study. (Wofford, 2013) Inflation has profound implications in most economies, due to the fact that international corporations with several locations in different regions of the world have to face substantial differences in monetary values for long term operations.

As an example the following chart depicts the dissimilarities from different countries in the world based on a five year timeframe in terms of inflation. Data from the World Bank.

Country	2011	2012	2013	2014	2015
Australia	3.30	1.80	2.40	2.50	1.50
Austria	3.30	2.50	2.00	1.60	0.90
Belgium	3.50	2.80	1.10	0.30	0.60
Bolivia	9.80	4.60	5.70	5.80	4.10
Brazil	6.60	5.40	6.20	6.30	9.00
Cambodia	5.50	2.90	2.90	3.90	1.20
Cameroon	2.90	2.90	1.90	1.90	2.70
Canada	2.90	1.50	0.90	1.90	1.10
Chile	3.30	3.00	1.80	4.40	4.30
China	5.40	2.60	2.60	2.00	1.40
Colombia	3.40	3.20	2.00	2.90	5.00
Czech Republic	1.90	3.30	1.40	0.30	0.30
Denmark	2.80	2.40	0.80	0.60	0.50
Ecuador	4.50	5.10	2.70	3.60	4.00
Egypt	10.10	7.10	9.40	10.10	10.40
Finland	3.40	2.80	1.50	1.00	-0.20
France	2.10	2.00	0.90	0.50	0.00
Germany	2.10	2.00	1.50	0.90	0.20
Ghana	8.70	9.20	11.60	15.50	17.10
India	8.90	9.30	10.90	6.40	5.90
Italy	2.70	3.00	1.20	0.20	0.00
Jamaica	7.50	6.90	9.30	8.30	3.70
Japan	-0.30	0.00	0.40	2.70	0.80
Mexico	3.40	4.10	3.80	4.00	2.70
Netherlands	2.30	2.50	2.50	1.00	0.60
New Zealand	4.40	0.90	1.30	0.90	0.20
Peru	3.40	3.70	2.80	3.20	3.60
Russia	8.40	5.10	6.80	7.80	15.50
Saudi Arabia	5.80	2.90	3.50	2.70	2.20
Spain	3.20	2.40	1.40	-0.10	-0.50
Sweden	3.00	0.90	0.00	-0.20	0.00
Switzerland	0.20	-0.70	-0.20	0.00	-1.10
Turkey	6.50	8.90	7.50	8.90	7.70
United Kingdom	4.50	2.80	2.60	1.50	0.10
United States	3.20	2.10	1.50	1.60	0.10

From the previous chart is seen that developed nations' economies, unless an unforeseen event occurs, are deemed as very stable with minor fluctuations. For the most part, corporations from such developed nations expand their international operations to countries where economic conditions are not similar to their country of origin. This circumstance forces a disparity on the overall yearly income by affecting its purchasing power within unstable economies.

Bearing this in mind, the constant fluctuation of inflation, and dissimilar economic circumstances act as a force upon Investment Decisions. Inflation is a key player in terms of competitiveness, corporations seeking further expansions, such expansions will be deterred in unstable economic nations, since high inflation is a signal of economic instability.

In terms of the Internal Rate of Return Analysis, Inflation has not been considered as a factor in any previous literature. This situation must be adapted, since even in developed nations, price suffer variations; therefore, cash flows must be subjected to these fluctuations. Such fluctuations can have a positive or negative effect direct to the cash flow. Positive effects would occur in terms of proper adjustments in the expectancy of the cash flow. Negative effects would be a decrease in the real inflow of cash.

The following chart depicts a proposed consideration of both positive and negative effect of Inflation in the cash flow, considering an Inflation rate of 3%:

POSITIVE EFFECT	
YEAR	NEUTRAL CASH FLOW
0	(1,000,000.00)
1	300,000.00
2	309,000.00
3	318,270.00
4	327,818.10
5	337,652.64
NPV	592,740.74

NEGATIVE EFFECT	
YEAR	NEUTRAL CASH FLOW
0	(1,000,000.00)
1	300,000.00
2	291,000.00
3	282,270.00
4	273,801.90
5	265,587.84
NPV	412,659.74

Source: Author's Creation.

As it can be seen the positive effect will maintain the present value of money, while a negative effect will consider that Inflation affects customers' purchasing power turning the expected plan less profitable by 30%.

