VSB – TECHNICAL UNIVERSITY OF OSTRAVA
FACULTY OF ECONOMICS

DEPARTMENT OF FINANCE

CorporateMetrics Methodology Application for the Risk Analysis in PepsiCo Company
Aplikace metody CorporateMetrics pro analýzu rizika ve společnosti PepsiCo

Student: Bc. Yini Chen
Supervisor of diploma thesis: doc. Ing. Miroslav Čulík, Ph.D.

Ostrava 2022

VSB – Technical University of Ostrava
Faculty of Economics
Department of Finance

Diploma Thesis Assignment

Student: **Bc. Yini Chen**

Study Programme: N0412A050005 Finance

Title: CorporateMetrics Methodology Application for the Risk Analysis in PepsiCo Company
Aplikace metody CorporateMetrics pro analýzu rizika ve společnosti PepsiCo

The thesis language: English

Description:

1. Introduction
2. Description of CorporateMetrics Methodology
3. Basic Introduction about PepsiCo
4. Application of CorporateMetrics Methodology for Risk Analysis
5. Interpretation of the Results
6. Conclusion

Bibliography
List of Abbreviations
List of Annexes
Annexes

References:

ALEXANDER, Carol. *Market Risk Analysis: Quantitative Methods in Finance.* New York: John Wiley & Sons, 2008. ISBN 978-0470998007.
BENNINGA, Simon. *Financial Modeling.* 4th ed. New York: The MIT Press, 2014. ISBN 978-0262027281.
LEE, Alvin. *CorporateMetrics Technical Document [online].* New York: RiskMetrics Group, J. P. Morgan, 1999. [2017-08-04]. Available at: https://www.msci.com/documents/10199/8af520af-3e63-44b2-8aab-fd55a989e312.

Extent and terms of a thesis are specified in directions for its elaboration that are opened to the public on the web sites of the faculty.

Supervisor: **doc. Ing. Miroslav Čulík, Ph.D.**

Date of issue: 19.11.2021

Date of submission: 22.04.2022

Ing. Petr Gurný, Ph.D.	doc. Ing. Vojtěch Spáčil, CSc.
Head of Department	*Dean*

Content

1 Introduction

Corporate risk management has expanded dramatically over the past decade. Nowadays, international trading has been rapidly developed and have taken a series of risks associated with the increasing pace of changes in consumer demands, supply chain, international operations as well as the market risks. Among which, the market risks are the risks that the corporate exposed from adverse changes in commodity prices which affecting the cost of raw materials and energy of corporates, foreign exchange rates and currency restrictions, and interest rates. As one of the famous global corporates, PepsiCo company also face the challenges that discussed above.

The aim of this thesis is to predict the total operating income for PepsiCo in 2021 by analysing the influence of potential changes in Sales and Aluminum price to the Earnings of PepsiCo with the application of CorporateMetrics Methodology and estimate the EAR for the corporate in 2021.

For Chapter 2, which is the paragraph that focus on the description of CorporateMetric Methodology introducing the definition of CorporateMetrics, the procedures of applying CorporateMetrics and the comparison of CorporateMetrics and RiskMetrics. In addition, there are the introduction of financial modelling methodology.

For Chapter 3, it is the part that focus on the information introduction of PepsiCo company, including company overview and operation, develop history, market risks of company, and financial performance summary.

For Chapter 4 and Chapter 5, which are the most significant part of the thesis. Chapter 4 describes detail procedures of how the CorporateMetrics applied including the data collection and preparation, market variables estimation and prediction, and corporate financial metrics estimation for 2021. Chapter 5 presents the results from the several calculations in Chapter 4 and the results interpretations.

For Chapter 6, which is the conclusion for the thesis, summarizing the whole information that the previous chapters have presented.

2 Description of CorporateMetrics Methodology

For the Chapter 2, it is mainly focus on the detail description for the methodology of CorporateMetrics applied in the thesis. And this chapter will be divided into two parts. First part is the overview of CorporateMetrics consist of the three subchapters to introduce the definition of CorporateMetrics with its application procedures, and the comparison of CorporateMetrics and RiskMetrics. The second part focus on the financial modelling theories including Monte Carlo simulation, Random Walk theory and Stochastic Processes.

2.1 Overview of CorporateMetrics

Under this subchapter, it is started with the definition introduction of CorporateMetrics, and the procedures of it will be as follow. Also, there will be the comparison between CorporateMetrics and RiskMectics.

2.1.1 Introduction of CorporateMetrics definition

CorporateMetrics is a comprehensive set of definitions, methodologies, data sets and software for measuring market risk in the corporate environment. Generally, CorporateMetrics focuses on two corporate financial results including earnings and cash flow that affect, as well as are commonly used to measure the value of a company. Specifically, CorporateMetrics enables companies to forecast earnings and cash flows for a range of different projected market rates such as foreign exchange rates, interest rates, commodity prices and equity prices. From the resulting range of forecasts, market risk measures can be obtained. (*Alvin Y. Lee - CorporateMetrics Technical Document New York: RiskMetrics Group, J. P. Morgan, 1999. [2017-08-04]*) This methodology is designed to accommodate long-term forecasting to match the long-term management cycles typically of corporate planning and business management. Additionally, CorporateMetrics provides a VaR-type approach, the principles of which have long been widely used in portfolio risk analysis, where market exposures to financial instruments are routinely measured.

The key features of CorporateMetrics include:

- Definitions of risk measures: Earnings-at-Risk (EaR), Earnings-per-Share-at-Risk (EPSaR), and Cash-Flow-at-Risk (CFaR).

- Methodology guidelines, which explain how to identify and map market-sensitive exposures and describe the methods available for calculating market risk.
- Data sets and methodologies for long-horizon forecasting (2 to 24 months). The data and methodologies are described in a companion publication, the *LongRun Technical Document (LongRun)*.

2.1.2 Procedures for Applying CorporateMetrics

The procedure for measuring market risk by applying corporate metrics can be summarized in five steps:

Step 1: Metric specification. To specify the financial result such as earnings or cash flow and specify the time horizons and the confidence level for risk measurement.

Step 2: Exposure mapping. To identify all earnings or cash flow components after metric specified in step 1. Observe the relationship of exposures to market rates by defining how the value of each exposure is influenced by each market rate.

Step 3: Scenario generation. To generate a large number of scenarios that represent different possible value for a given set of market rates over time.

Step 4: Valuation. Estimate the future financial results for each market rate scenario.

Step 5: Risk measure computation. Calculate the risk statistics by the results of distribution of financial results.

This five-step process[1] is known as a simulation-based approach, which forms the basis of CorporateMetrics. In a simulation-based approach, a large set of market rate scenarios is used to generate a distribution of future financial results. The advantage of this approach is the ability to describe in detail a distribution of future financial results, from which a variety of risk measures may be obtained.

Metric specification

The first step of the methodology is to decides which financial result to analyze, and which of risk measures to calculate. According to the features of CorporateMetics, risk measures include Earnings-at-Risk (EaR), Earnings-per-Share-at-Risk (EPSaR), and

[1] Alvin Y. LEE - *CorporateMetrics Technical Document* New York: RiskMetrics Group, J. P. Morgan, 1999. [2017-08-04]

Cash-Flow-at-Risk (CFaR). In addition, it is necessary to specifies the time horizons and confidence level used for risk measurement.

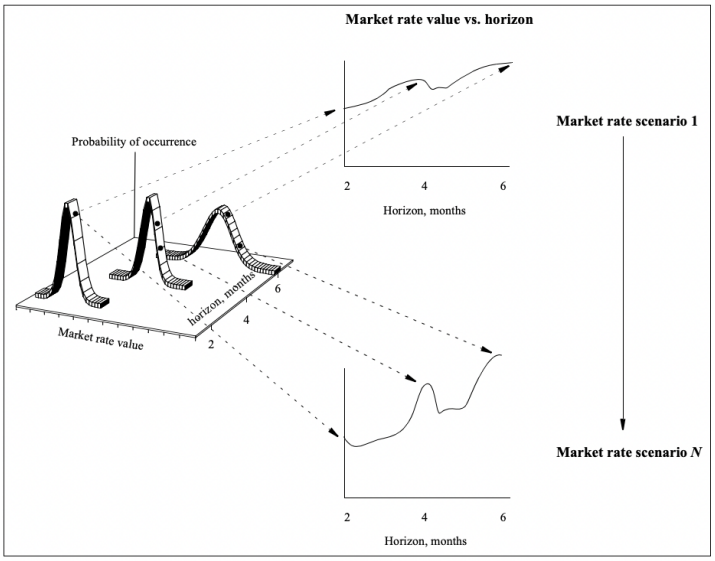
Exposure mapping

In order to forecast financial results from different market rate scenarios, the problem that how the financial results and the market rates are related must be specified by the equations or pro forma statements. For which are called *exposure maps*. In this step, there are two key considerations needed to be decided, which are the exposure to analyze, and the type of functions will be used to relate financial results and market variables. Generally, exposure maps various from each company and each situation, which means different companies may choose to apply different scopes of analysis depending on the type of risk analysis needed. Also, the quantitative relationships between market variables and financial results can be various forms.

Scenario generation

For measuring the market risks of specified financial results over planning horizons, a major challenge is to forecast the market rates over the given long horizons. Typically, it is associated with planning cycles and focuses on horizons of up to one or two years. What's more, the measurement requires market rate scenarios generation, which means forecasting models are needed to specify the probability distributions of market variables, and therefore to develop the necessary scenarios.

Chart 2.1 Generating market rate scenarios



Source: Alvin Y. LEE - *CorporateMetrics Technical Document*

To be specify, market rate scenarios are generated by sampling points from market rate distributions as shown in Chart 2.1. According to the theory from Alvin Y. LEE in *CorporateMetrics Technical Document*, market price and rate scenarios (such as those shown in Chart 2.1) can be generated by using *LongRun's* procedures. What is necessary to remind is that the final goal of *LongRun's* forecasting is to assess market risk at long horizons. Since there are variety of forecasting procedures are available, it is important to choose the procedures according to the specified assumptions. As it was present in *CorporateMetrics Technical Document*, there are two forecasting methodologies as shown as Table 2.1. For this thesis, the Random Walk theory and Mean-Reversion model are applied which will be introduced in the next following subchapters.

Table 2.1 Summary of methods for forecasting market rate distributions

Class	**Type**	**Description**
Current market information	Random walk with and without drift	Based on current market information, such as implied volatility and forward rate data.
Economic structure	Econometric modeling	Uses historical financial market and macroeconomic data. Examples include the Vector Error Correction Model (**VECM**) described in *LongRun*.

Source: Alvin Y. LEE - *CorporateMetrics Technical Document*

Valuation

In this step, by inputting the market rates for a particular scenario into the exposure map, a particular value for a future financial result can be obtained. And by repeating this process for each scenario, a distribution of financial results for given time horizon is obtained.

Risk computation

By using the resulting distribution of financial results in step 4, we can calculate sample statistics that describe the distribution and characterize the riskiness of the results.

2.1.3 Comparison between CorporateMetrics and RiksMetrics

Both CorporateMetrics and RiskMetrics provide an analytical framework for market risk measurement. However, here are some differences should be determined. RiskMetrics is designed for portfolio analysis, while CorporateMetrics handles corporate

financial results[2]. Specifically, RiskMetrics is the method to forecast the potential volatility of financial instrument portfolios due to market risks. For example, fixed income securities, foreign exchange, commodities, equities, and their derivatives can apply RiskMetrics to measure their potential change in value under market risks. Besides, the analysis horizon is relatively short, ranging from one day to one month, and it is focus on potential changes in portfolio value. Whereas CorporateMetrics is more appropriate for corporate environment since it uses performance benchmarks that are based on company-specific internal or equity analyst forecasts and targets, rather than directly observable market indices, and it is more focus on corporate financial results. In addition, CorporateMetrics requires market rate data for longer horizons than those addressed by RiskMetrics, which provides 1-day and 1-month volatility forecasts.

Despite the different focusing measurement of value between RiskMetrics and CorporateMetrics that it discussed above, both metrics require assumptions for market rate distributions in order to calculate values at a chosen horizon. The following Table 2.2 presents the comparison of risk management approaches used in financial environment and corporate environment.

Table 2.2 Comparison of risk management in financial and corporate environments

Parameter	Financial	Corporate
Framework	RiskMetrics	CorporateMetrics
Measure of value	Portfolio value	Earnings, cash flow
Accounting treatment	Fair value	Accrual, fair value, hedge accounting
Horizon	Daily, monthly	Monthly, quarterly, annual
Benchmark	Market index	Specified targets

Source: Alvin Y. LEE - *CorporateMetrics Technical Document*

According to the shown table above, it is highlighting the complexities of corporate market risk analysis, in which there are numerous options and different considerations for value measures, horizons, accounting treatment, and benchmarks.

2.2 Simulation of Random Evolution

In this subchapter, the particular part is to describe and explain the methodology and application of the Monte Carlo simulation, which can serve as a tool for generation of

[2] Alvin Y. LEE - *CorporateMetrics Technical Document* New York: RiskMetrics Group, J. P. Morgan, 1999. [2017-08-04]

random scenarios and probability distribution of either particular assets or portfolios of financial assets. Here we apply this technique for the market variables random scenarios and its probability distribution in the thesis. In addition, there will introduce the definition of random walk model, and show the procedure of simulating the random evolution of market variables including its probability distribution on the basis of the geometric Brownian motion.

2.2.1 Monte Carlo Simulation

Monte Carlo simulation is a type of simulation that relies on repeated random sampling and statistical analysis to compute the results[3]. Hence, random experiments which the specific result is not known in advance are the closely related components to the simulation. In Monte Carlo simulation, the following steps are typically performed:

- **Static Model Generation.** To the beginning of every Monte Carlo simulation, it starts with developing a deterministic model which closely resembles the real scenario. The most likely value (base case) will be used as the input parameters in deterministic model. Then the mathematical relationships which using the values of the input variables and transforming them into the desired output will be applied.

- **Input Distribution Identification.** After the deterministic model have been constructed, we add the risk components to the model. Since the risks comply with the stochastic nature, the underlying distributions needed to be identified. and the historical data is necessary for the input variables in this step.

- **Random Variable Generation.** Generating a set of random numbers from the distributions that identified in the last step is the main idea for this step. Each set of random variables will be used in the deterministic model to provide one set of output values. Then repeat this process by generating more sets of random numbers. To generate the random numbers, we can apply Excel model called the *Random Number Generation* by which can generate random numbers for a prespecified probability distribution. In the application of this thesis, the standard normal distributions of random numbers are generated. However, if the probability distribution that we need is not available, it can be feasible to generate

[3] S. Raychaudhuri, *Introduction to Monte Carlo simulation*, 2008 Winter Simulation Conference, 2008, pp. 91-100, DOI: 10.1109/WSC.2008.4736059.

it by means of uniformly distributed random variables on the [0;1] interval. This technique is referred to as the *Inverse transform method*[4]. For this method, it is based on the fact that any distribution function is non-decreasing. Thus, given a sequence of uniformly distributed random variables, we can generate random variables from a wide range of other probability distribution. Consequently, there exists unique assignment from the unit interval [0;1] of uniform distribution to the other distribution functions. Generally, we can write:

$$x = F^{-1}(r) \tag{2.1}$$

where, $x \in [a; b]$ is a random number from the distribution function *F* and *r* is a random number which is generated from the unit interval of uniform distribution. Since for uniform distribution on the [0;1] interval it holds that $G(r) = r$ and consequently $F(x) = G(r)$, then $x = F^{-1}[G(r)]$.

