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Unlocking Financial Efficiency: A Practical Guide to Using Google Spreadsheets for Future Value and Amortized Loan Calculations

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Abstract. The paper addresses the use of spreadsheets to determine the future value (FV) of amortized loans and simple annuities, two components of time value of money calculations. This paper uses a library research approach with the main data from the book Financial Management: Principles and Applications by Titman et al (2018). The methods for calculating future value in this paper can be used to determine interest rates on loans and long-term investments. Moreover, this paper also discusses the amortized loan as a calculation of repayment process to a debt that is carried out periodically to end of the term. This paper contributes to provide an open-access Google spreadsheet that can be freely utilized by the public to facilitate future value and annuity payment calculations. Financial computations become more efficient and user-friendly, as users may modify the input data as needed, and the spreadsheet produces instantaneous results.

Keywords: Amortized Loan; Financial Management; Future Value of Simple Annuities

1. Introduction

Various components of financial management are involved in every aspect of corporate operations. Annuities are one type of them; they are a series of equal payments paid out over a predetermined period of time at regular intervals. In this financial context, annuities serve as a tool for computing the present value of forthcoming cash flows, a pivotal tool for facilitating prudent investment choices. Notably, the ordinary annuity formula specializes in the assessment of the present value of a set of equal payments issued at the conclusion of each defined period (Blaylock, 2014).

The ordinary annuity formula can be used to assess the present value of future cash flows, which, in turn, informs strategic investment decisions (Dutta et al., 2015). It equips businesses with the ability to calculate the present value of expected cash flows, providing data needed for making informed investment choices (Tzur et al., 2007). To illustrate its practical utility, imagine a scenario where a company is evaluating an investment opportunity expected to yield consistent annual cash flows of $10,000 for the next five years. In this case, the ordinary annuity calculation will allow the company to determine the present value of these cash flows and thereby uncovering the true value of the investment.

Many studies have discussed the use of such formula. Some, such as those by Viskotová & Říhová (2016) and Kumar & Hennessey (2006), have explored the intricacies of annuities, specifically focusing on ordinary annuities and cost-of-living considerations, others like Flórez at al. (2019) have delved into the calculation of interest rates within this context. Fisk' patent (United States Patent No. US20050137965A1, 2005) has also introduced a unique business method to be utilized in home construction and mortgage financing. However, there remains a need for further research aimed at simplifying and enhancing the practical application of these financial concepts. Hence, this study seeks to address this gap by providing a comprehensive and practical guide on utilizing Google Spreadsheet, a widely accessible tool, to calculate ordinary annuities and amortized loans. By bridging the gap between theory and application, this research helps students, individuals, businesses, and financial professionals to make informed and efficient financial decisions through hands-on calculations, and contributing to the broader understanding of implementation of annuities and loans in real-world scenarios.

2. Theoretical Framework

The concept of the time value of money is a foundational theory in financial management, recognized extensively in disciplines like actuarial science and finance (Poggi, 2023). Essentially, it posits that the value of money today has the potential to transform positively over time. This principle encompasses a comprehension of interest rates and functions as a valuable instrument for analyzing and comparing various financial undertakings, spanning loans, bonds, mortgages, pawnshops, contracts, and savings (Wilkinson & Wilkinson, 2023).

Among the formulas originating from this theory is the concept of the future value of an ordinary annuity. This calculation quantifies the total value of a set of regular fixed payments at a specific future date when coupled with a particular interest rate. The word "value" in this term is the cash potential that a series of future payments can achieve. The payments in a typical annuity are distributed at the end of a pay period.

An annuity represents a series of regular and consistent payments or receipts, unfolding over a defined timeframe. What distinguishes this structure is the consistent nature of these payments, providing customers with the convenience of making pre-determined nominal installments at regular intervals. Annuity principles find applications in various financial contexts, whether it's managing loans or handling long-term investments (Oktavia et al., 2023). Additionally, annuities are integral in contracts between workers and insurance companies, where workers make a series of payments and, in return, receive regular disbursements after a specified time (Mardiyanti, 2023). Among these, the ordinary annuity stands as a sequence of uniform payments, each occurring at the conclusion of a designated time period and spanning a predetermined duration (Violita et al., 2023).

The concept of future annuity value offers numerous advantages. Firstly, it prompts the assessment of one's intended retirement age, taking into account the time between their present age and the desired retirement age. A longer duration implies reduced financial requirements (Edianto et al., 2023).

Future annuity value also aids in estimating future living expenses, encompassing various outlays such as food, transportation, electricity, vehicle maintenance, home upkeep, and various leisure and entertainment expenses. For instance, if someone anticipates monthly living expenses of 5 million rupiahs, this can serve as a foundation for future calculations. However, it's crucial to note that the current value of 5 million rupiahs will significantly differ from its future worth during retirement (Ouazzani et al., 2022).

Furthermore, the future value of annuity can be used to calculate annual inflation. Annual inflation gradually erodes the value of money over time, and prices of various products steadily rise each year. Therefore, calculating the inflation factor can help in planning for retirement (Oktavia et al., 2023).