Another factor being analyzed is the presence of Marginal Returns, defined as the additional income derived from the reinvestment of the daily cash inflow. There have been two major analysis performed over this topic, one in Russia by a group of four researchers led by Trifonov, another commanded by Carlo Magni, an Italian economist. Both analysis propose the inclusion of marginal returns on investments, and even propose alternative formulas for this purpose to be fulfilled. Those researchers provided thorough evidence to prove that Capital Budgeting analysis methods have been lacking the presence of marginal returns. (Trifonov, Yashin, Koshelev, & Makarov, 2011) (Magni, 2010)

Another study provided by Dean Altshuler, in conjunction with Carlo Magni, researched the Real Estate industry in the United States. Altshuler's research demonstrate that all the previous knowledge regarding the Internal Rate of Return model does not depict the present circumstances, due to the lack of Marginal Returns factor into the determination of profit values relative to the projects being analyzed. (Altshuler & Magni, 2012) As seen, Magni has specialized in the research of this topic, and has comprised himself to develop further analysis regarding this topic.

A different approach from Magni, is the proposal of the Average Internal Rate of Return, which according to him, it's a model that serves multiple purposes for different sectors. This proposed method provides a class of rates of return. A specific rate of return is found by specifying the capital base on which the rate is applied. (Magni, Average Internal Rate of Return and Investment Decisions: A new perspective, 2007) As stated under this proposal, analysts will obtain different classifications of rates of return, when all the required data is accessed, the final result will be assessed and valued under the capital base specific to each corporation, and their availability of funds.

A different proposal comes from Salamon, where an examination for the methodology of the Internal Rate of Return model in terms of Accounting Disciplines is proposed, due to the lack of a relationship to fiscal accountancy. (Salamon, 2010) Although it is important to consider this important aspect, it needs to be treated separately, since the analysis is for specific projects that if accepted as an Investment Decision, will conform part of the entirety of the cash inflows and outflows of the integral corporation's activities, and its effect on the fiscal side will vary upon the size and further deployment of such projects.

Another relevant factor being analyzed is Productive Assets' Efficiency on an investment project. This factor has very limited bibliographical framework for analysis, due to the fact that corporations restrict its access to corporate outsiders for such research. The proposed analysis depicts the need to undergo an empirical study from real projections, and the actual development of the project. This factor is variable, and faces other characteristics such as quality, maintenance, and performance. Nonetheless, the actual deployment of the project certainly affects the distribution of the monetary inflows deemed as proper for each project.

A project's actual performance varies resulting in more profitable projects than others. Under this assumption, it is entailed that machinery with good quality, and well-designed equipment with a proper fit for each specific project results in higher monetary results. On the other hand, underachieving productive equipment will result in lesser profitable results. There's a stochastic study that has proven that through technology, performance results are improved by reducing human errors, and the maximum utilization of raw materials input by reducing defects and waste. (Adkins & Paxson, 2014) Hence attempting to evidence the need for outstanding quality productive equipment.

As stated through such obvious assumptions, and the lack of presence of bold bibliographical references, this paper attempts to prove through an empirical analysis that the actual performance of productive equipment has a sound impact affecting monetary results.

III. Methodology

This paper studies a real case from a metallurgical sector corporation that has undergone a recent investment in Salinas Victoria, Nuevo León, México for its epoxy bond fusion covering for the production of Steel Pipes specific for the Oil Industry usage. This move is a backward vertical integration, since it was previously outsourced to a specialist corporation, the reason behind this investment was the reduction of costs and improving delivery times for their customers achieving better monetary results from such sources. The investment was the acquisition of land, and equipment for developing a manufacturing plant valued in the 9 million euros range, that will perform the epoxy bond fusion covering on the Steel Pipes being manufactured in their other plants located in the metropolitan area of Monterrey, Nuevo León, México. The corporation at hand has had improved its results surpassing their expectations of performance.

To better assess the present analysis, a comparison of Internal Rate of Return and a relative method the modified, IRR will be performed with the empirical results obtained as actual performance from the described Investment. Subsequently, under Wilcoxon signed-rank test to prove which method converges more with the performance results obtained from the actual operation of this manufacturing plant.

