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The Evolution of Financial Risk Management

Cantürk Kayahan[a,*], **Tolga Murat**[b]

[a]Afyon Kocatepe University, Department of Business Administration, Turkey
[b]Afyon Kocatepe University, Department of Business Administration PhD Student, Turkey

A B S T R A C T

Purpose: This paper aims to track the history of financial risk management and how this progress affected the evolution of financial risk management. In the first part of this paper, we will look at how risk is defined, the concept of risk management, and the transaction from risk philosophy to the risk culture. The second part examines the evolution of risk management and different models used in financial risk measurements, such as variance, covariance, standard deviation, and value at risk models. In the third part, the Bretton Woods system, its effects on the global financial system, and after the Bretton Woods system is studied. In the final cut, we conclude and present our recommendations for future studies.

Methodology: This theoretical research will focus on the historical evolution of financial risk management and the financial tools used while measuring risk. The finance field has evolved with crises, technological developments, and globalization. While the finance field has been growing, how financial risks are defined, managed, and measured has also changed. In addition to these changes, the finance field was introduced with a new area called "blockchain" and new investment instruments called cryptocurrencies.

Practical Implications: This theoretical research investigates the evolution of financial risk management from a historical perspective and argues that the current financial risk management tools are insufficient to project today's risks fully.

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**Corresponding author:*
tolgamurat23@gmail.com
(Tolga Murat)

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INTRODUCTION

The world we live in is often defined as the finance world. The finance world's focal point focuses on three major fields; financial institutions, markets, and investments. Investors focus on primary and secondary financial markets while making their decisions. These markets are; banks for initial public offerings, money markets, capital markets, futures markets, spot markets, organized markets and over-the-counter markets, and more. Investment is essential for investors to make more money, and entrepreneurs/businesses require these investments to grow or create new companies. Thus, investors consider various risk factors while making investments. Indeed, while driving long-term decisions such as capital budgeting, risk factors are one of the major determinants. In this environment where financial decisions are made, financial institutions are fundamental organizations both investors and the financial system need. Therefore, the risk concept has been one of the primary focus points for financial institutions, and these institutions always consider risk in their plans and strategies.

The first part of this research focuses on the concept of risk, its historical development, and different types of risk while focusing on how the risk philosophy has become the risk culture of today. The second part investigates the risk measurement tools and evaluates the financial risk measurement models and the progress that led to the creation of these models. Return, variance, standard deviation, correlation, and covariance are explained, and VAR (value at risk) models are analyzed. The third part includes the financial system established after the second world war and the effects of this system on the world's financial system. Finally, in the last part, a general evaluation is drawn within the framework of the future of financial risk management and its reflections on financial institutions. An available review of digitalization and cryptocurrencies is mentioned at the end of this paper.

1. CONCEPT OF RISK AND ITS FUTURE

Throughout history, humans have constantly been exposed to risks. These risks and how they occur have been continuously changing, fueled by human cultural and biological evolution (Lia et al., 2020). People define risk based on the risks and uncertainties they encounter in their environment, and these risks have constantly changed. During the World Wars, people faced the risk of invasions, starvation, and losing their sovereignty. During the Cold War, the whole world faced the threat of nuclear weapons of mass destruction. Today, we face the risks and uncertainties of the Covid-19 pandemic, global warming, and financial and political instabilities. In today’s finance world, organizations often face delays and exist in such an environment, and organizations require to deal with uncertainties to a certain degree. Risk and uncertainty live together in our modern world. In the literature, the concept of risk is defined in various ways by researchers from different backgrounds; "uncertainty and the results of the uncertainty" (Tevfik, 1997), "uncertainly about the future results" (Bangia et al., 2002), “actual results being different than expected results” (Bolak, 2004), “probability of losing through the changes in financial markets” (Horcher, 2005), “undesired events that may occur without the certainty of when or it will occur" (Çipil, 2008), and “being unprepared for the damage that will occur

without any indicators" (Merih, 2009). In these definitions, the concept of risk is defined by researchers from different fields such as mathematics, insurance and statistics.

When defining financial risk, it is not so simple to come up with a definition that can cover all the different threats in the field. In Finance, the risk exists in various forms, such as market, liquidity, credit, and operational and legal risks (Meyfredi, 2004). In economics, accounting, and Finance, the value of an investment is one of the critical factors in the decision-making process. If a decision is made about a financial asset, the decision is highly dependent on the investment's risk and return. Therefore, its threat must be measurable to estimate a value for this asset (McGoun, 1995). Therefore, it is fair to say that while discussing financial risk, we discuss the risk that can be measured.