- **Analysis and Decision Making.** After the output values from the simulation have collected, the statistical analysis will be used on those values in this step, which provides statistical confidence for the decisions that we might make. The following formulas represents the basic statistics calculation for statistical analysis of a set of output values. Assume that we have *N* values for each of the output parameters, each value represented as x_i, $i = 1(1)N$. Note that, these are the estimates of the complete population from the simulated sample, so se use sample statistics.

Mean ($\bar{x}$).

$$\bar{x} = \frac{1}{n}\sum_i x_i \tag{2.2}$$

Standard Deviation (s)

$$s = \sqrt{\frac{1}{N-1}\sum_i (x_i - \bar{x})^2} \tag{2.3}$$

Variance (s^2)

$$s^2 = \frac{1}{N-1}\sum_i (x_i - \bar{x})^2 \tag{2.4}$$

[4] Z. ZMEŠKAL, D. DLUHOŠOVÁ and T. TICHÝ. *Financial Models*. 1st ed. Ostrava: VSB-Technical University of Ostrava, 2004. ISBN 80-24807548.

Minimum (x_{min})

$$x_{min} = \min_i x_i \tag{2.5}$$

Maximum (x_{max})

$$x_{max} = \max_i x_i \tag{2.6}$$

2.2.2 Random Walk Theory

As a theory from stochastic process, Random Walk model is one of the simplest and most important models in time series forecasting. The model assumes that one variable takes a random "step" away from its previous value in each period, and the processes are independently and identically distributed in size.

$$Y_t = Y_{t-1} + \alpha \tag{2.7}$$

where, t is the time period, α is the mean of the first difference.

A random walk model is connected with "drift" or "without drift" depending on whether the distribution of step sizes has a non-zero mean or a zero mean. In other words, as the formula (2.7) shows, if the alpha is zero, there is the random walk without drift. If the alpha isn't zero, we can say there is the random walk with drift.

2.2.3 Stochastic Process – Wiener process, Geometric Brownian motion[5]

In the market, all random market variables are typical by their random evolution in time, which process is referred to as the stochastic process. In principle, any stochastic process can be described either discretely or continuously. According to this theory, there are two crucial terms of stochastic process which are the Wiener process, and the Geometric Brownian motion will be introduced in the thesis.

Wiener process, sometimes referred to as the specific Wiener process, which is the basic element of many other processes. It is based on the following assumptions: It follows the Markov process, and increments are independent in time. The Wiener process can be defined by:

$$\tilde{z_t} - z_0 = dz = \tilde{z} \cdot \sqrt{dt} \tag{2.8}$$

[5] Z. ZMEŠKAL, D. DLUHOŠOVÁ and T. TICHÝ. *Financial Models*. 1st ed. Ostrava: VSB-Technical University of Ostrava, 2004. ISBN 80-24807548.

where $\tilde{z}$ is a random variable from the standard normal distribution $N(0;1)$. Its basic parameters can be computed by following equations, in particular the mean value $E(dz) = 0$, the variance $var(dz) = t$, and the standard deviation $\sigma(dz) = \sqrt{t}$.

If we consider a random variable evolution in several time moments, then

$$\tilde{z}_T - z_0 = \sum_{i=1}^{n} \tilde{z}_i \cdot \sqrt{d_t} \tag{2.9}$$

And it results into $E(\tilde{z}_T) = 0,\ var(\tilde{z}_T) = n \cdot dt = T,\ \sigma(\tilde{z}_T) = \sqrt{T}$.

Similarly, Geometric Brownian motion (GBM), also called exponential Brownian motion, is a stochastic process in the continuous time case in which the logarithm of a random variable follows Brownian motion. The geometric Brownian motion can be defined by:

$$dx = \mu \cdot x \cdot dt + \sigma \cdot x \cdot dz \tag{2.10}$$

It can be reformulated in such way that there will be a clear interpretation of the particular processes as well as of the overall process:

$$\frac{dx}{x} = \mu \cdot dt + \sigma \cdot dz \tag{2.11}$$

It is obvious that this process is suitable for the formulation of the price return. Here α states the average return (drift), commonly per annum, and σ is the standard deviation per annum.

The mean value and the variance can be defined in a similar way as previous,

$$E(dx) = \mu \cdot dt, \qquad E(x_T) = x_0 + x_0 \cdot \mu \cdot T,$$

$$var(dx) = \sigma^2 \cdot dt, \qquad var(x_T) = x_0 + x_0 \cdot \sigma^2 \cdot T$$

However, the most important type of Brownian motion is the one of the formula (2.10) applied on continuous value of S. Hence,

$$S_T = S \cdot e^{\mu} \tag{2.12}$$

So that the continuous return μ is given by

$$\mu = \ln \frac{S_T}{S} \tag{2.13}$$

We can see that although the value S is lognormally distributed, its logarithm is distributed normally. So that,

Random evolution of the value S

$$S_t = S_{t-1} \cdot exp(\alpha \cdot \Delta t + \sigma \cdot \tilde{z} \cdot \sqrt{\Delta t}) \quad (2.14)$$

Mean value of the value S

$$E(S_T) = S_0 \cdot \exp(\alpha \cdot \Delta t \cdot n) = S_0 \cdot \exp(\mu \cdot T) \quad (2.15)$$

Variance of the value S

$$var(S_T) = {S_0}^2 \cdot \exp(2 \cdot \alpha \cdot \Delta t \cdot n) \cdot [\exp(\sigma^2 \cdot \Delta t \cdot n) - 1] \quad (2.16)$$

Quantile for the lognormal probability distribution of the value S

$${S_T}^\gamma = S_0 \cdot exp(\alpha \cdot \Delta t \cdot n + \Phi^{-1}(\gamma) \cdot \sigma \cdot \sqrt{\Delta t \cdot n}) \quad (2.17)$$

For the formulas above, $\widetilde{dz}$ is a random component with $\widetilde{dz} = \tilde{z} \cdot \sqrt{\Delta t}$, and $\tilde{z}$ is a random value from the standard normal distribution $N(0;1)$. Hence, the term $\alpha \cdot \Delta t$ characterizes the deterministic drift of the value S and the term $\sigma \cdot \widetilde{dz}$ characterizes the random residuum of the value in a given time interval. In addition, $\alpha = \mu - \sigma^2/2$ is the mean correcting term.

2.2.4 Simulation of the Probability Distribution of Variable Evolution

By applying the formulas 2.14 – 2.16, the random value can be identified that follows the geometric Brownian motion, and the parameters including mean, standard deviation and variance can be calculated. The next task is to verify the type of the probability distribution of random value by Monte Carlo simulation and illustrate the simulated probability distribution graphically.

The value of particular random samples can be formulated similarly to the previous step.

$$S_{t,K} = S_{t-\Delta t,K} \cdot \exp\left(\alpha \cdot \Delta t + \sigma \cdot \tilde{z}_{t,K} \cdot \sqrt{\Delta t}\right) \quad for\ K = 1,2,\dots,N \quad (2.18)$$

After the random value was computed by the formula 2.18, the Excel function FREQUENCY () is applied to determine the probability distribution. To begin with, in order to set intervals, we first apply the function MAX () and MIN () respectively, to state the maximal and minimal generated value. Subsequently, calculate the equidistant interval and compute boundaries of each interval. Then, apply the function FREQUENCY ().

3 Basic Introduction about PepsiCo

In Chapter 3, the information of the PepsiCo company will be introduced, including the company overview and operation, development history of company, market risks analysis and financial performance overview. All of which are based on the contents from the *Annual Report of PepsiCo 2021*.

3.1 Company Overview and Operation

In this subchapter, the overview of company with its operation will be introduced.

The PepsiCo were incorporated in Delaware in 1919 and reincorporated in North Carolina in 1986. They are a leading global beverage and convenient food company with a complementary portfolio of brands, including Lays, Doritos, Cheetos, Gatorade, Pepsi-Cola, Mountain Dew, Quaker and SodaStream. Through the operations, authorized bottlers, contract manufacturers and other third parties, they make, market, distribute and sell a wide variety of beverages and convenient foods, serving customers and consumers in more than 200 countries and territories.

They are organized into seven reportable segments, as follows:

1) Frito-Lay North America (FLNA), which includes our branded convenient food businesses in the United States and Canada;

2) Quaker Foods North America (QFNA), which includes our branded convenient food businesses, such as cereal, rice, pasta and other branded food, in the United States and Canada;

3) PepsiCo Beverages North America (PBNA), which includes our beverage businesses in the United States and Canada;

4) Latin America (LatAm), which includes all of our beverage and convenient food businesses in Latin America;

5) Europe, which includes all of our beverage and convenient food businesses in Europe;

6) Africa, Middle East and South Asia (AMESA), which includes all of our beverage and convenient food businesses in Africa, the Middle East and South Asia; and

7) Asia Pacific, Australia and New Zealand and China Region (APAC), which includes all of our beverage and convenient food businesses in Asia Pacific, Australia and New Zealand, and China region.

Frito-Lay North America

Either independently or in conjunction with third parties, FLNA makes, markets, distributes and sells branded convenient foods. These foods include branded dips, Cheetos cheese-flavored snacks, Doritos tortilla chips, Fritos corn chips, Lay's potato chips, Ruffles potato chips and Tostitos tortilla chips. FLNA's branded products are sold to independent distributors and retailers. In addition, FLNA's joint venture with Strauss Group makes, markets, distributes and sells Sabra refrigerated dips and spreads.

Quaker Foods North America

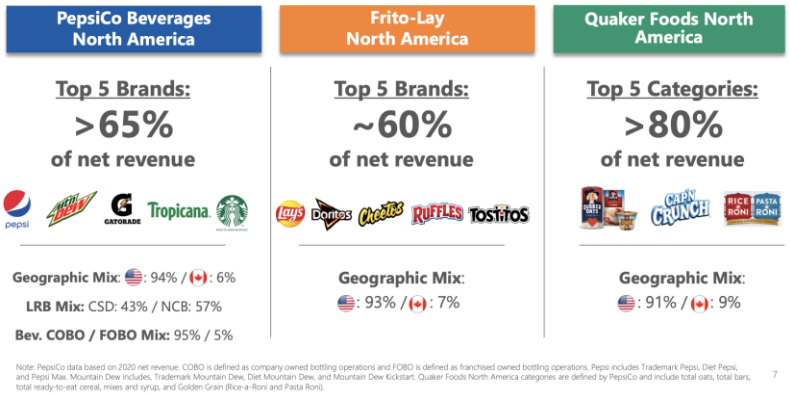
Either independently or in conjunction with third parties, QFNA makes, markets, distributes and sells branded convenient foods, which include cereals, rice, pasta and other branded products. QFNA's products include Cap'n Crunch cereal, Life cereal, Pearl Milling Company syrups and mixes, Quaker Chewy granola bars, Quaker grits, Quaker oatmeal, Quaker rice cakes, Quaker Simply Granola and RiceA-Roni side dishes. QFNA's branded products are sold to independent distributors and retailers.

PepsiCo Beverages North America

Either independently or in conjunction with third parties, PBNA makes, markets and sells beverage concentrates, fountain syrups and finished goods under various beverage brands including Aquafina, Diet Mountain Dew, Diet Pepsi, Gatorade, Gatorade Zero, Mountain Dew, Pepsi and Propel. PBNA operates its own bottling plants and distribution facilities and sells branded finished goods directly to independent distributors and retailers. PBNA also sells concentrate and finished goods for the brands to authorized and independent bottlers, who in turn sell our branded finished goods to independent distributors and retailers in certain markets. PBNA also, either independently or in conjunction with third parties, makes, markets, distributes and sells ready-to-drink tea and coffee products through joint ventures with Unilever (under the Lipton brand name) and Starbucks, respectively. Further, PBNA manufactures and distributes certain brands licensed from Keurig Dr Pepper Inc., including Crush, Dr Pepper and Schweppes, and certain juice brands licensed from Dole Food Company, Inc. and Ocean Spray Cranberries, Inc. (Ocean Spray).

The Figure 3.1 shows the percentage of North America divisions account for net revenues of the company, Where the top 5 categories from Quaker Foods in North America accounts more than 80% of net revenue.

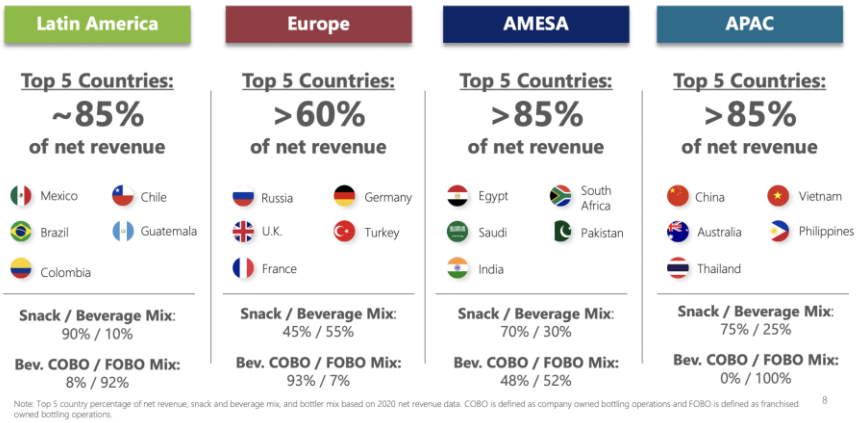
Figure 3.1 North America Divisions of PepsiCo



Source: PepsiCo Consumer Analyst Group Conference Presentation 2021 https://www.pepsico.com/

And the Figure 3.2 present the percentage of international divisions of PepsiCo company account for net revenue, where the top 5 countries from Latin America, AMESA, and APAC account about 85% of net revenue.

Figure 3.2 International Divisions of PepsiCo



Source: PepsiCo Consumer Analyst Group Conference Presentation 2021 https://www.pepsico.com/

3.2 PepsiCo Company History

In this subchapter, it is focus on the description about the development history of PepsiCo company.

Origins

The recipe for Pepsi (the soft drink), was first developed in the 1880s by a pharmacist and industrialist from New Bern, North Carolina, named Caleb Bradham who called it "Pepsi-Cola" in 1898. As the cola developed in popularity, he created the *Pepsi-Cola Company* in 1902 and registered a patent for his recipe in 1903. The Pepsi-Cola Company was first incorporated in the state of Delaware in 1919. The company went bankrupt in 1931 and on June 8 of that year, the trademark and syrup recipe were purchased by Charles Guth who owned a syrup manufacturing business in Baltimore, Maryland. Guth was also the president of Loft, Incorporated, a leading candy manufacturer, and he used the company's labs and chemists to reformulate the syrup. He further contracted to stock the soda in Loft's large chain of candy shops and restaurants, which were known for their soda fountains, used Loft resources to promote Pepsi, and moved the soda company to a location close by Loft's own facilities in New York City. In 1935, the shareholders of Loft sued Guth for his 91% stake of Pepsi-Cola Company in the landmark case *Guth v. Loft Inc.* Loft won the suit and on May 29, 1941 formally absorbed Pepsi into Loft, which was then re-branded as Pepsi-Cola Company that same year. (Loft restaurants and candy stores were spun off at this time.) In the early 1960s, the company's product lines expanded with the creation of Diet Pepsi and purchase of Mountain Dew.Origins

In 1965, the Pepsi-Cola Company merged with Frito-Lay, Inc. to become *PepsiCo, Inc.*, the company it is known as at present. At the time of its foundation, PepsiCo was incorporated in the state of Delaware and headquartered in Manhattan, New York. The company's headquarters were relocated to its still-current location of Purchase, New York in 1970, and in 1986 PepsiCo was reincorporated in the state of North Carolina.