This specific case has surpassed the projected estimations by huge margins, this situation which is a desirable outcome, is not a normal outcome for a five year empirical data. For this analysis, it represents a limitation, instead of properly assessing the actual performance of the deemed methods under normal circumstances, it's done under exceptional circumstances. According to the corporation at hand, the projections were based on the stated 90% capacity from the machinery. That is the reason why the Wilcoxon signed-rank test is the most appropriate comparison method, since it provides the pertinent information deemed specific for this analysis of non-parametric data.

The results section will portray the tables and graphs obtained from the present analysis.

IV. Results

The present analysis was over the Capital Budgeting that this corporation had undergone previously to the acquisition of the Salinas Victoria Plant. The corporation provided 5 years of cash flows, since it is the amount of time that the plant has been in operations. The cash flows provided were in the form of estimated savings in cost vs. the actual performance of such savings.

The data gave the opportunity to perform an overall analysis, by obtaining the Net Present Value at 5%, which according to this corporation is their regular Market Value Rate of Return with their regular banking institutions. At this Rate of Return such corporation budgeted a Return of roughly 5.6 million euros; while the actual performance is surpassing so far the 12.5 million euros, with a Variance Coefficient of 53.6%. The budgeted IRR was 24.5%, while the performance rate so far is over 43%, with a Variance Coefficient of 39.1%. The modified IRR under its budgeting stage was 15.2%, under its performance the result was 23.4%, with a Variance Coefficient of 33.8%.

Subsequently, the Wilcoxon signed-rank test was performed. On this analysis, the investment outflow was removed from the equation, since it was an

atypical value for the equation. On both cases, budget and actual performance, the value will have been the same; therefore, disregarded from this equation.

VALUE	BUDGET	ACTUAL	VAR. COEFF.
NPV	5.6 M €	12.5 M €	53.6%
IRR	24.5%	43%	39.1%
MIRR	15.2%	23.4%	33.8%

The Wilcoxon signed-rank test was based on the following hypothesis:

H_0: There is no Significant Difference between the Budgeted and the Actual Performance Results.

H_1: There is a Significant Difference between the Budgeted and the Actual Performance Results.

The level of significance of reference was 5%, from which we obtained a P Value of .043, since it is a two sided test, the resulting P Value indicates the H_1 is accepted that there is a Significant Difference between results.

The following table provides the results obtained:

Wilcoxon sign-rank test		
	BUDGET	***ACTUAL***
Median	3,410,359	5,235,687
Interquartile Range	511,761	1,218,611
Observations	5	
Z-Value	**-2.023**	
P Value	**.043**	

After proving that there is a significant difference between the Budget and the Results obtained, adjustments were made to the Corporations' Budget Figures, adjusting with an average inflation rate for México during the time frame, Marginal Returns valued at the Market Rate for this Corporation, and adjusting the Machinery's Efficiency to 100%.

The following Results were obtained from the comparison of the proposed method against the results obtained from the operations:

VALUE	PROPOSED	ACTUAL	VAR. COEFF.
NPV	11.6 M €	12.5 M €	5.6%
IRR	41%	43%	3.8%
MIRR	23.3%	23.4%	3.3%

Subsequently, testing the data under the same hypothesis as on the previous exercise the result was to accept the null hypothesis that there is no significant difference between this proposed method and the results obtained.

Wilcoxon sign-rank test		
	PROPOSED	***ACTUAL***
Median	4,773,988	5,235,687
Interquartile Range	1,265,073	1,218,611
Observations	5	
Z-Value	**-1.214**	
P Value	**.225**	

The level of significance of reference was 5%, from which we obtained a P Value of .226, since it is a two sided test, the resulting P Value indicates the H_0 is accepted that there is No Significant Difference between results, proving that the addition of the proposed factors turn Capital Budgeting Methods more accurate up to the degree of having no significant difference in results.

V. Conclusions

The conclusions that arise from this analysis is that according to the theoretical framework, there is an ample background for depicting the overall actualization of the Capital Budgeting Methods, deemed outdated by several authors, and for over three decades there has been discussions about the adaptability of such methods. This discussion is current, due to the availability of concurrent analysis undergoing for such methods, and the fact that entities require to suffice the need for more accurate Capital Budgeting procedures.

International Corporations attempting to expand to newer markets struggle with global economic factors such as different inflation rates, different interest rates, and monetary exchange rates, among others. The presence of such factors must be taken into consideration in the different processes of Capital Budgeting with the option to improve its turnout of results.