Managers of financial institutions started to consider risk management a vital topic in the 1990s, and risk was managed by balancing the firm's assets and liabilities (Mulvey et al., 1997). Later on, with the diversification of financial instruments and globalization, new risks arose, and financial markets were no longer the same. This new environment turned financial markets into more complex, competitive, and risk-containing environments. Naturally, the traditional ways of defining, measuring, and dealing with the risk were no longer sufficient. Instead, new tools could answer the questions in the new environment where needed.

2. THE HISTORY OF MODERN FINANCIAL RISK MEASUREMENT MODELS

While studying the history of financial risk management, researchers will likely find that economic risk management literature is divided into two parts. These two distinctive periods are traditional risk management (traditional portfolio management) and modern risk management (modern portfolio management). During conventional risk management, investors manage financial risk by diversifying the securities in their portfolios. However, while diversifying their portfolios to minimize the risk, investors did not consider the return of the deposits.

It was a common practice to build a portfolio by choosing securities from different sectors that were not directly related, and investors believed diversifying their portfolio would eliminate the risk (Özeralp Zeren et al., 2015). However, in 1952 Harry Markowitz published his pioneering theory, and the field entered a new era that would later be called "Modern Portfolio Management."

The field of Finance was introduced with the first financial risk measurement model that applied mathematics for choosing securities and creating a portfolio almost 70 years ago. In 1952, Harry Markowitz published his article "Portfolio Selection" and changed how investors and researchers perceive and measure financial risk. Markowitz defined risk and return using mean and variance, and his work became the starting point of the evolution of financial risk management (Miller, 1999). With his mean-variance model, Harry Markowitz offered a theoretical solution to the problem of financial risk, and later this model became the foundation of modern portfolio theory (Witt & Dobbins, 1979). After the revolutionary work of Markowitz, giant steps were taken in the field of Finance. It is not wrong to say that today's finance world was shaped between the 1950s and 1970s. Later, financial markets

became more diverse, complex, and competitive, but how risks are measured has not changed significantly. In Table 1 below, the theories and models that shaped the modern financial world are shown.

Table 1: Historical Development of Modern Financial Risk Theories & Models

Founders	Year	Theory	Focus
Harry Markowitz	1952	Portfolio Selection	Risk and Return
Modigliani & Miller	1958	M&M Theorem	Capital Structure
William Sharpe	1964	CAPM	Systematic Risk and Return
Fischer Black, Myron Scholes	1973	Option Pricing	Eliminating Risk
JP Morgan	1994	Value at Risk	Quantify Market Risk

2.1. Harry Markowitz's Mean-Variance Portfolio Theory

In 1952, Harry Markowitz presented his theoretical solution for the problem of portfolio risk. Later, his mean-variance model became the foundation of modern portfolio theory (Witt & Dobbins, 1979). Markowitz provided a solid ground that will be used as the foundation of modern portfolio management. Markowitz proved that the portfolio risk could not be eliminated by only diversifying the portfolio with his theory. Using his mean-variance model, he also confirmed that the relationship between the securities of a portfolio and the direction of this relationship has great importance in minimizing the risk (Demirtaş & Güngör, 2004).

$$E(Rp) = \sum_{i} w_i E(R_i)$$

According to Markowitz's theory, *Rp* represents the return on the portfolio, *Ri* is the return on asset *I,* and *wi* is the weight of the support *I,* which means the proportion of help *I* in the portfolio.

2.2. Modigliani & Miller – M&M Theorem

This research paper is focused on financial risk management and financial risk management tools. Still, we think it is necessary to mention the important work of Modigliani & Miller since it is accepted as one of the cornerstones of corporate Finance and it is related to the valuation of corporations; therefore, it is not wrong to say that the work of Modigliani & Miller concerns the financial risk management field as well. In modern finance theory, Modigliani & Miller's theorem represents the proper use of no-arbitrage discussion (Stulz, 2016). When the theorem was first introduced, it was perceived as a model considering a firm's

debt-equity mix. Later, applications of the theorem expanded its considerations into the topics of debt maturity and risk management (Titman, 2002). Modigliani & Miller's theorem builds upon the irrelevance hypothesis of capital structure; in other words, the theory assumes that a firm's capital structure does not affect its value. The second proposition of the theorem is;

$$r_E = r_0 + \frac{D}{E}(r_0 - r_D)$$

Where; r_E represents the cost of equity or the expected rate of return while investing in a leveraged company. r_0 represents the cost of equity while investing in a company with a capital structure without leverage, r_D is the cost of borrowing, and $\frac{D}{E}$ is the debt-to-equity ratio. Taxes are not taken into account while explaining these equations. In the case of testing the theorem where taxes exist, the tax variable has to be added to the model.