PepsiCo was the first company to stamp expiration dates, starting in March 1994.

Acquisitions and divestments

Between the late-1970s and the mid-1990s, PepsiCo expanded via acquisition of businesses outside of its core focus of packaged food and beverage brands; however it exited these non-core business lines largely in 1997, selling some, and spinning off others into a new company named Tricon Global Restaurants, which later became known as Yum! Brand, Inc. PepsiCo also previously owned several other brands that it later sold so it could focus on its primary snack food and beverage lines, according to investment analysts reporting on the divestments in 1997. Brands formerly owned by PepsiCo include: Pizza Hut, Taco Bell, KFC, Hot 'n Now, East Side Mario's, D'Angelo Sandwich Shops, Chevys Fresh Mex, California Pizza Kitchen, Stolichnaya(via licensed agreement), Wilson Sporting Goods and North American Van Lines.

The divestments concluding in 1997 were followed by multiple large-scale acquisitions, as PepsiCo began to extend its operations beyond soft drinks and snack foods into other lines of foods and beverages. PepsiCo purchased the orange juice company Tropicana Products in 1998, and merged with Quaker Oats Company in 2001, adding with it the Gatorade sports drink line and other Quaker Oats brands such as Chewy Granola Bars and Aunt Jemima, among others.

In August 2009, PepsiCo made a $7 billion offer to acquire the two largest bottlers of its products in North America: Pepsi Bottling Group and PepsiAmericas. In 2010 this acquisition was completed, resulting in the formation of a new wholly owned subsidiary of PepsiCo, *Pepsi Beverages Company*. In February 2011, the company made its largest international acquisition by purchasing a two-thirds (majority) stake in Wimm-Bill-Dann Foods, a Russian food company that produces milk, yogurt, fruit juices, and dairy products. When it acquired the remaining 23% stake of Wimm-Bill-Dann Foods in October 2011, PepsiCo became the largest food and beverage company in Russia.

Competition

The Coca-Cola Company has historically been considered PepsiCo's primary competitor in the beverage market, and in December 2005, PepsiCo surpassed The Coca-Cola Company in market value for the first time in 112 years since both companies began to compete. In 2009, The Coca-Cola Company held a higher market share in carbonated soft drink sales within the U.S. In the same year, PepsiCo maintained a higher share of the U.S. refreshment beverage market, however, reflecting the differences in

product lines between the two companies. As a result of mergers, acquisitions and partnerships pursued by PepsiCo in the 1990s and 2000s, its business has shifted to include a broader product base, including foods, snacks and beverages. The majority of PepsiCo's revenues no longer come from the production and sale of carbonated soft drinks. Beverages accounted for less than 50 percent of its total revenue in 2009. In the same year, slightly more than 60 percent of PepsiCo's beverage sales came from its primary non-carbonated brands, namely Gatorade and Tropicana.

PepsiCo's Frito-Lay and Quaker Oats brands hold a significant share of the U.S. snack food market, accounting for approximately 39 percent of U.S. snack food sales in 2009.One of PepsiCo's primary competitors in the snack food market overall is Kraft Foods, which in the same year held 11 percent of the U.S. snack market share. Other competitors for soda are RC Cola, Cola Turka, Kola Real, Inca Kola, Zam Zam Cola, Mecca-Cola, Virgin Cola, Parsi Cola, Qibla Cola, Evoca Cola, Corsica Cola, Breizh Cola, Afri Cola.

3.3 The Market Risks of PepsiCo

Under the following subchapter, market risks of the company will be analyzed which the company is exposed to market risks arising from adverse changes in:

- commodity prices, affecting the cost of our raw materials and energy;
- foreign exchange rates and currency restrictions; and
- interest rates.

In the normal course of business, they manage commodity price, foreign exchange and interest rate risks through a variety of strategies, including productivity initiatives, global purchasing programs and hedging. Ongoing productivity initiatives involve the identification and effective implementation of meaningful cost-saving opportunities or efficiencies, including the use of derivatives. Their global purchasing programs include fixed-price contracts and purchase orders and pricing agreements.

Commodity Prices

The commodity derivatives of the company had a total notional value of $1.6 billion as of December 25, 2021 and $1.1 billion as of December 26, 2020. At the end of 2021, the potential change in fair value of commodity derivative instruments, assuming a 10% decrease in the underlying commodity price, would have decreased our net unrealized

gains in 2021 by $177 million, which would generally be offset by a reduction in the cost of the underlying commodity purchases.

Foreign Exchange

The operations outside of the United States generated 44% of consolidated net revenue in 2021, with Mexico, Russia, Canada, China, the United Kingdom and South Africa, collectively, comprising approximately 23% of consolidated net revenue in 2021. As a result, they are exposed to foreign exchange risks in the international markets in which the products are made, manufactured, distributed or sold. Additionally, the company are exposed to foreign exchange risk from net investments in foreign subsidiaries, foreign currency purchases, foreign currency assets and liabilities created in the normal course of business. During 2021, favorable foreign exchange contributed 1 percentage point to net revenue growth, primarily due to appreciation in the Mexican peso, Canadian dollar and South African rand. Currency declines against the U.S. dollar which are not offset could adversely impact future financial results. In addition, volatile economic, political and social conditions and civil unrest in certain markets in which the products are made, manufactured, distributed or sold, including in Argentina, Brazil, China, Mexico, the Middle East, Russia and Turkey, and currency controls or fluctuations in certain of these international markets, continue to, and the threat or imposition of new or increased tariffs or sanctions or other impositions in or related to these international markets may, result in challenging operating environments. The foreign currency derivatives had a total notional value of $2.8 billion as of December 25, 2021 and $1.9 billion as of December 26, 2020. At the end of 2021, it was estimated that an unfavorable 10% change in the underlying exchange rates would have decreased net unrealized gains in 2021 by $278 million, which would be significantly offset by an inverse change in the fair value of the underlying exposure. The total notional amount of our debt instruments designated as net investment hedges was $2.1 billion as of December 25, 2021 and $2.7 billion as of December 26, 2020.

Interest Rates

The interest rate derivatives had a total notional value of $2.1 billion as of December 25, 2021, and $3.0 billion as of December 26, 2020. Assuming year-end 2021 investment levels and variable rate debt, a 1- percentage-point increase in interest rates would have

decreased net interest expense in 2021 by $47 million due to higher cash and cash equivalents and short-term investments levels, as compared with variable rate debt.

3.4 Financial Performance Overview

For this subchapter, it is mainly present the net revenue and operating profit of PepsiCo company.

From Table 3.1 which is shown that Operating profit grew 11% and operating margin declined 0.3 percentage points. Operating profit growth was primarily driven by net revenue growth and productivity savings, partially offset by certain operating cost increases, a 14-percentage-point impact of higher commodity costs, and higher advertising and marketing expenses. The operating margin decline primarily reflects higher commodity costs.

Table 3.1 Consolidated Net Revenue and Operating Profit

	2020	2021	Change (%)
Net revenue	$79474	$70372	13
Operating profit	$11162	$10080	11
Operating margin	14%	14.3%	-0.3

Source: PepsiCo 2021 Annual Report https://www.pepsico.com/

Lower charges taken as a result of the COVID-19 pandemic compared to the prior year contributed 6 percentage points to operating profit growth. Additionally, lower acquisition and divestiture-related charges included in “Items Affecting Comparability” contributed 3 percentage points to operating profit growth.

4 Application of the CorporateMetrics Methodology for Risk Analysis

In the Chapter 4, which is the most important part of the thesis, focusing on the application of the CorporatemMetrics methodology used to proceed the market risk analysis. The aim is to estimate how the related market risks affect the PepsiCo company' s total operating income and to forecast the EaR. The following contents will be divided into four parts. For each part of calculation, we have collected basic financial information from the company' s annual financial reports during the period of 2016 to 2020 including the Balance sheet statement, Income statement and Cash flow statement. The application of the CorporateMetrics methodology is under the assumption that the company is only selling Pepsi-Cola as the operating revenue. The key market variables are the potential changes in sales of cola and Aluminum price for the time horizon of next one year under 1000 scenarios. The methodology is applied to forecast the total operating income in 2021, which is processed by following steps:

1. Estimation of Corporate's Operating Revenues for 52 weeks in 2021.
2. Prediction of Aluminum Price for 52 weeks in 2021.
3. Calculation of Estimated Revenues and Predicted Aluminum price for Quarter and Whole Year.
4. Estimation of Corporate's Total Operating Income.

4.1 Estimation of corporate's operating revenues

In this subchapter, we have two steps to achieve the goal of estimation for the number of sales of cola in the next 52 weeks which are data collection and preparation, and geometric Brownian motion application.

4.1.1 Data collection and preparation for sales

To make an estimation for the next 52 weeks sales of the cola, we started with the collection of the previous selling data. However, it is only possible to observe the quarterly selling data, hence, we prepared the quarterly data from 2013Q1 to 2020Q4. Later we will make an adjustment to match the time serious of weekly estimation.

When we collected the previous sales data, we used the formula (2.13) to get the amount of logarithm return (Log R-sales). see Table 4.1.

Table 4.1 The sample of the data preparation of sales

Quarterly | Millions of US$	Sales	Log R-sales
2013Q1	12,581	
2013Q2	16,807	0.289607727
2013Q3	16,909	0.006050558
2013Q4	20,118	0.173768912
…	…	…

Source: quarterly sales data from PepsiCo

4.1.2 Estimation of sales by Geometric Brownian motion

By apply the formulas from geometric Brownian motion, we can model the number of sales for the next 52 weeks. To begin with, we have prepared the basic parameters that we need from the previous step. See Table 4.2.

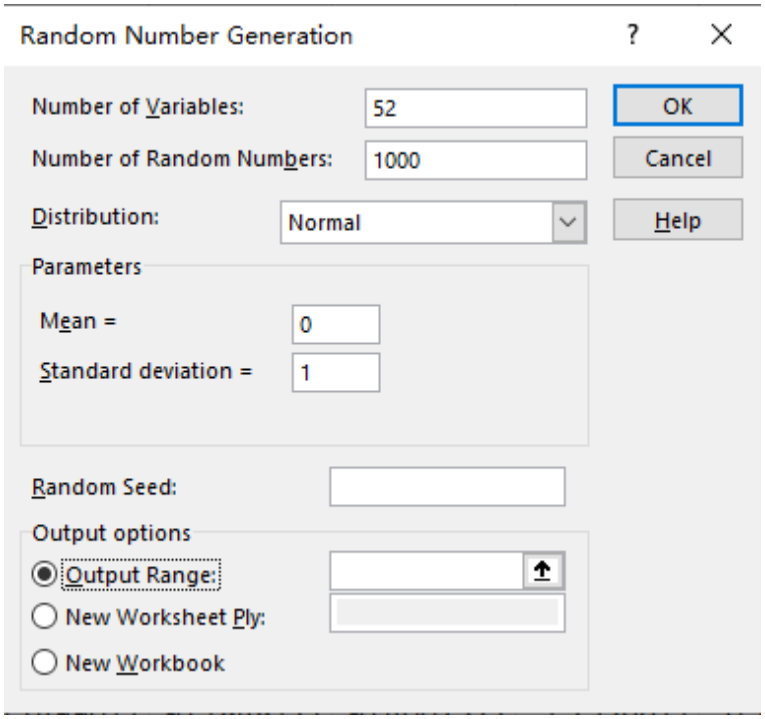
Table 4.2 The Basic Parameters for modelling of sales

Mean value	μ	0.018687922
Standard deviation	σ	0.276087303
Interval	Δt	0.076923077
Initial sales	S_0	1,727.31
Number of scenarios	N	1000

In which, the mean value is calculated from the function of *AVERAGE (Log R-sales),* and the standard deviation is from the *STDEV.S (Log R-sales)* in excel. It is worth to mention that the time interval Δt is adjusted from quarterly to weekly, which means Δt = 1/13 assuming that there are 13 weeks in one quarter. And the initial sales are assumed as the amount from 2020Q4 adjusted to the time interval. In addition, we assumed 1000 scenarios.

After that we applied *Random Number Generation* from excel Data Analysis function to prepare the random variables from standard normal distribution as shown as the Figure 4.1.

Figure 4.1 The application of the Random Number Generation



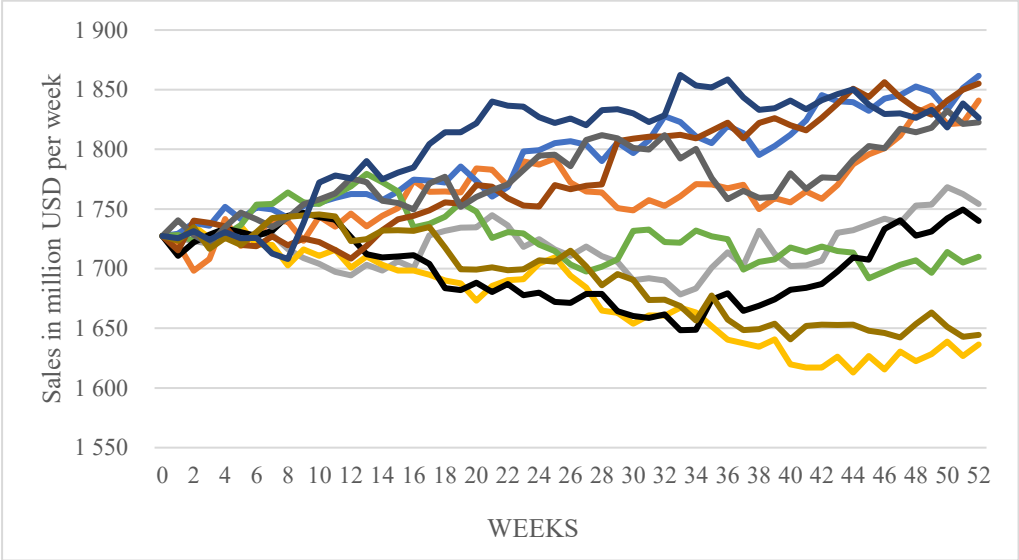
According to the formula (2.14), we can get the results of the estimation for the next 52 weeks which has shown as the Table 4.3 and Chart 4.1.

Table 4.3 The 5 Scenarios Samples of Sales of cola in 52 weeks

Million $	**WEEK1**	**WEEK2**	**WEEK3**	**…**	**WEEK50**	**WEEK51**	**WEEK52**
S1	1,720.38	1,698.27	1,708.13	…	1,821.04	1,822.21	1,840.92
S2	1,725.37	1,723.44	1,720.55	…	1,768.28	1,762.48	1,754.26
S3	1,726.75	1,735.74	1,725.83	…	1,638.81	1,626.83	1,636.50
S4	1,729.14	1,738.28	1,736.03	…	1,833.16	1,851.30	1,861.62
S5	1,728.16	1,723.30	1,727.30	…	1,713.97	1,705.06	1,709.91
…	…	…	…	…	…	…	…

From the geometric Brownian motion, we have the results of 52 weeks of sales for the cola in 1000 scenarios and the Chart 4.1 shows a clear version of how the volume of sales evolute in 52 weeks.