Lastly, this calculation streamlines the process of determining essential savings for retirement, facilitating informed financial planning. After determining the necessary retirement funds, calculating the yearly contributions necessary to accomplish that target will be easier (Julia, 2022).

The formula used to calculate future value of ordinary annuity is:

$$\text{FV} = PMT\ x\ \left(\frac{(1+i)^n - 1}{i}\right)$$

Where:

FV	= future value
PMT	= annuity
i	= interest rate per year
n	= number of time periods until payment

For example, if Abdi saves Rp 30,000,000 a year for ten years with 5% interest in bank X, the future value of his savings would be:

$$\text{FVn} = 30{,}000{,}000\ x\ \left(\frac{(1+0.05)^{10} - 1}{0.05}\right)$$

$$\text{FVn} = 30{,}000{,}000\ x\ \left(\frac{0.63}{0.05}\right)$$

$$\text{FVn} = 30{,}000{,}000\ x\ 12.58$$

$$\text{FVn} = 377{,}336{,}776$$

Therefore, the future value of Abdi's savings in bank X would be Rp 377,336,776. He may then compare this calculation to other saving or investment instruments, and decide what is best for his profile.

Derived from the theory of time value of money, another financial concept is the amortized loan. An amortized loan represents a well-structured financial arrangement in which borrowers are obliged to make consistent payments at regular intervals. These payments encompass both the principal amount borrowed and the accrued interest, ensuring that the entire loan is fully repaid by the conclusion of the predetermined term (Norberg, 2018). This approach contrasts with other types of loans, such as interest-only

loans, where borrowers initially only pay the interest, with the complete principal amount due at the term's end.

Amortized loans serve used in various financial scenarios, including mortgages, auto loans, and personal loans (García-Santillán et al., 2016). The payment schedule is designed to allocate a higher proportion of each instalment toward covering interest during the initial phases of the loan. As the loan goes on, the borrowers would pay less for interest and more for principal. This means that in amortized loans, borrowers pay more interest over the loan's lifespan when compared to shorter-term loan options. However, the advantage lies in the predictability and manageability of these payments, where borrowers will know precisely how much they need to allocate for their monthly payments, and plan their finances accordingly (Huang, 2018).

Amortized loan also reduced overall interest costs for borrowers. By spreading interest payments across the loan's term, borrowers can alleviate the financial burden of high interest expenses (Kljenak et al., 2019). Moreover, borrowers steadily accumulate equity in the financed asset as he pays his principal debt. This increases his ownership of whatever asset he bought toward full ownership of the asset (Memon et al. 2022).

The formula used to calculate future value of ordinary annuity is:

$$\text{PMT} = \frac{i \times PV}{1 - (1 + \text{i})^{-n}}$$

Where:

PMT = yearly payment

i = interest rate per year

PV = principal debt

n = number of time periods until payment

For example, if Abdi has Rp 150,000,000 of debt for ten years with 5% interest in bank X, the yearly payment for his debt would be:

$$\text{PMT} = \frac{0.05 \times 150{,}000{,}000}{1 - (1 + 0.05)^{-10}}$$

$$\text{PMT} = \frac{70{,}500{,}000}{0.39}$$

$$\text{PMT} = \text{Rp}19{,}425{,}686.24$$

Therefore, the yearly payment for Abdi's debt in bank X would be Rp 19,425,686 or Rp 1.618,807 per month. He may then compare this calculation to other financing products and decide what is best for his profile.

3. Methods

This is a qualitative paper with a library research approach. The primary material that is the main data for this paper is the book Financial Management: Principles and Applications by Titman, et al. (2018). The formulations of future value of ordinary annuity

and amortized loan put forward in the book are then formulated in the form of Google Spreadsheet to answer the objectives of this paper.

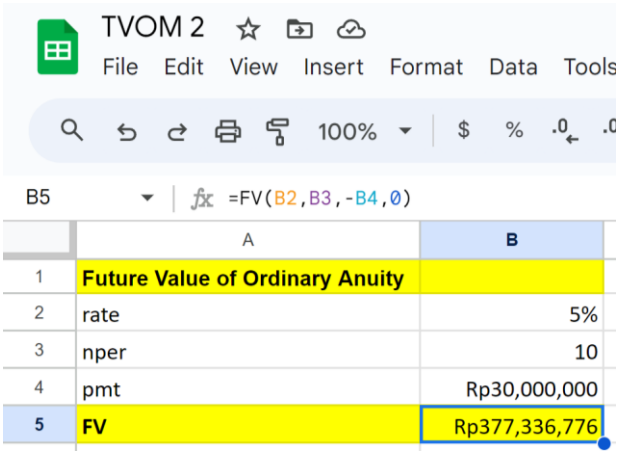
4. Result and Discussion

Calculating the future value of an ordinary annuity and amortized loan manually can be quite a daunting task. This complexity arises from the intricate formulas involved, featuring a multitude of variables and intricate steps. Hence, manually conducting these calculations can become a laborious task, often marred by the potential for errors. Recognizing the challenges that individuals may face in navigating these intricate calculations, the primary goal of this paper is to streamline the process and enhance its accessibility. Within this framework, the paper endeavors to offer a user-friendly guide, showcasing how readily available tools such as Google Spreadsheets and Microsoft Excel can be harnessed to perform these calculations with ease and precision. Through the provision of step-by-step instructions and illustrative examples, this guide is designed to efficiently determine the future value of ordinary annuities and amortized loans without the need for intricate manual computations.