2.3. William Sharpe's CAPM Model

The CAPM model builds on Harry Markowitz's mean-variance model, resulting in a Nobel Prize for Sharpe in 1990. The Capital Asset Pricing Model is the first model to introduce asset pricing to the finance world (Fama & French, 2004). When studying the history of financial risk management, as much as it is fair to say that Markowitz started the modern risk management period, it is also fair to say that Sharpe revolutionized it. With his CAPM model, Sharpe was the first to seek an answer to the problem of how the risk of an investment should affect its return (Perold, 2004).

$$ER_i = R_f + \beta_i\big(E(R_m) - R_f\big)$$

In the model; ER_i represents the expected return on the investment, R_f is defined as the risk-free rate (return of government bonds), β_i represents the beta of the investment, and to find beta: $\beta_i = \frac{\mathrm{cov}(R_i, R_m]}{Var(R_m)} = \rho i, m \frac{\sigma_i}{\sigma m}$. $E(R_m)$ represents the return on the market, and $\big(E(R_m) - R_f\big)$ gives the market premium.

2.4. Black & Scholes Option Pricing Model

Derivatives are financial instruments whose price depends on or originates from the price changes of another asset. While there is still an ongoing debate about the origins of financial derivatives, it is well known that the first attempt at pricing modern derivatives was the work of Charles Castelli, published in 1877. However, the idea of Fisher Black and Myron Scholes changed the finance world forever in 1973 (Ghandehari & Ranjbar, 2014). The idea behind the Black and Scholes equation is to form a riskless portfolio (Kumar et al., 2012). Black

and Scholes's formula assumes that the share values follow a log-Brownian process, constructing a strategy where banks can replicate the investor's portfolio risk-free (Bouchaud & Sornette, 1994).

Since the model was published, it has been the primary tool for evaluating European options. For the European stocks paying no dividends, European call options are calculated using the following equations:

$$V_{call} = P_0 N_{d1} - \frac{X}{e^{kRF^T}} N_{d2}$$

V_{call} = value of the call option, P_0 is the current price of the stock, N_{d1} is the cumulative area under the normal distribution curve to $d1$, X is the strike price of the option, k_{RF} is the risk-free interest rate, and N_{d2} represents the cumulative area under the normal distribution curve to $d2$.

2.5. Value at Risk (VAR) Models

In the financial sector, the need to have more control over financial risks has led to the progress of developing a new tool called value at risk (VAR). The financial sector started adopting this tool as its first line of defence against global economic threats soon after its development (Jorion, 1996). Value at stake is a statistical tool that can be used for calculating the losses of financial firms under normal market movements, indicating that losses greater than the amount calculated by VAR are faced with a small probability (Linsmeier & Pearson, 1996). VAR calculates a monetary amount of risk and states that this amount of money could be lost over the specified period with a probability (Best, 1998). VAR models differentiate from other financial risk measurement tools with their ability to test different crisis scenarios, often called "stress tests" in the literature. Using the stress test function of VAR models, a firm's exposure to the vulnerabilities that a hypothetical crisis might cause could be calculated. For example, an international airline company can stress test the scenario of a war breaking out in the middle east that might affect the oil supply and increase fuel prices. An agricultural company could use stress tests to calculate the possible losses it might face in case of seasonal drought.

At its core, a VAR statistic considers three components; a period, a confidence interval, and a loss amount. Investors are using different VAR models, analysts and researchers for calculating risk today. Three basic VAR models are; Parametric VAR, Historical VAR simulation, and the Monte Carlo Simulation (Tarpezan-Tabara, 2008).

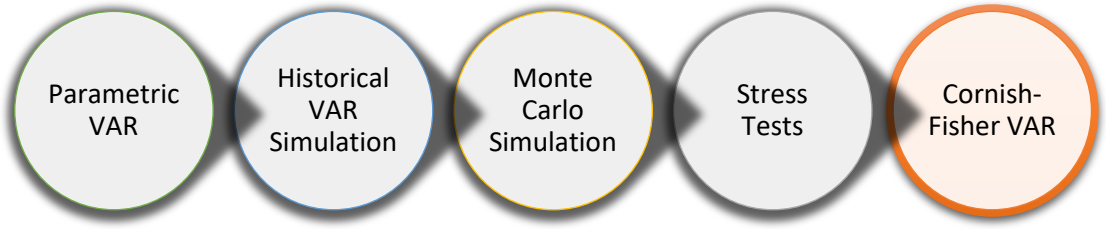

Figure 1: Fundamental VAR Models

While the Parametric VAR model assumes the returns follow a known probability distribution, the Monte Carlo model assumes that the returns follow a known stochastic process (Cheung & Powell, 2012). Historical VAR simulation constructs a distribution of future portfolio profits and losses using the historical changes in the prices and market rates (Linsmeier & Pearson, 2000). Cornish-Fisher VAR expansion is a semi-parametric approach that employs the information from whole distribution, and unlike other VAR models, it is less dependent on historical data (Chai & Zhou, 2018). Stress tests measure the effects of hypothetical scenarios such as possible losses that may occur if natural gas prices went up by 60% due to a conflict in Russia.