Chart 4.1 The Estimation of next 52 weeks Sales in first 10 scenarios



4.2 Prediction of the price of Aluminium

This part is focus on the prediction of the aluminium price in the following 52 weeks. We mainly divided into two steps including data collection and preparation, and geometric Brownian motion application to achieve it.

4.2.1 The historical price collection and preparation

Firstly, we collected the historical price of aluminium in the past 96 months and then calculated the logarithm return (Log R-price). See Table 4.4. Since the historical data is in monthly, we need to make an adjustment later.

Table 4.4 The sample of preparation of historical price

	Aluminium, 99.5% minimum purity, LME spot price, CIF UK ports, US$ per metric ton	**Log R-price**
Frequency	**Monthly**	
2013M1	2037.61	
2013M2	2053.60	0.00781592
2013M3	1911.28	-0.07181743
2013M4	1861.02	-0.02664771
2013M5	1832.57	-0.01540664
2013M6	1814.54	-0.00988952
…	…	…

Source: Historical data from International Monetary Fund (IMF)

4.2.2 Price prediction by Geometric Brownian motion

As what we did to the application of GBM for the sales estimation in last subchapter, we started with the preparation of the basic parameters. See Table 4.5.

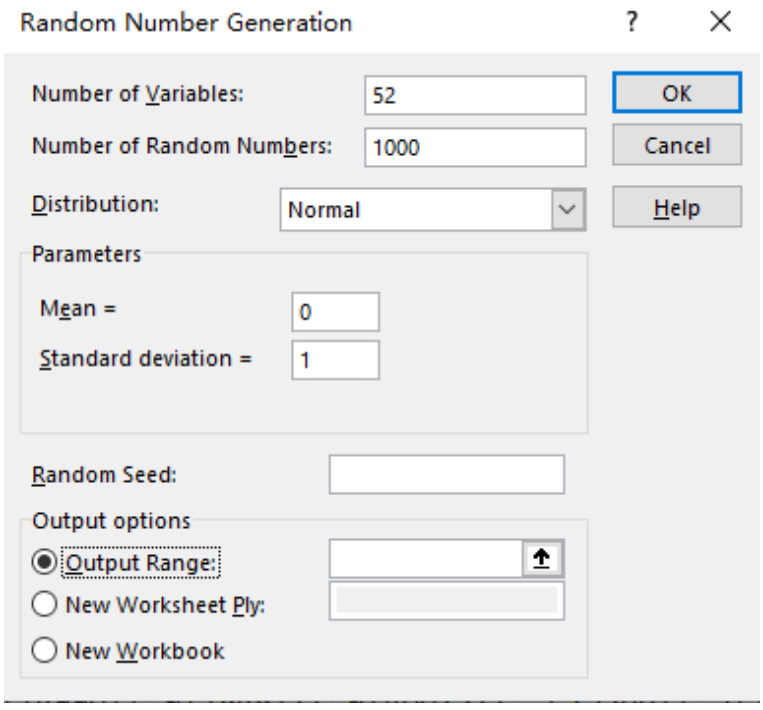
Table 4.5 The basic parameters for modelling

Mean value	μ	-0.00011915
Standard deviation	σ	0.03680076
Interval	Δt	0.25
Initial Aluminium price	A_0	2014.67
Number of scenarios	N	1000

where, the mean value is calculated from excel function AVERAGE (Log R-price) and standard deviation is from the result of function *STDEV.S (Log R-price)*. The time interval is adjusted from monthly to weekly, which assuming there are 4 weeks in one month. Hence, $\Delta t = 1/4$. Then we applied the price of 2020M12 as the initial aluminium price and assumed 1000 scenarios.

Additionally, we prepared random variables from standard normal distribution by *Random Number Generation* as shown as the Figure 4.2.

Figure 4.2 The application of Random Number Generation

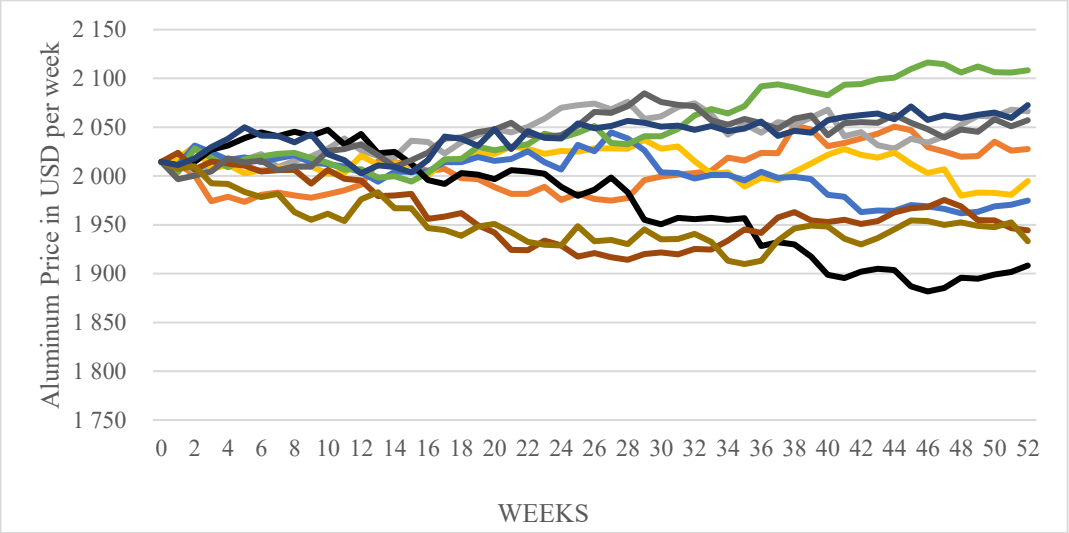


After above procedures, we can model the evolution of aluminium price in the next 52 weeks by applying the formula (2.14) of geometric Brownian motion as the result of Table 4.6 and finally get the chart as shown as Chart 4.2.

Table 4.6 The 5 Scenarios Samples of Aluminium prices in 52 weeks

US$	WEEK1	WEEK2	WEEK3	…	WEEK50	WEEK51	WEEK52
S1	2012.83	2000.70	1974.09	…	2035.04	2025.91	2027.78
S2	2014.13	2004.64	2007.87	…	2060.74	2067.86	2066.17
S3	2018.06	2030.53	2007.44	…	1982.80	1980.79	1994.91
S4	2010.76	2031.22	2024.19	…	1968.97	1970.47	1974.69
S5	2003.93	2028.15	2018.84	…	2106.29	2106.01	2108.46
…	…	…	…	…	…	…	…

Chart 4.2 The Aluminium price in the next 52 week for first 10 scenarios



4.3 The calculation of quarterly and yearly data

In this subchapter, we will calculate the quarterly sales of cola in 2021 and quarterly price of Aluminium, as well as the yearly sales of cola and yearly price of Aluminium in 2021.

From what we get from the previous estimation in subchapter 4.1, we can calculate the quarterly sales of cola by sum of the 13 weeks as one quarter. And then sum of the

four quarters to get the result of the whole year 2021 for 1000 scenarios. The results are shown as the Table 4.7 which shows the first 5 scenarios of the results.

Table 4.7 The result of sales of four quarters and whole year in 2021

N	2021Q1	2021Q2	2021Q3	2021Q4	YEAR 2021
S1	22,480.23	24,804.13	22,877.87	21,639.72	91,801.96
S2	22,306.34	24,103.36	22,114.13	20,880.80	89,404.62
S3	22,346.75	23,705.55	21,458.57	19,499.23	87,010.10
S4	22,732.68	24,944.34	23,510.72	22,116.54	93,304.28
S5	22,735.33	24,278.36	22,332.50	20,486.08	89,832.27
…	…	…	…	…	…

(In millions of US$)

Additionally, the prediction in subchapter 4.2 for the aluminium price in the next 52 weeks are used to calculate the quarterly price as well as the whole year in 2021. For each quarter we sum up the result of 13 weeks and then add the results of four quarters together to get the whole year price of aluminium for 1000 scenarios. The results can be found in the Table 4.8.

Table 4.8 The Aluminium price in 2021 (in US$) for first 5 scenarios

N	2021Q1	2021Q2	2021Q3	2021Q4	YE2021
S1	1987.23	1991.62	2014.91	2033.05	2006.70
S2	2018.12	2048.31	2059.95	2047.27	2043.41
S3	2010.85	2020.69	2012.82	2003.02	2011.84
S4	2014.47	2017.28	2003.51	1967.94	2000.80
S5	2014.38	2025.91	2067.25	2105.64	2053.29
…	…	…	…	…	…

4.4 Estimation of corporate's operating profit

In this subchapter, the corporate's total operating income will be estimated and in order to make an estimation, we have separated several steps as follow.

4.4.1 Estimation for the cost of goods sold

According to the Income statement in the past 5 years of the Pepsi Co company, we assumed that there are mainly two parts which to be the composition of the Costs of goods sold: Costs of Ingredients and costs of Aluminium. Also, in order to be more precisely estimate the costs of Aluminium we assume there are 80% of COGS as the costs of ingredients and 20% of COGS as the costs of Aluminium.

Estimation of Cost of Ingredient

Together with what it assumed above and the past five years' COGS from Income statement we can calculate the amount of costs of ingredients in the past by applying the formula (4.1), and to figure out the percentage of the costs of ingredients accounts for the total revenues by the formula (4.2). Then we found that the costs of ingredients accounts for nearly 36% of total revenues in the past five years and may conclude that the percentage in 2021 remains 36%. Table 4.9 make a summary about the amount spent in ingredients during last five years, and the percentage accounts for the total revenues in the past.

$$Cost\ of\ Ingredient_t = 0.8 \times COGS_t \tag{4.1}$$

$$Cost\ of\ Ingredient\ \%_t = \frac{Cost\ of\ Ingredient_t}{Total\ Revenue_t} \tag{4.2}$$

Table 4.9 The calculation of costs of ingredients in past 5 years

	2016	**2017**	**2018**	**2019**	**2020**
Cost of Goods Sold (millions of US$)	28209	28785	29381	30132	31797
Cost of ingredient (millions of US$)	22567	23028	23505	24106	25438
Total Revenue (millions of US$)	62799	63525	64661	67161	70372
Cost of ingredient / Total Revenue (%)	35.9	36.3	36.4	35.9	36.1

Since we already know the amount of total revenues in 2021 from the subchapter 4.3, we can calculate the amount of the cost of ingredient by multiplying 36% to the total revenues and get the result of 1000 scenarios as the formula (4.3).

$$Cost\ of\ Ingredient_t^i = R_t^i \times 0.36 \tag{4.3}$$

Figure 4.3 The calculation of the cost of ingredients

YEAR 2021 N	**Total Revenues** in million US$	**Cost of good sold** in million US$	**Cost of Ingredient** in million US$
1	91,802	52,399	=0. 36*I4
2	89,405	51,376	32,186
3	87,010	49,711	31,324
4	93,304	53,199	33,590
5	89,832	51,715	32,340
6	88,449	50,131	31,842
7	92,620	52,417	33,343

The Figure 4.3 shows the calculation of the formula (4.3).

Estimation of the Cost of Aluminium

Besides, according to the research the price of one can (0.33 liter) Pepsi cola is 1.19 US$ and assume one metric ton of Aluminium produced 80000 cans cola (0.33 liter).

From the estimation of the sales in 2021 above, we have the result for the year for 1000 scenarios, thus, we divided the total sales in 2021 by the price per can (0.33 liter) of Pepsi cola to know the quantity of cola sold in 2021. Then, by dividing the quantity of cola sold in 2021 by the 0.008, there is the result of quantity of Aluminium needed in 2021. The relations above are shown as formula (4.4) and (4.5). See Figure 4.4 which present the calculation application.

$$Quantity\ of\ Goods\ sold_t^i = \frac{Total\ Sales_t^i}{1.19} \tag{4.4}$$

$$Quantity\ of\ Needed\ Aluminum_t^i = \frac{Quantity\ of\ Goods\ sold_t^i}{0.008} \tag{4.5}$$

Figure 4.4 The calculation of the quantity of Aluminium needed

Price per can (0.33 liter) $ **1.19**	**Quantity of good sold (can) in million** 2021Q1	2021Q2	2021Q3	2021Q4	YE2021	**Quantity of Aluminum needed** YE2021 **in metric tons**
Assume ONE metric ton produce 80000 can cola (0.33 liter)	18891	20844	19225	18185	77145	=V4/0. 008
	18745	20255	18583	17547	75130	9,391,241
	18779	19921	18032	16386	73118	9,139,716
	19103	20962	19757	18585	78407	9,800,869
	19105	20402	18767	17215	75489	9,436,162
	18906	19862	18205	17353	74327	9,290,830
	18828	20660	19786	18558	77832	9,728,986
	19087	20861	19517	18185	77651	9,706,408
	18923	20148	18212	16641	73924	9,240,461

What's more, from the prediction of the Aluminium price in 2021 in subchapter 4.3, we know the 1000 scenarios price of the Aluminium. Hence, we finally can estimate the cost of Aluminium in 2021 for 1000 scenarios by the formula (4.6). See Figure 4.5.

$$Cost\ of\ Aluminum_t^i = Quantity\ of\ Aluminum_t^i \times Price\ of\ Aluminum_t^i \quad (4.6)$$

Figure 4.5 The calculation of the cost of Aluminium

Quantity of Aluminum needed	Price of Aluminum per metric ton in US$					Cost of Aluminum
YE2021	2021Q1	2021Q2	2021Q3	2021Q4	YE2021	YE2021
in metric tons						in million US$
9,643,063	1987	1992	2015	2033	2007	=W4*AB4/1000000
9,391,241	2018	2048	2060	2047	2043	19,190
9,139,716	2011	2021	2013	2003	2012	18,388
9,800,869	2014	2017	2004	1968	2001	19,610
9,436,162	2014	2026	2067	2106	2053	19,375
9,290,830	2034	1999	1944	1897	1969	18,290
9,728,986	2004	1943	1936	1958	1960	19,073
9,706,408	2014	2042	2062	2052	2043	19,826
9,240,461	1980	1944	1933	1945	1950	18,023
9,871,782	2028	2035	2050	2063	2044	20,177
9,822,500	2012	2008	1974	2016	2002	19,668
9,591,332	1990	1972	1973	1984	1980	18,988

In order to get the result of cost of goods sold in 2021, it is necessary to make a sum of the amount of cost of Ingredient and the cost of Aluminium as the formula (4.7). And the Figure 4.6 presents the calculation.

$$COGS_t^i = COI_t^i + COA_t^i \quad (4.7)$$

where, COI is cost of ingredient, COA is cost of Aluminum.

Figure 4.6 The calculation of the COGS

Cost of good sold	Cost of Ingredient	Cost of Aluminum
in million US$	in million US$	in million US$
=K4+L4	33,049	19,351
51,376	32,186	19,190
49,711	31,324	18,388
53,199	33,590	19,610
51,715	32,340	19,375
50,131	31,842	18,290
52,417	33,343	19,073
53,092	33,266	19,826
49,692	31,669	18,023
54,010	33,833	20,177
53,332	33,664	19,668
51,859	32,871	18,988

4.4.2 Estimation for total operating expenses

Since there are only two elements contributed to the total operating expenses, we estimate the total operating expenses in 2021 is the average of the past five years which equal to 25888 (in million US$).