Most situations depict the overall presence of Marginal Returns during performance cash flows. There are current methods or modified methods that

have adapted the presence of both Returns, the financing of the project and the marginal returns. Modified IRR uses this inclusion of factors, which was proven to have a lesser Variance Coefficient, but still had a significant difference between the results obtained under both processes of nearly 34%.

The factor that has the lesser degree of bibliographical research is the efficiency of the productive equipment, due to the fact that there is minor accessibility for empirical research from corporations. The conclusions relative to this factor are obvious that through accessing more technologically sound equipment, and reducing the presence of human error, meaning that equipment that require limited or null human intervention tend to be more efficient. Nonetheless, without proper maintenance, and strict controls machinery will tend to reduce its efficiency.

According to the corporation that served the present research, the cause for such outstanding results was the fact that the equipment provided a higher efficiency than the expected initially, allowing them to increase their cost's savings. Therefore, this factor addition must be considered in the Capital Budgeting as a correction method for a better allocation of the financial results.

The present research has shown at a level of confidence of 95%, through empirical analysis of results that Capital Budgeting Methods deviate substantially from the actual performance of the Investment Project at hand.

As a final conclusion, the addition of factors in a single model improved results up to the point of no significant difference between results. This proves that such factors addition are in fact necessary for more accuracy when performing Capital Budgeting Analysis.

VI. Bibliography

Adkins, R., & Paxson, D. (2014). Stochastic Equipment Capital Budgeting with Technological Progress. *European Financial Management*, 1031-1049.

Altshuler, D., & Magni, C. (2012). Why IRR is Not the Rate of Return for Your Investment: Introducing AIRR to the Real Estate Community. *Journal of Real Estate Portfolio Management*, 219-230.

Arshad, A. (2012). Net Present Value is better than Internal Rate of Return. *Interdisciplinary Journal of Contemporary Research in Business*, 212-219.

Dudley, C. L. (1998). A Note on Reinvestment Assumptions in choosing between Net Present Value and Internal Rate of Return. *The Journal of Finance*, 907-915.

Evans, D., & Forbes, S. m. (1993). Decision making and display methods: the case of prescription and practice in capital budgeting. Eng. Econ. 39, 87–92. *Eng. Economics*, 39, 87–92.

Fisher, I. (1930). *The Theory of Interest.* New York: Macmillan.

Lutz, F. A. (1968). *The Theory of Interest.* New Brunswick: Transaction Publishers.

Magni, C. A. (2005). On decomposing net final values: EVA, SVA, and shadow project. *Munich Personal RePEc Archive*, 1-29.

Magni, C. A. (2007). Addendum to "Average Internal Rate of Return and Investment Decisions: A new perspective.". *The Engineering Economist*, 181-182.

Magni, C. A. (2007). Average Internal Rate of Return and Investment Decisions: A new perspective. *The Engineering Economist*, 140-169.

Magni, C. A. (2009). Investment decisions, net present value and bounded rationality. *Quantitative Finance*, 967-979.

Magni, C. A. (2010). Aggregate Return on Investment and Investment Decisions: A new Perspective. *The Engineering Economist*, 140-169.

Magni, C. A. (2011). In search of the "Lost Capital". A Theory for Valuation, Investment Decisions, Performance Measurement. *Frontiers in Finance and Economy*, 87-147.

Pae, J., & Yoon, S.-S. (2012). Determinants of Analysts' Cash Flow Forecast Accuracy. *Journal of Accounting, Auditing & Finance.*, 123-144.

Salamon, G. L. (2010). Models of the Relationship between the Accounting and Internal Rate of Return: An Examination of the Methodology. *Journal of Accounting Research*, 296-303.

Sarnat, M., & Levy, H. (1990). The relationship of Rules of thumb to the Internal Rate of Return: A Restatement and Generalization. *The Journal of Finance*, 479-490.

Trifonov, Y. V., Yashin, S. N., Koshelev, E. V., & Makarov, S. A. (2011). Planning an Investment Program of a company in view of Reinvestment Opportunities. *International Journal of Business and Social Science*, 307-314.

Wofford, R. (2013, April 12). Economics Lecture during University of the Ozarks Alumni Weekend.

World Bank. (2016, May 15). *Inflation, consumer prices annual.* Retrieved from World Bank: http://data.worldbank.org/indicator/FP.CPI.TOTL.ZG