To calculate future value of ordinary annuity in Google Speadsheet, the following formula can be used:

$$=FV(rate,nper,-pmt, pv)$$

In this formula, *FV* is future value, *rate* is the interest rate, *nper* is the time period (years), *pmt* is the number of regular investments, and PV is the present value which is not present in this calculation and hence stated as 0. The calculation seen in Google Spreadsheet will be as follows**:**



	A	B
1	**Future Value of Ordinary Anuity**	
2	rate	5%
3	nper	10
4	pmt	Rp30,000,000
5	**FV**	Rp377,336,776

Figure 1. FVn Calculation in Google Speadsheet. Processed by authors (2023).

In figure 1, *rate* is located in cell B2, *nper* in cell B3, and *pmt* in cell B4. *pv* will be stated as 0 as it does not exist in this calculation. Hence, to formula to calculate the future value of Abdi's savings if he saves Rp 30,000,000 a year for ten years with 5% interest in bank X would be:

$$=FV(B2,B3,-B4, 0)$$

After the formula is entered in cell B5, press Enter and the calculation result will immediately appear. The calculation result in Google Spreadsheet is exactly the same as the

manual calculation result that has been exemplified in the theory section of this paper. The values in cells B2-B4 can also be changed according to the existing data, and the FV value will immediately appear as long as the formula in cell B6 is not changed.

Next, to calculate amortized loan in Google Speadsheet, the following formula can be used:

=PMT(rate,nper,-pv,fv)

In this formula, *PMT* is the payment amount, *rate* is the interest rate, *nper* is the number of period (years), *pv* is the present value of principal debt, and FV is the future value which is not present in this calculation and hence stated as 0. The calculation seen in Google Spreadsheet will be as follows**:**

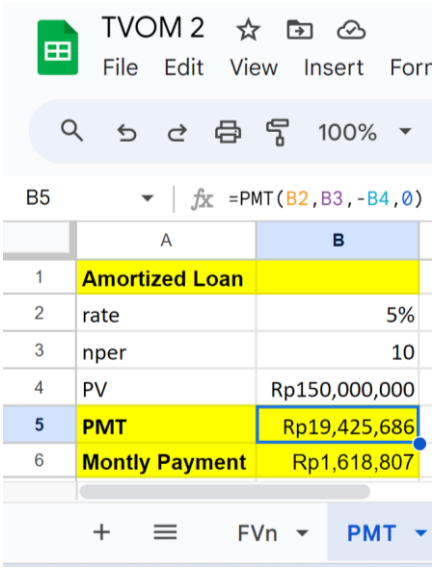


Figure 2. PMT Calculation in Google Speadsheet. Processed by authors (2023).

In figure 2, *rate* is located in cell B2, *nper* in cell B3, and *pv* in cell B4. *fv* will be stated as 0 as it does not exist in this calculation. Hence, to formula to calculate the amount of payment that of Abdi has to pay if he has Rp 150,000,000 of debt for ten years with 5% interest in bank X would be:

=PMT(B2,B3,-B4, 0)

Just as before, after the formula is entered in cell B5, the calculation result will immediately appear after the Enter button is pressed, which would have the same result as the manual calculation. We can then proceed to determine the monthly payment by dividing PMT result by 12 (=B5/12), which in this case is calculated in cell B6.

This spreadsheet can be accessed freely this link: https://docs.google.com/spreadsheets/d/1pChvnF7xLp81vns3LYaShW9LFap08EeeFgjqZv-wzGo/edit?usp=sharing. However, we still strongly encourage users, especially students to take the opportunity to perform these calculations manually and become acquainted with the underlying formulas for future value of an ordinary annuity and amortized loans. While the spreadsheet offers convenience and efficiency, understanding the principles and formulas behind these financial calculations can also serve as an

educational exercise, and enhance the skills to perform these calculations independently when needed.

5. Conclusions

Leveraging Google Spreadsheet for calculating the future value of an ordinary annuity and amortized loan comes with several notable benefits. It enhances productivity by automatically refreshing the pivot table when new data is input, making work more efficient. Moreover, it ensures precise calculations, surpassing the accuracy of manual mathematical formulas. However, performing these calculations manually is recommended for those seeking a deeper understanding of the financial concepts involved.

This paper only presents how to calculate future value of ordinary annuity and amortized loan through Google Spreadsheet, and does not present other formulas. In addition, this paper also does not apply these calculations through other tools such as financial calculators, special computer programs, etc. Therefore, future authors can develop this financial management study by filling in these gaps.

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