Table 4.10 Prediction of total operating expenses in 2021 in millions of US$

Operating expense	2016	2017	2018	2019	2020	2021
Selling, General and Administrative Expenses	24,735	24,231	25,170	26,738	28,495	
Depreciation and Amortization	70	0	0	0	0	
Total Operating Expenses	24,805	24,231	25,170	26,738	28,495	**25,888**

4.4.3 Estimation for gross profit and total operating income

According to the formula (4.8), the gross profit is equal to the difference between total revenues and cost of goods sold. So, we can get 1000 results of the gross profit as the Figure 4.7 shown. Then we apply the formula (4.9) to calculate the total operating income which equal to the difference between gross profit and total operating expenses. See Figure 4.8.

$$GP_t^i = TR_t^i - COGS_t^i \tag{4.8}$$

where, GP is Gross Profit, TR is Total Revenues.

Figure 4.7 The calculation of the gross profit for 10 scenarios

YEAR 2021	Total Revenues	Cost of good sold	Cost of Ingredient	Cost of Aluminum	Gross Profit
N	in million US$	in million US$	in million US$	in million US$	in million US$
1	91,802	52,399	33,049	19,351	=I4-J4
2	89,405	51,376	32,186	19,190	38,029
3	87,010	49,711	31,324	18,388	37,299
4	93,304	53,199	33,590	19,610	40,105
5	89,832	51,715	32,340	19,375	38,117
6	88,449	50,131	31,842	18,290	38,317
7	92,620	52,417	33,343	19,073	40,203
8	92,405	53,092	33,266	19,826	39,313
9	87,969	49,692	31,669	18,023	38,277
10	93,979	54,010	33,833	20,177	39,969

$$TOI_t^i = GP_t^i - TOE_t^i \tag{4.9}$$

where TOI is Total Operating Income, TOE is Total Operating Expenses.

Figure 4.8 The calculation of the total operating income

Gross Profit	Total Operating Expens	Total Operating Income
in million US$	in million US$	in million US$
39,403	25,888	=M4-N4
38,029	25,888	12,141
37,299	25,888	11,411
40,105	25,888	14,217
38,117	25,888	12,230
38,317	25,888	12,430
40,203	25,888	14,316

5 Interpretation of the Results

In chapter 4 it has described the procedures of how to make the estimation of operating revenues (Sales) and prediction of Aluminium price in 2021 through the geometric Brownian motion, as well as to estimate the cost of goods sold and operating profit in 2021. In this chapter, it will focus on the results interpretation about what we get in last chapter and make the frequency and probability distribution analysis.

5.1 Main Results Presentation and Interpretation

Under this subchapter, it will be presents the detail results for several main variables and interpretate it.

From the relationship it mentioned above, we assume one metric ton Aluminium can be produced 80 thousand cans of cola (0.33 liter), which can be used to calculate the quantity of Aluminium needed. Hence, firstly it is necessary to calculate the quantity of cola sold. Then it may get the results as the Table 5.1 shows.

Table 5.1 The detail of Cost of Aluminium

	Quantity of cola sold (can) in million	**Quantity of Aluminium needed in metric ton**	**Cost of Aluminium in million US$**
S1	77145	9,643,063	19351
S2	75130	9,391,241	19190
S3	73118	9,139,716	18388
S4	78407	9,800,869	19610
S5	75489	9,436,162	19375
…	…	…	…

According to the data from above table, the PepsiCo company may spend around 19 thousand million US dollar on the consumption of material Aluminium. However, the estimated results have some bias compared to the assumption mentioned that there are 80% of COGS as the costs of ingredients and 20% of COGS as the costs of Aluminium. The actual data about the percentage of two components account for from the estimation are shown as the Table 5.2. The PepsiCo company spend 63% of Cost of Goods Sold for the Cost of ingredient and spend 37% of Cost of Goods Sold as the Cost of Aluminium.

Table 5.2 The detail of the Cost of Goods Sold

	Cost of Ingredient (million $)	Percentages accounts for Cost of Goods Sold (%)	Cost of Aluminium (million $)	Percentages accounts for Cost of Goods Sold (%)	Cost of goods sold (million $)
S1	33,049	63	19,351	37	52,399
S2	32,186	63	19,190	37	51,376
S3	31,324	63	18,388	37	49,711
S4	33,590	63	19,610	37	53,199
S5	32,340	63	19,375	37	51,715
…	…	…	…	…	…

Due to fact that the company have the need of Aluminium as the main material for the production, the price volatility of Aluminum can be the one of risk to the company since the change of the Aluminum price will affects the costs of the company. From the estimation process it is known that there is a significant relationship between the Aluminum and the "cans". In last chapter, it is assumed that one metric ton Aluminum can be produced 80 thousand cans, however, as the results shown as Chart 4.2 there have some trends that the price of Aluminum will grow up which means there is probability that PepsiCo company will face the increasing costs in 2021. If the selling price unchanged the company will lose part of profit when the total sales decreased.

As it was mentioned above, another factor that influence the total operating income is the sales, the operating revenues. The following Table 5.3 shows 5 scenarios samples of the revenues.

Table 5.3 Summary of the Company's Revenue and Profit for 5 Scenarios

	Revenues (million $)	Gross Profits (million $)	Total Operating Income (million $)
S1	91,802	39,403	13,515
S2	89,405	38,029	12,141
S3	87,010	37,299	11,411
S4	93,304	40,105	14,217
S5	89,832	38,117	12,230
…	…	…	…

When look at the evolution of the sales from Chart 4.1, there have the probability that the sales will be lower than last year. It may be the risk for the company that the operating revenues will be decreased, thus, if together with the increasing price of Aluminum the operating profit for PepsiCo in 2021 may become lower. However, the charts also show us the probability of the Aluminum price grows down and operating revenues increased more than last year.

To be more precisely estimate the operating profit for PepsiCo in 2021, we are going to make frequency and probability analysis.

5.2 The Frequency and Probability distribution Analysis

In this subchapter, it will continue to analysis the PepsiCo company's operating revenues and operating profit from the point of view of Frequency and Probability distribution.

5.2.1 The Analysis of Operating Revenues in 2021

To begin with, the quarterly operating revenues will be analysis. For each quarter there are 21 of samples of operating revenues are selected from 1000 scenarios that we estimated in chapter 4, including the minimum and maximum amount, each of them has calculated the interval. The functions MIN, MAX, and FREQUENCY will be used. From the following Table 5.4 – 5.7, it indicates that 22609 million US$ is the most frequent amount with 13.5% probability in the first Quarter of 2021, 24398 million US$ has 12.8% probability for the revenues in 2021 of second Quarter, in addition, there are 13.4% of probability that the revenues are 22939 million US$ in third Quarter of 2021 and 14.2% of probability that the revenues are 20998 million US$ in fourth Quarter of 2021.

Table 5.4 2021 Quarter 1 Operating Revenues Frequency and Probability

Revenues (million $)	Q1	Frequency	Probability (%)
MIN	21,571	1	0.10
	21,665	2	0.20
	21,760	4	0.40
	21,854	10	1.00
	21,948	7	0.70
	22,043	31	3.10
	22,137	63	6.30
	22,232	72	7.20
	22,326	112	11.20
	22,421	128	12.80
	22,515	122	12.20
	22,609	135	13.50
	22,704	109	10.90
	22,798	85	8.50
	22,893	50	5.00
	22,987	30	3.00
	23,082	22	2.20
	23,176	8	0.80
	23,270	6	0.60
	23,365	2	0.20
MAX	23,459	1	0.10
		Interval	94.43
		Scenario	1000

Table 5.5 2021 Quarter 2 Operating Revenues Frequency and Probability

Revenues (million $)	Q2	Frequency	Probability (%)
MIN	22,410	1	0.10
	22,591	1	0.10
	22,772	4	0.40
	22,952	8	0.80
	23,133	12	1.20
	23,314	31	3.10
	23,494	52	5.20
	23,675	69	6.90
	23,856	88	8.80
	24,036	111	11.10
	24,217	115	11.50
	24,398	128	12.80
	24,578	101	10.10
	24,759	93	9.30
	24,940	69	6.90
	25,120	50	5.00
	25,301	32	3.20
	25,482	14	1.40
	25,662	8	0.80
	25,843	9	0.90
MAX	26,024	4	0.40
		Interval	180.66
		Scenarios	1000

Table 5.6 2021Quarter 3 Operating Revenues Frequency and Probability

Revenues (million $)	Q3	Frequency	Probability (%)
MIN	20,055	1	0.10
	20,317	0	0.00
	20,580	1	0.10
	20,842	10	1.00
	21,104	9	0.90
	21,366	26	2.60
	21,628	51	5.10
	21,891	94	9.40
	22,153	127	12.70
	22,415	128	12.80
	22,677	132	13.20
	22,939	134	13.40
	23,202	105	10.50
	23,464	77	7.70
	23,726	53	5.30
	23,988	22	2.20
	24,250	17	1.70
	24,513	9	0.90
	24,775	3	0.30
	25,037	0	0.00
MAX	25,299	1	0.10
		Interval	262.19
		Scenario	1000

Table 5.7 2021 Quarter 4 Operating Revenues Frequency and Probability

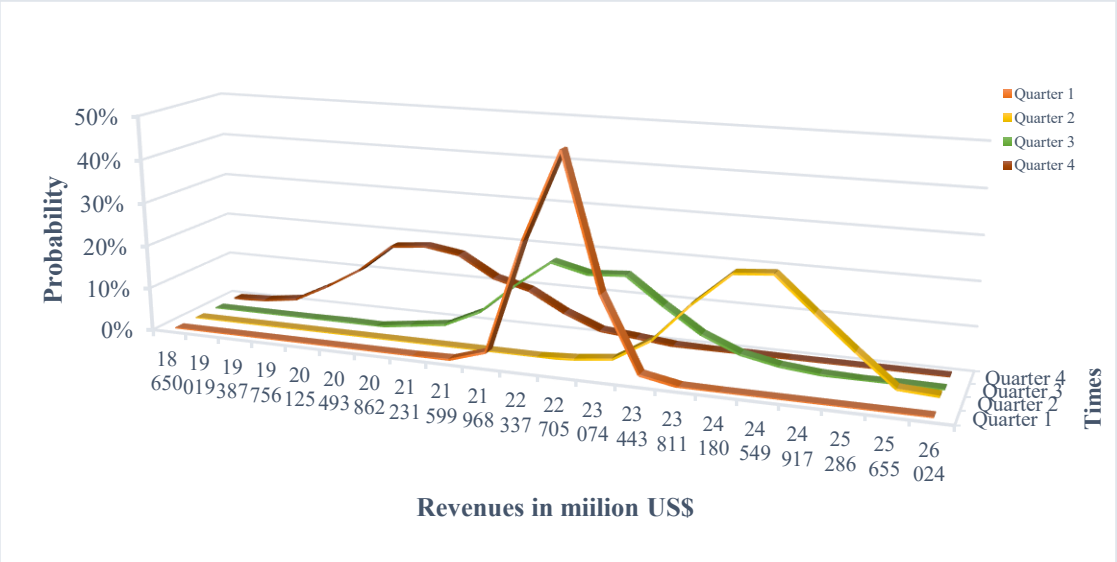
Revenues (million $)	Q4	Frequency	Probability (%)
MIN	18,650	1	0.10
	18,911	3	0.30
	19,172	5	0.50
	19,433	19	1.90
	19,693	42	4.20
	19,954	70	7.00
	20,215	86	8.60
	20,476	122	12.20
	20,737	111	11.10
	20,998	142	14.20
	21,259	110	11.00
	21,520	84	8.40
	21,781	80	8.00
	22,041	55	5.50
	22,302	29	2.90
	22,563	22	2.20
	22,824	9	0.90
	23,085	7	0.70
	23,346	1	0.10
	23,607	1	0.10
MAX	23,868	1	0.10
		Interval	260.88
		Scenario	1000

In order to make a chart to combine theses four quarters' probability of operating revenues, it is necessary to prepare a revenue rang for the four quarters, which shown in Table 5.8. According to the table, there are 21 samples of revenues, but the minimum and maximum amount are the predetermined amount from four individual quarters' data set which means they are the minimum amount and maximum amount among four data sets. Then, the Chart 5.1 shows the probability distribution for company revenues of four quarters in 2021. As the chart shows, after adjustment, there are 48.4% probability the revenue will be 22705 million $ in first Quarter, 23.8% probability that the revenue is 24549 million $ in second Quarter, and 19.4% probability that 22337 million $ will be the revenue in third Quarter, 17.9% probability that 20862 million $ is the revenue in fourth Quarter in 2021.

Table 5.8 The combination of Four Quarters' Revenue Frequency and Probability

	Boundary	Quarter 1		Quarter 2		Quarter 3		Quarter 4	
		FREQ.	Prob. (%)	FREQ.	Prob. (%)	FREQ.	Prob. (%)	FREQ.	Prob. (%)
min	18,650	0	0.0	0	0.0	0	0.0	1	0.1
	19,019	0	0.0	0	0.0	0	0.0	5	0.5
	19,387	0	0.0	0	0.0	0	0.0	16	1.6
	19,756	0	0.0	0	0.0	0	0.0	57	5.7
	20,125	0	0.0	0	0.0	1	0.1	105	10.5
	20,493	0	0.0	0	0.0	0	0.0	171	17.1
	20,862	0	0.0	0	0.0	11	1.1	179	17.9
	21,231	0	0.0	0	0.0	22	2.2	166	16.6
	21,599	2	0.2	0	0.0	61	6.1	118	11.8
	21,968	28	2.8	0	0.0	132	13.2	97	9.7
	22,337	284	28.4	0	0.0	194	19.4	52	5.2
	22,705	484	48.4	5	0.5	174	17.4	19	1.9
	23,074	184	18.4	15	1.5	180	18.0	11	1.1
	23,443	17	1.7	67	6.7	119	11.9	2	0.2
	23,811	1	0.1	156	15.6	63	6.3	0	0.0
	24,180	0	0.0	231	23.1	28	2.8	1	0.1
	24,549	0	0.0	238	23.8	11	1.1	0	0.0
	24,917	0	0.0	163	16.3	3	0.3	0	0.0
	25,286	0	0.0	90	9.0	0	0.0	0	0.0
	25,655	0	0.0	20	2.0	1	0.1	0	0.0
max	26,024	0	0.0	15	1.5	0	0.0	0	0.0
							Interval	369	
							Scenario	1,000	

Chart 5.1 The Quarterly Probability Distribution of Revenues in 2021



To sum up the probability distribution of whole year operating revenues of the PepsiCo in 2021, the construction of boundaries is needed which the data of estimation for whole year revenues in chapter 4 will be used. After that, the same functions will be used as above to get the results of minimum, maximum amount, and frequency, then calculate the probability as well as accumulated probability. Table 5.9 shows the calculated results.

Table 5.9 Data Summary of Revenues (million $) Frequency and Probability in 2021

	YE2021	Frequency	Probability (%)	Accumulated (%)
MIN	83,292	1	0.10	0.1
	84,019	0	0.00	0.1
	84,747	3	0.30	0.4
	85,474	13	1.30	1.7
	86,201	11	1.10	2.8
	86,928	40	4.00	6.8
	87,656	65	6.50	13.3
	88,383	94	9.40	22.7
	89,110	114	11.40	34.1
	89,837	122	12.20	46.3
	90,565	131	13.10	59.4
	91,292	115	11.50	70.9
	92,019	105	10.50	81.4
	92,746	75	7.50	88.9
	93,474	42	4.20	93.1
	94,201	35	3.50	96.6
	94,928	19	1.90	98.5
	95,655	8	0.80	99.3
	96,383	5	0.50	99.8
	97,110	1	0.10	99.9
MAX	97,837	1	0.10	100.0
			Interval	727
			Scenario	1000

In the whole year, there are 13.1% probability that the total operating revenues will be 90565 million US$, 12.2% probability that total operating revenues is 89837 million US$ and 11.5% probability the total operating revenues is 91292 million US$.

Chart 5.2 Yearly Probability Distribution of Operating Revenues

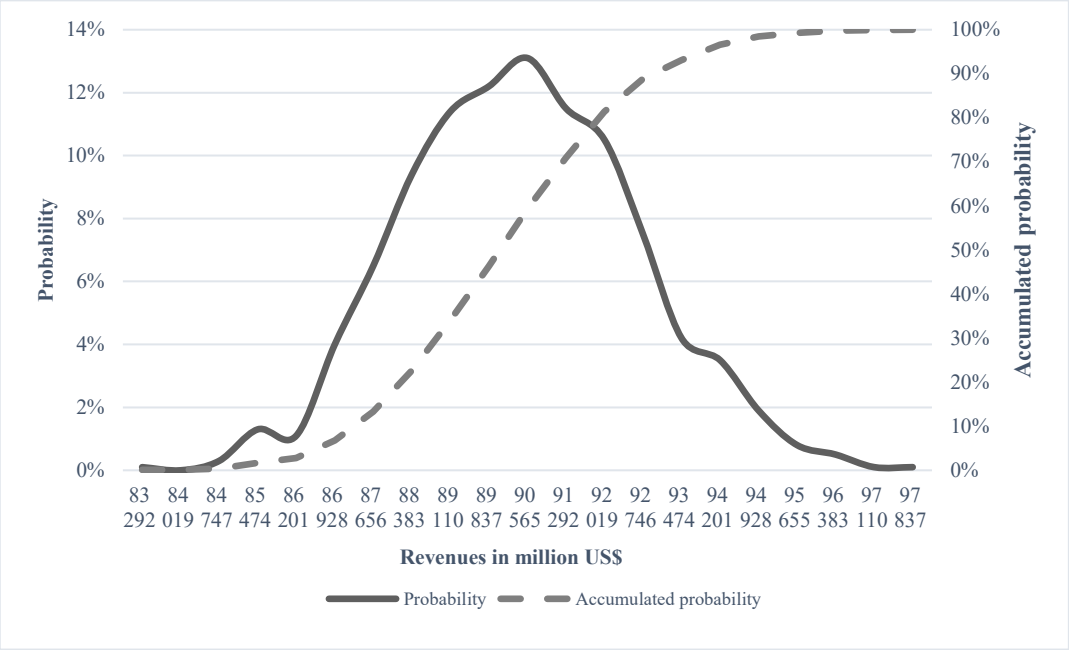
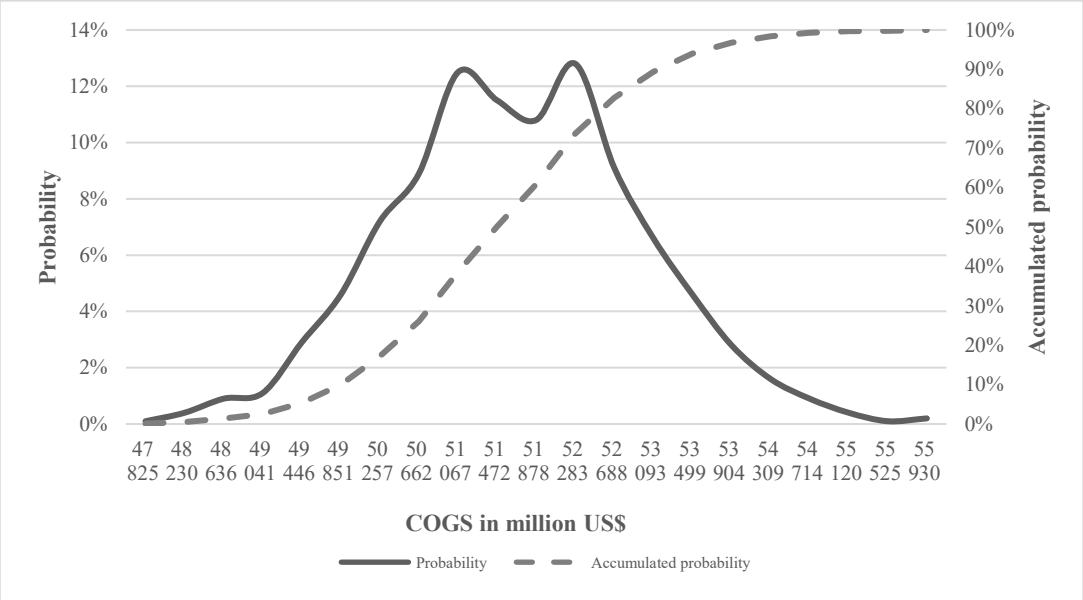


Chart 5.2 shows the graphically probability and accumulated probability distribution of Revenues in 2021.

5.2.2 The Analysis of Cost of Goods Sold

After the operating revenues probability analysis of PepsiCo company, the next part is going to analyse the frequency and probability of cost of goods sold.

Chart 5.3 Probability distribution of Cost of Goods Sold in 2021



For the cost of goods sold, we selected the 21 samples data from 1000 scenarios and calculated the minimum value by function MIN and maximum value by function MAX. Applying the same interval by dividing the difference between maximum and minimum amount by 20 and figure out the boundaries of cost of goods sold. Then the function FREQUENCY used to get the result of frequency and dividing it by 1000 to calculate the probability. To accumulate each of probability until it equal to 100%. The Table 5.10 shows all the results from the calculation above. And it is clearer that the amount of 52283 million US$ have the 12.8% probability to be the cost of goods sold for PepsiCo company in year 2021 from the Table 5.10. Besides, there are two kurtoses for the probability distribution of cost of goods sold in 2021, which are 51067 and 52283 respectively, where the probability is close according to the Chart 5.3.

Table 5.10 Data Summary of Cost of Goods Sold (million $) in Year 2021

COGS	YE2021	Frequency	Probability (%)	Accumulated (%)
MIN	47,825	1	0.10	0.10
	48,230	4	0.40	0.5
	48,636	9	0.90	1.4
	49,041	11	1.10	2.5
	49,446	29	2.90	5.4
	49,851	46	4.60	10.0
	50,257	72	7.20	17.2
	50,662	89	8.90	26.1
	51,067	125	12.50	38.6
	51,472	115	11.50	50.1
	51,878	108	10.80	60.9
	52,283	128	12.80	73.7
	52,688	91	9.10	82.8
	53,093	66	6.60	89.4
	53,499	46	4.60	94.0
	53,904	28	2.80	96.8
	54,309	16	1.60	98.4
	54,714	9	0.90	99.3
	55,120	4	0.40	99.7
	55,525	1	0.10	99.8
MAX	55,930	2	0.20	100.0
			Interval	405
			Scenario	1000

5.2.3 The Analysis of Total Operating Income

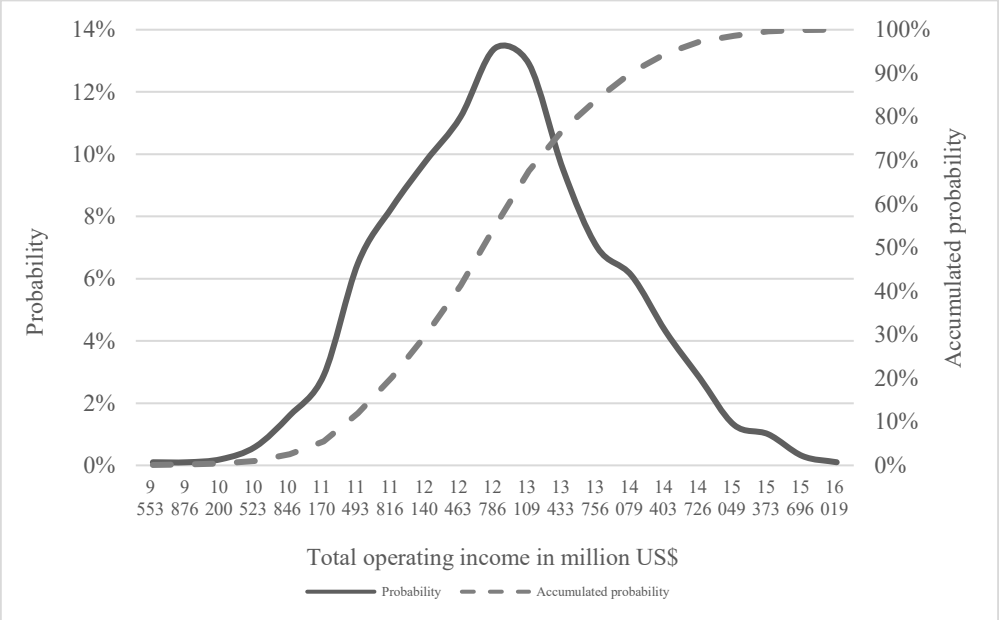
For the total operating income, we apply the same way to make the analysis of probability distribution. There 21 samples selected from 1000 scenarios of calculated total operating income and calculated the minimum and maximum amount by functions MIN and MAX respectively. The calculated interval for each amount is 323. By applying the function FREQUENCY to calculate frequency distribution of selected samples.

Table 5.11Data Summary of Total Operating Income (million $) in 2021

	YE2021	Frequency	Probability (%)	Accumulated (%)
MIN	9,553	1	0.1	0.1
	9,876	1	0.1	0.2
	10,200	2	0.2	0.4
	10,523	6	0.6	1.0
	10,846	16	1.6	2.6
	11,170	29	2.9	5.5
	11,493	65	6.5	12.0
	11,816	83	8.3	20.3
	12,140	98	9.8	30.1
	12,463	112	11.2	41.3
	12,786	134	13.4	54.7
	13,109	129	12.9	67.6
	13,433	95	9.5	77.1
	13,756	70	7.0	84.1
	14,079	61	6.1	90.2
	14,403	43	4.3	94.5
	14,726	28	2.8	97.3
	15,049	13	1.3	98.6
	15,373	10	1.0	99.6
	15,696	3	0.3	99.9
MAX	16,019	1	0.1	100.0
			Interval	323
			Scenario	1000

According to the calculation results from Table 5.11, there are 13.4% probability that the total operating income for the company is 12786 million US$. In addition, there are 11.2% probability that the total operating income is 12463 million US$, and 12.9% probability that the total operating income will be 13109 million US$.

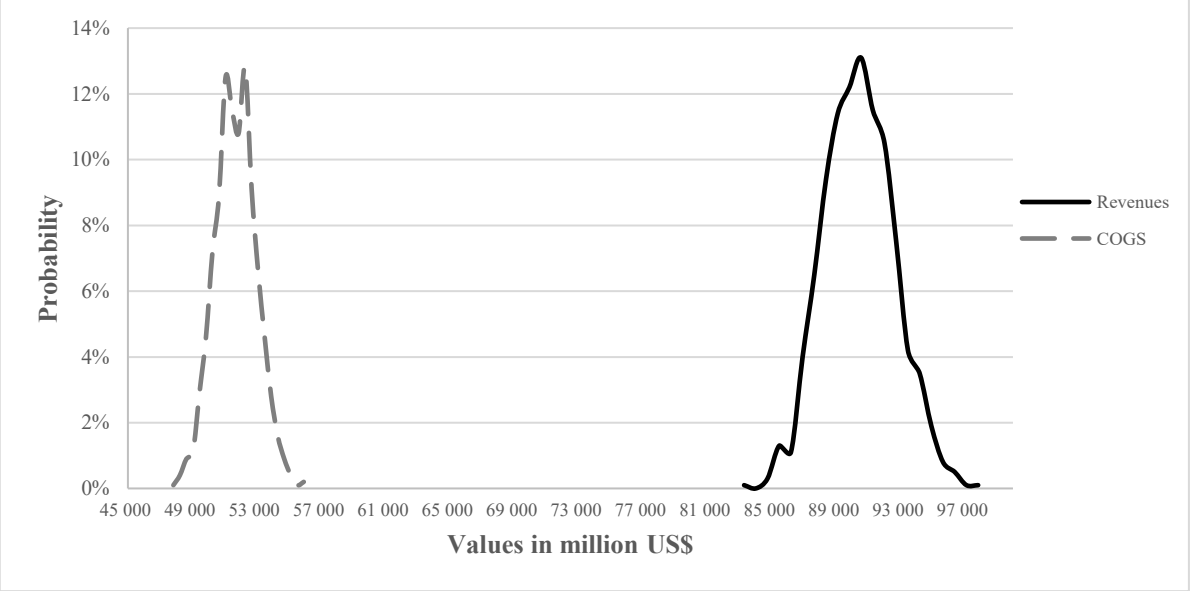
Chart 5.4 Probability Distribution of Total Operating Income in 2021



And the Chart 5.4 shows the graphically distribution of probability and accumulated probability for total operating income in 2021.

When compare the probability distribution of operating revenues and the cost of goods sold as shown as the Chart 5.5, we can see that they have different shape of distribution. The range of cost of goods sold distributed is between 49000 to 57000 with two significant kurtoses. However, the operating revenues are distributed around 84000 to 98000.

Chart 5.5 Probability Comparison of Revenues and Cost of Goods Sold



From Chart 5.5 it is indicates that there is probability that the operating revenues will be nearly twice more than the cost of goods sold. According to this fact, the PepsiCo company is running at the efficient way.

Chart 5.6 Accumulated Probability Comparison of Revenues and COGS

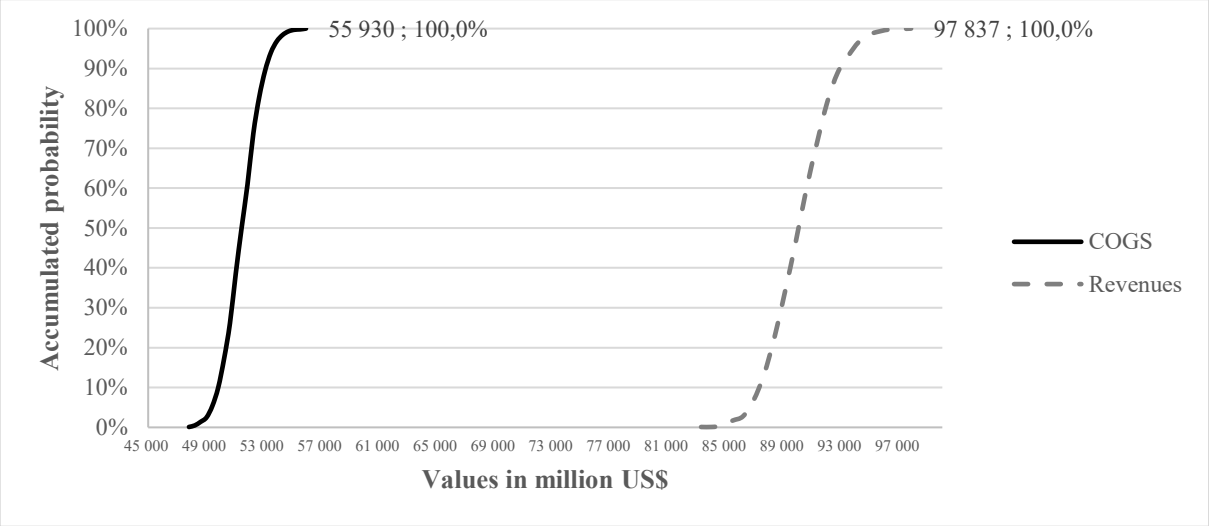


Chart 5.6 shows the accumulated probability distribution for operating revenues and cost of goods sold.

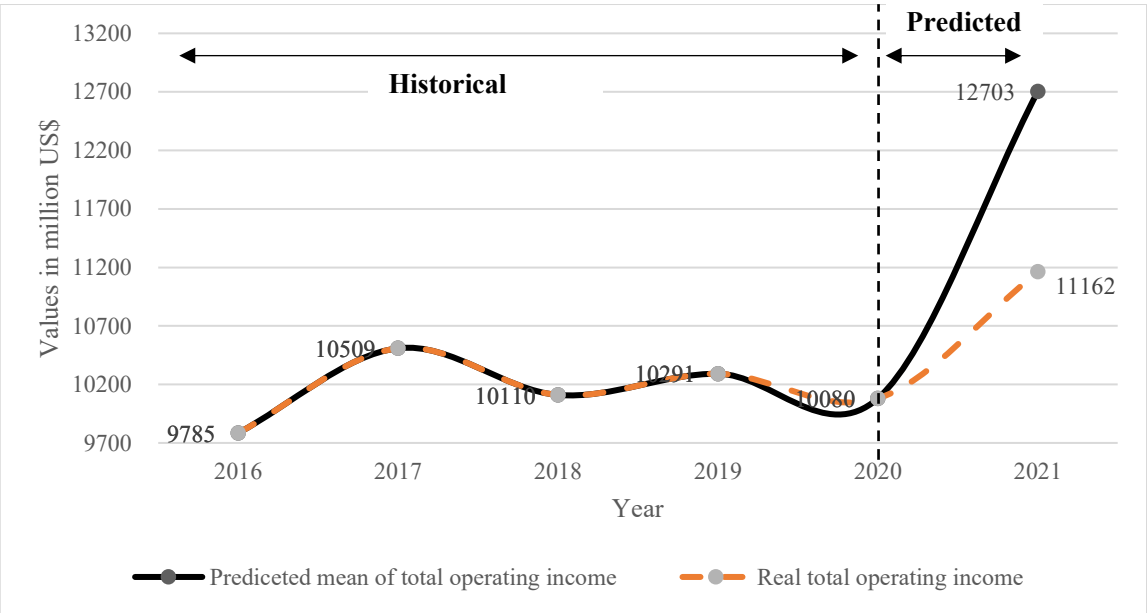
Table 5.12 Key Statistics of Total Operating Income

MEAN	12703
Standard deviation	1019
Variance	1038263
MIN	9553
MAX	16019
Percentile - 97.5%	14757
Percentile - 2.5%	10845

Table 5.12 shows the key statistics for the 1000 scenarios of estimated operating income by the formulas 2.2 - 2.6, where the mean value is 12703 million US$ calculated by the function AVERAGE, the standard deviation is 1019 calculated by function STDEV.S and the variance is the power of 2 the standard deviation. Among 1000

scenarios the minimum number is 9553 million US$ and maximum number is 16019 million US$.

Chart 5.7 Overall Evolution of Total Operating Income During 2016-2021



The Chart 5.7 display the evolution trend of total operating income during period 2016-2021, where the chart is divided into two parts. The left part is the evolution based on the real data from PepsiCo and the right part is the estimation. From the prediction, the total operating income in 2021 will be 12703 million US$ which about 2000 million US$ more than 2020. The line of orange indicates the real evolution of the PepsiCo company where the data is from the company's income statement. It can be seen that the real total operating income is 11162 million US$ in 2021 which is lower than the estimation, but it is about 1000 million US$ higher than 10080 million US$ in 2020.

6 Conclusion

Companies face a wide variety of risks to their long-run profitability and value. According to the theory of risk management[6], the risks are divided into three general categories: market, commercial, and external events. Market risk relate to price movements in financial markets and include interest rate risk, foreign exchange risk and commodity price risk. For this thesis, it focuses on evaluating how the random changes in Sales and Aluminum price affect the earnings of PepsiCo company in 2021.

From theoretical part of Chapter 2, CorporateMetrics is described as a comprehensive set of definition, methodologies, data sets and software for measuring market risk in corporate environment, and there are five steps to form the basis of CorporateMetrics. In addition, the random walk theory which is the theory behind the forecasting is defined, also, the Monte Carlo simulation and geometric Brownian motion with its formulation are presented for the practical calculation. What's more, the basic information about PepsiCo is introduced detailly with its main operations, business development history, and the market risks that the company faces in Chapter 3.

In the practical part of Chapter 4, the Sales of Cola and Aluminum price assumed as the main market variables for PepsiCo that affect its earnings. Firstly, to collect historical data of Sales and Aluminum price and process them for the preparation, together with the generated random variables to apply the Monte Carlo simulation and get the results of predicted Sales and Aluminum price which based on the geometric Brownian motion in the 2021. Besides, based on the financial data of PepsiCo company annual reports from 2016 to 2020, the relationship between market variables and financial metrics such as revenue, cost of goods sold and total operating income is connected. Then in the Chapter 5, which shows the results from the calculation. From which, it presents that there are 13.1% probability that the operating revenue will be 90565 million $ in 2021, 12.5% probability that the COGS is 51067 million $, and 13.4% probability that the total operating income is 12786 million $ in 2021. In the end, when we compare the forecasted result to the real value from Chart 5.7, there has difference between two values where the real total operating income is 11162 million $ in 2021 for PepsiCo. However, both of the values are indicating an increased total operating income compared to the last 5 years. It

[6] Servaes, H., Tamayo, A. and Tufano, P. (2009), *The Theory and Practice of Corporate Risk Management.* Journal of Applied Corporate Finance, 21: 60-78. https://doi.org/10.1111/j.1745-6622.2009.00250.x

can be concluded that the PepsiCo company have involved in the efficient risks management even during the pandemic.

Bibliography

[1] ALEXANDER, Carol. *Market Risk Analysis: Quantitative Methods in Finance*. New York: John Wiley & Sons, 2008. ISBN 978-0470998007.

[2] BENNINGA, Simon. *Financial Modelling*. 4th ed. New York: The MIT Press, 2014. ISBN 978- 0262027281.

[3] CRÉPEY, Stéphane. *Financial Modeling.* 1st ed. Springer-Verlag Berlin Heidelberg 2013. ISBN 978-3-642-37113-4.

[4] DLUHOŠOVÁ, Dana et al. *Financial Management and Decision-making of a Company. Analysis, Investing, Valuation, Sensitivity, Risk, Flexibility*. SAEI, vol. 28. Ostrava: VSB-TU Ostrava, 2014. ISBN978-80-248-3619-5.

[5] STULZ, Rene M. (Fall 1996). *Rethinking Risk Management, Journal of Applied Corporate Finance*, 9(3), pp. 8–24.

[6] Z.ZMEŠKAL, D.DLUHOŠOVÁ and T. TICHÝ. *Financial Models.* 1st ed. Ostrava: VSB-Technical University of Ostrava, 2004. ISBN 80-24807548.

Electronic documents and others

[1] Alvin Y. LEE. *CorporateMetrics Technical Document [online]*. New York: RiskMetrics Group, J.P.Morgan, 1999. [2017-08-04]. Available at: https://www.msci.com/documents/10199/8af520af-3e63-44b2-8aab-fd55a989e312

[2] PepsiCo Company website. Available at: https://www.pepsico.com/

[3] S. Raychaudhuri, *Introduction to Monte Carlo simulation*, 2008 Winter Simulation Conference, 2008, pp. 91-100, DOI: 10.1109/WSC.2008.4736059.

[4] Servaes, H., Tamayo, A. and Tufano, P. (2009), *The Theory and Practice of Corporate Risk Management.* Journal of Applied Corporate Finance, 21: 60-78. https://doi.org/10.1111/j.1745-6622.2009.00250.x

List of Abbreviations

COI	Cost of Ingredient
COA	Cost of Aluminium
COGS	Cost of Goods Sold
TOI	Total Operating Income
GP	Gross Profit
TOE	Total Operating Expenses
EaR	Earnings-at-Risk
EPSaR	Earnings-per-Share-at-Risk
CFaR	Cash-Flow-at-Risk
GBM	Geometric Brownian Motion
FREQ.	Frequency
Prob.	Probability

List of Annexes

Annex 1 Consolidated Balance Sheet in 2016-2017

Consolidated Balance Sheet
PepsiCo, Inc. and Subsidiaries
December 30, 2017 and December 31, 2016
(in millions except per share amounts)

	2017	2016
ASSETS		
Current Assets		
Cash and cash equivalents	**$ 10,610**	$ 9,158
Short-term investments	**8,900**	6,967
Accounts and notes receivable, net	**7,024**	6,694
Inventories	**2,947**	2,723
Prepaid expenses and other current assets	**1,546**	908
Total Current Assets	**31,027**	26,450
Property, Plant and Equipment, net	**17,240**	16,591
Amortizable Intangible Assets, net	**1,268**	1,237
Goodwill	**14,744**	14,430
Other nonamortizable intangible assets	**12,570**	12,196
Nonamortizable Intangible Assets	**27,314**	26,626
Investments in Noncontrolled Affiliates	**2,042**	1,950
Other Assets	**913**	636
Total Assets	**$ 79,804**	$ 73,490
LIABILITIES AND EQUITY		
Current Liabilities		
Short-term debt obligations	**$ 5,485**	$ 6,892
Accounts payable and other current liabilities	**15,017**	14,243
Total Current Liabilities	**20,502**	21,135
Long-Term Debt Obligations	**33,796**	30,053
Other Liabilities	**11,283**	6,669
Deferred Income Taxes	**3,242**	4,434
Total Liabilities	**68,823**	62,291
Commitments and contingencies		
Preferred Stock, no par value	**41**	41
Repurchased Preferred Stock	**(197)**	(192)
PepsiCo Common Shareholders' Equity		
Common stock, par value $1^2/_3$¢ per share (authorized 3,600 shares, issued, net of repurchased common stock at par value: 1,420 and 1,428 shares, respectively)	**24**	24
Capital in excess of par value	**3,996**	4,091
Retained earnings	**52,839**	52,518
Accumulated other comprehensive loss	**(13,057)**	(13,919)
Repurchased common stock, in excess of par value (446 and 438 shares, respectively)	**(32,757)**	(31,468)
Total PepsiCo Common Shareholders' Equity	**11,045**	11,246
Noncontrolling interests	**92**	104
Total Equity	**10,981**	11,199
Total Liabilities and Equity	**$ 79,804**	$ 73,490

Annex 2 Consolidated Statement of Income in 2015-2017

Consolidated Statement of Income
PepsiCo, Inc. and Subsidiaries
Fiscal years ended December 30, 2017, December 31, 2016 and December 26, 2015
(in millions except per share amounts)

	2017	2016	2015
Net Revenue	**$ 63,525**	$ 62,799	$ 63,056
Cost of sales	**28,785**	28,209	28,731
Gross profit	**34,740**	34,590	34,325
Selling, general and administrative expenses	**24,231**	24,805	24,613
Venezuela impairment charges	**—**	—	1,359
Operating Profit	**10,509**	9,785	8,353
Interest expense	**(1,151)**	(1,342)	(970)
Interest income and other	**244**	110	59
Income before income taxes	**9,602**	8,553	7,442
Provision for income taxes (See Note 5)	**4,694**	2,174	1,941
Net income	**4,908**	6,379	5,501
Less: Net income attributable to noncontrolling interests	**51**	50	49
Net Income Attributable to PepsiCo	**$ 4,857**	$ 6,329	$ 5,452
Net Income Attributable to PepsiCo per Common Share			
Basic	**$ 3.40**	$ 4.39	$ 3.71
Diluted	**$ 3.38**	$ 4.36	$ 3.67
Weighted-average common shares outstanding			
Basic	**1,425**	1,439	1,469
Diluted	**1,438**	1,452	1,485
Cash dividends declared per common share	**$ 3.1675**	$ 2.96	$ 2.7625

Annex 3 Consolidated Statement of Cash Flows in 2015-2017

Consolidated Statement of Cash Flows
PepsiCo, Inc. and Subsidiaries
Fiscal years ended December 30, 2017, December 31, 2016 and December 26, 2015
(in millions)

	2017	2016	2015
Operating Activities			
Net income	**$ 4,908**	$ 6,379	$ 5,501
Depreciation and amortization	**2,369**	2,368	2,416
Share-based compensation expense	**292**	284	295
Restructuring and impairment charges	**295**	160	230
Cash payments for restructuring charges	**(113)**	(125)	(208)
Charges related to the transaction with Tingyi	**—**	373	73
Venezuela impairment charges	**—**	—	1,359
Pension and retiree medical plan expenses	**221**	501	467
Pension and retiree medical plan contributions	**(220)**	(695)	(205)
Deferred income taxes and other tax charges and credits	**619**	452	78
Provisional net tax expense related to the TCJ Act	**2,451**	—	—
Change in assets and liabilities:			
Accounts and notes receivable	**(202)**	(349)	(461)
Inventories	**(168)**	(75)	(244)
Prepaid expenses and other current assets	**20**	10	(50)
Accounts payable and other current liabilities	**201**	997	1,692
Income taxes payable	**(338)**	329	55
Other, net	**(341)**	64	(134)
Net Cash Provided by Operating Activities	**9,994**	10,673	10,864
Investing Activities			
Capital spending	**(2,969)**	(3,040)	(2,758)
Sales of property, plant and equipment	**180**	99	86
Acquisitions and investments in noncontrolled affiliates	**(61)**	(212)	(86)
Reduction of cash due to Venezuela deconsolidation	**—**	—	(568)
Divestitures	**267**	85	76
Short-term investments, by original maturity:			
More than three months - purchases	**(18,385)**	(12,504)	(4,428)
More than three months - maturities	**15,744**	8,399	4,111
More than three months - sales	**790**	—	—
Three months or less, net	**2**	16	3
Other investing, net	**29**	9	(5)
Net Cash Used for Investing Activities	**(4,403)**	(7,148)	(3,569)
Financing Activities			
Proceeds from issuances of long-term debt	**7,509**	7,818	8,702
Payments of long-term debt	**(4,406)**	(3,105)	(4,095)
Debt redemptions	**—**	(2,504)	—
Short-term borrowings, by original maturity:			
More than three months - proceeds	**91**	59	15
More than three months - payments	**(128)**	(27)	(43)
Three months or less, net	**(1,016)**	1,505	53
Cash dividends paid	**(4,472)**	(4,227)	(4,040)
Share repurchases - common	**(2,000)**	(3,000)	(5,000)
Share repurchases - preferred	**(5)**	(7)	(5)
Proceeds from exercises of stock options	**462**	465	504
Withholding tax payments on RSUs, PSUs and PEPunits converted	**(145)**	(130)	(151)
Other financing	**(76)**	(58)	(52)
Net Cash Used for Financing Activities	**(4,186)**	(3,211)	(4,112)
Effect of exchange rate changes on cash and cash equivalents	**47**	(252)	(221)
Net Increase in Cash and Cash Equivalents	**1,452**	62	2,962
Cash and Cash Equivalents, Beginning of Year	**9,158**	9,096	6,134
Cash and Cash Equivalents, End of Year	**$ 10,610**	$ 9,158	$ 9,096

Annex 4 Consolidated Balance Sheet in 2018-2019

Consolidated Balance Sheet
PepsiCo, Inc. and Subsidiaries
December 28, 2019 and December 29, 2018
(in millions except per share amounts)

	2019	2018
ASSETS		
Current Assets		
Cash and cash equivalents	**$ 5,509**	$ 8,721
Short-term investments	**229**	272
Restricted cash	**—**	1,997
Accounts and notes receivable, net	**7,822**	7,142
Inventories	**3,338**	3,128
Prepaid expenses and other current assets	**747**	633
Total Current Assets	**17,645**	21,893
Property, Plant and Equipment, net	**19,305**	17,589
Amortizable Intangible Assets, net	**1,433**	1,644
Goodwill	**15,501**	14,808
Other indefinite-lived intangible assets	**14,610**	14,181
Indefinite-Lived Intangible Assets	**30,111**	28,989
Investments in Noncontrolled Affiliates	**2,683**	2,409
Deferred Income Taxes	**4,359**	4,364
Other Assets	**3,011**	760
Total Assets	**$ 78,547**	$ 77,648
LIABILITIES AND EQUITY		
Current Liabilities		
Short-term debt obligations	**$ 2,920**	$ 4,026
Accounts payable and other current liabilities	**17,541**	18,112
Total Current Liabilities	**20,461**	22,138
Long-Term Debt Obligations	**29,148**	28,295
Deferred Income Taxes	**4,091**	3,499
Other Liabilities	**9,979**	9,114
Total Liabilities	**63,679**	63,046
Commitments and contingencies		
PepsiCo Common Shareholders' Equity		
Common stock, par value $1^2/_3$¢ per share (authorized 3,600 shares; issued, net of repurchased common stock at par value: 1,391 and 1,409 shares, respectively)	**23**	23
Capital in excess of par value	**3,886**	3,953
Retained earnings	**61,946**	59,947
Accumulated other comprehensive loss	**(14,300)**	(15,119)
Repurchased common stock, in excess of par value (476 and 458 shares, respectively)	**(36,769)**	(34,286)
Total PepsiCo Common Shareholders' Equity	**14,786**	14,518
Noncontrolling interests	**82**	84
Total Equity	**14,868**	14,602
Total Liabilities and Equity	**$ 78,547**	$ 77,648

Annex 5 Consolidated Statement of Income in 2017-2019

Consolidated Statement of Income
PepsiCo, Inc. and Subsidiaries
Fiscal years ended December 28, 2019, December 29, 2018 and December 30, 2017
(in millions except per share amounts)

	2019	2018	2017
Net Revenue	**$ 67,161**	$ 64,661	$ 63,525
Cost of sales	**30,132**	29,381	28,796
Gross profit	**37,029**	35,280	34,729
Selling, general and administrative expenses	**26,738**	25,170	24,453
Operating Profit	**10,291**	10,110	10,276
Other pension and retiree medical benefits (expense)/income	**(44)**	298	233
Interest expense	**(1,135)**	(1,525)	(1,151)
Interest income and other	**200**	306	244
Income before income taxes	**9,312**	9,189	9,602
Provision for/(benefit from) income taxes (See Note 5)	**1,959**	(3,370)	4,694
Net income	**7,353**	12,559	4,908
Less: Net income attributable to noncontrolling interests	**39**	44	51
Net Income Attributable to PepsiCo	**$ 7,314**	$ 12,515	$ 4,857
Net Income Attributable to PepsiCo per Common Share			
Basic	**$ 5.23**	$ 8.84	$ 3.40
Diluted	**$ 5.20**	$ 8.78	$ 3.38
Weighted-average common shares outstanding			
Basic	**1,399**	1,415	1,425
Diluted	**1,407**	1,425	1,438

Annex 6 Consolidated Statement of Cash Flows in 2017-2019

Consolidated Statement of Cash Flows
PepsiCo, Inc. and Subsidiaries
Fiscal years ended December 28, 2019, December 29, 2018 and December 30, 2017
(in millions)

	2019	2018	2017
Operating Activities			
Net income	**$ 7,353**	$ 12,559	$ 4,908
Depreciation and amortization	**2,432**	2,399	2,369
Share-based compensation expense	**237**	256	292
Restructuring and impairment charges	**370**	308	295
Cash payments for restructuring charges	**(350)**	(255)	(113)
Pension and retiree medical plan expenses	**519**	221	221
Pension and retiree medical plan contributions	**(716)**	(1,708)	(220)
Deferred income taxes and other tax charges and credits	**453**	(531)	619
Net tax related to the TCJ Act	**(8)**	(28)	2,451
Tax payments related to the TCJ Act	**(423)**	(115)	—
Other net tax benefits related to international reorganizations	**(2)**	(4,347)	—
Change in assets and liabilities:			
Accounts and notes receivable	**(650)**	(253)	(202)
Inventories	**(190)**	(174)	(168)
Prepaid expenses and other current assets	**(87)**	9	20
Accounts payable and other current liabilities	**735**	882	201
Income taxes payable	**(287)**	448	(338)
Other, net	**263**	(256)	(305)
Net Cash Provided by Operating Activities	**9,649**	9,415	10,030
Investing Activities			
Capital spending	**(4,232)**	(3,282)	(2,969)
Sales of property, plant and equipment	**170**	134	180
Acquisition of SodaStream, net of cash and cash equivalents acquired	**(1,939)**	(1,197)	—
Other acquisitions and investments in noncontrolled affiliates	**(778)**	(299)	(61)
Divestitures	**253**	505	267
Short-term investments, by original maturity:			
More than three months - purchases	**—**	(5,637)	(18,385)
More than three months - maturities	**16**	12,824	15,744
More than three months - sales	**62**	1,498	790
Three months or less, net	**19**	16	2
Other investing, net	**(8)**	2	29
Net Cash (Used for)/Provided by Investing Activities	**(6,437)**	4,564	(4,403)
Financing Activities			
Proceeds from issuances of long-term debt	**4,621**	—	7,509
Payments of long-term debt	**(3,970)**	(4,007)	(4,406)
Debt redemption/cash tender and exchange offers	**(1,007)**	(1,589)	—
Short-term borrowings, by original maturity:			
More than three months - proceeds	**6**	3	91
More than three months - payments	**(2)**	(17)	(128)
Three months or less, net	**(3)**	(1,352)	(1,016)
Cash dividends paid	**(5,304)**	(4,930)	(4,472)
Share repurchases - common	**(3,000)**	(2,000)	(2,000)
Share repurchases - preferred	**—**	(2)	(5)
Proceeds from exercises of stock options	**329**	281	462
Withholding tax payments on restricted stock units (RSUs), performance stock units (PSUs) and PepsiCo equity performance units (PEPunits) converted	**(114)**	(103)	(145)
Other financing	**(45)**	(53)	(76)
Net Cash Used for Financing Activities	**(8,489)**	(13,769)	(4,186)
Effect of exchange rate changes on cash and cash equivalents and restricted cash	**78**	(98)	47
Net (Decrease)/Increase in Cash and Cash Equivalents and Restricted Cash	**(5,199)**	112	1,488
Cash and Cash Equivalents and Restricted Cash, Beginning of Year	**10,769**	10,657	9,169
Cash and Cash Equivalents and Restricted Cash, End of Year	**$ 5,570**	$ 10,769	$ 10,657

Annex 7 Consolidated Balance Sheet in 2020-2021

Consolidated Balance Sheet
PepsiCo, Inc. and Subsidiaries
December 25, 2021 and December 26, 2020
(in millions except per share amounts)

	2021	2020
ASSETS		
Current Assets		
Cash and cash equivalents	$ 5,596	$ 8,185
Short-term investments	392	1,366
Accounts and notes receivable, net	8,680	8,404
Inventories	4,347	4,172
Prepaid expenses and other current assets	980	874
Assets held for sale	1,788	—
Total Current Assets	21,783	23,001
Property, Plant and Equipment, net	22,407	21,369
Amortizable Intangible Assets, net	1,538	1,703
Goodwill	18,381	18,757
Other Indefinite-Lived Intangible Assets	17,127	17,612
Investments in Noncontrolled Affiliates	2,627	2,792
Deferred Income Taxes	4,310	4,372
Other Assets	4,204	3,312
Total Assets	$ 92,377	$ 92,918
LIABILITIES AND EQUITY		
Current Liabilities		
Short-term debt obligations	$ 4,308	$ 3,780
Accounts payable and other current liabilities	21,159	19,592
Liabilities held for sale	753	—
Total Current Liabilities	26,220	23,372
Long-Term Debt Obligations	36,026	40,370
Deferred Income Taxes	4,826	4,284
Other Liabilities	9,154	11,340
Total Liabilities	76,226	79,366
Commitments and contingencies		
PepsiCo Common Shareholders' Equity		
Common stock, par value $1^2/_3$¢ per share (authorized 3,600 shares; issued, net of repurchased common stock at par value: 1,383 and 1,380 shares, respectively)	23	23
Capital in excess of par value	4,001	3,910
Retained earnings	65,165	63,443
Accumulated other comprehensive loss	(14,898)	(15,476)
Repurchased common stock, in excess of par value (484 and 487 shares, respectively)	(38,248)	(38,446)
Total PepsiCo Common Shareholders' Equity	16,043	13,454
Noncontrolling interests	108	98
Total Equity	16,151	13,552
Total Liabilities and Equity	$ 92,377	$ 92,918

Annex 8 Consolidated Statement of Income in 2019-2021

Consolidated Statement of Income
PepsiCo, Inc. and Subsidiaries
Fiscal years ended December 25, 2021, December 26, 2020 and December 28, 2019
(in millions except per share amounts)

	2021	2020	2019
Net Revenue	**$ 79,474**	$ 70,372	$ 67,161
Cost of sales	**37,075**	31,797	30,132
Gross profit	**42,399**	38,575	37,029
Selling, general and administrative expenses	**31,237**	28,495	26,738
Operating Profit	**11,162**	10,080	10,291
Other pension and retiree medical benefits income/(expense)	**522**	117	(44)
Net interest expense and other	**(1,863)**	(1,128)	(935)
Income before income taxes	**9,821**	9,069	9,312
Provision for income taxes	**2,142**	1,894	1,959
Net income	**7,679**	7,175	7,353
Less: Net income attributable to noncontrolling interests	**61**	55	39
Net Income Attributable to PepsiCo	**$ 7,618**	$ 7,120	$ 7,314
Net Income Attributable to PepsiCo per Common Share			
Basic	**$ 5.51**	$ 5.14	$ 5.23
Diluted	**$ 5.49**	$ 5.12	$ 5.20
Weighted-average common shares outstanding			
Basic	**1,382**	1,385	1,399
Diluted	**1,389**	1,392	1,407

Annex 9 Consolidated Statement of Cash Flows in 2019-2021

Consolidated Statement of Cash Flows
PepsiCo, Inc. and Subsidiaries
Fiscal years ended December 25, 2021, December 26, 2020 and December 28, 2019
(in millions)

	2021	2020	2019
Operating Activities			
Net income	**$ 7,679**	$ 7,175	$ 7,353
Depreciation and amortization	**2,710**	2,548	2,432
Operating lease right-of-use asset amortization	**505**	478	412
Share-based compensation expense	**301**	264	237
Restructuring and impairment charges	**247**	289	370
Cash payments for restructuring charges	**(256)**	(255)	(350)
Acquisition and divestiture-related charges	**(4)**	255	55
Cash payments for acquisition and divestiture-related charges	**(176)**	(131)	(10)
Pension and retiree medical plan expenses	**123**	408	519
Pension and retiree medical plan contributions	**(785)**	(562)	(716)
Deferred income taxes and other tax charges and credits	**298**	361	453
Tax expense/(benefit) related to the TCJ Act	**190**	—	(8)
Tax payments related to the TCJ Act	**(309)**	(78)	(423)
Change in assets and liabilities:			
Accounts and notes receivable	**(651)**	(420)	(650)
Inventories	**(582)**	(516)	(190)
Prepaid expenses and other current assets	**159**	26	(87)
Accounts payable and other current liabilities	**1,762**	766	735
Income taxes payable	**30**	(159)	(287)
Other, net	**375**	164	(196)
Net Cash Provided by Operating Activities	**11,616**	10,613	9,649
Investing Activities			
Capital spending	**(4,625)**	(4,240)	(4,232)
Sales of property, plant and equipment	**166**	55	170
Acquisitions, net of cash acquired, and investments in noncontrolled affiliates	**(61)**	(6,372)	(2,717)
Divestitures and sales of investments in noncontrolled affiliates	**169**	6	253
Short-term investments, by original maturity:			
More than three months - purchases	**—**	(1,135)	—
More than three months - maturities	**1,135**	—	16
More than three months - sales	**—**	—	62
Three months or less, net	**(58)**	27	19
Other investing, net	**5**	40	(8)
Net Cash Used for Investing Activities	**(3,269)**	(11,619)	(6,437)

Annex 10 Consolidated Statement of Cash Flows in 2019-2021 (continued)

Consolidated Statement of Cash Flows (continued)
PepsiCo, Inc. and Subsidiaries
Fiscal years ended December 25, 2021, December 26, 2020 and December 28, 2019
(in millions)

	2021	2020	2019
Financing Activities			
Proceeds from issuances of long-term debt	**$ 4,122**	$ 13,809	$ 4,621
Payments of long-term debt	**(3,455)**	(1,830)	(3,970)
Cash tender offers/debt redemption	**(4,844)**	(1,100)	(1,007)
Short-term borrowings, by original maturity:			
More than three months - proceeds	**8**	4,077	6
More than three months - payments	**(397)**	(3,554)	(2)
Three months or less, net	**434**	(109)	(3)
Payments of acquisition-related contingent consideration	**(773)**	—	—
Cash dividends paid	**(5,815)**	(5,509)	(5,304)
Share repurchases - common	**(106)**	(2,000)	(3,000)
Proceeds from exercises of stock options	**185**	179	329
Withholding tax payments on restricted stock units (RSUs) and performance stock units (PSUs) converted	**(92)**	(96)	(114)
Other financing	**(47)**	(48)	(45)
Net Cash (Used for)/Provided by Financing Activities	**(10,780)**	3,819	(8,489)
Effect of exchange rate changes on cash and cash equivalents and restricted cash	**(114)**	(129)	78
Net (Decrease)/Increase in Cash and Cash Equivalents and Restricted Cash	**(2,547)**	2,684	(5,199)
Cash and Cash Equivalents and Restricted Cash, Beginning of Year	**8,254**	5,570	10,769
Cash and Cash Equivalents and Restricted Cash, End of Year	**$ 5,707**	$ 8,254	$ 5,570