2.6. Cryptocurrencies and Risk Measurement

Since the introduction of the first cryptocurrency by Satoshi Nakamoto in 2008 (Nakamoto, 2008), these have been growing in numbers and volume. As of today (March 19th, 2022), there are 18,338 cryptocurrencies and 469 crypto exchanges with a total market cap of $1,905,255,583,104 in the world, according to coinmarketcap.com statistics (Anon., 2022). However, cryptocurrency investments remain very risky due to crypto assets' volatile nature, which can show substantial price changes in short periods. The value of traditional currencies (USD, EUR, TL, etc.) strongly depends on global and local economic conditions such as inflation, politics, crises, and central bank decisions. This makes it possible to fairly accurately calculate these currencies' risks and price movements (Hrytsiuk et al., 2019). However, unlike in traditional currencies, price changes of cryptocurrencies are highly speculative and very sensitive to rumours, making it difficult to calculate the risks and returns. In addition, cryptocurrencies are volatile by nature, and returns of crypto-assets do not follow a normal distribution, making it even more challenging to apply the current risk and return measurement models to these assets and project accurate results.

Extreme volatility is not the only risk cryptocurrencies contain. Unlike fiat currencies, cryptocurrencies do not exist in physical form and are not backed up by a government. This indicates that there is no authority, such as a central bank, to control and regulate price movements in case of crises, which means there is no limit on how much damage can occur.

The decentralized structure of cryptocurrencies is often marketed as "free from the intermediaries," which is correct; no intermediary organization is required to act as a guarantor while performing transactions between the sides. However, while it might sound practical, it also means there is no intermediary organization that holds records of the transaction. Instead, the transfer happens through a network of computers that records the transaction as one digital wallet sending cryptocurrency to another, and the transaction is completed once the network verifies the process. However, questions like who owns these wallets, the purpose of the transfer, and whether it is a legitimate trade or a money-laundering scheme remain unanswered.

3. THE CHANGES IN THE FINANCIAL SYSTEM

While studying financial risk management, it is essential to note that the evolution of financial risk measurement tools was shaped by historical events in the international monetary system. After World War II, the need to control and regulate global financial markets emerged. The war destroyed economies; European and Asian countries started undervaluing their currencies, imposing controls over capital flows and international trade and reserve accumulations. As a result, governments undervalued their currencies to gain an advantage in international trade, and these devaluations led to the destabilization of the global economy.

In 1944, World War II allied nations' representatives gathered in New Hampshire to seek a solution to the destabilized global economy problem. As a result, the United Nations signed the Bretton Woods Agreement, and a new international financial system was introduced. In this new system, allied countries agreed to change from the gold standard to the USD, deciding that an ounce of gold would be pegged to $35 and maintaining fixed exchange rates. Another vital element of the agreement was that in case of a country's currency became too weak against the USD, that country's central bank was going to buy national currency from the markets using foreign currencies, trying to stabilize the currency's position against the USD (Amadeo, 2020). The World Bank Foundation and the IMF were among the important decisions taken at Bretton Woods. These organizations would later play important roles in rebuilding the world that World War II destroyed and assisting countries in need with financial aid and credits.

The USD-gold standard was established with the Bretton Woods Agreement, and with this new financial system, allied countries aimed to create a more predictable and stable global commerce. The new system was a success, and for the next 25 years, Europe recovered from

the destruction caused by World War II, USD became the global currency, and everyone was happy to hold USD because it meant if people doubted USD using its value, they could exchange it for gold. Bretton Woods system created economic prosperity in the U.S. that would last 25 years (Garten, 2021).

The Nixon administration took office in the U.S. in 1969. Soon after, the Nixon administration realized the world economy had become enormous, so big that there was a non-stop demand for the U.S. Dollar, and U.S. Federal Reserve was printing USD to keep up with the order. That demand led to having four times more USD in circulation than the amount of gold in the U.S. Federal Reserves (Garten, 2021). The rate of $35 for an ounce of gold seemed ideal in 1944; this ratio did not change while the world's economy grew tremendously. However, having four times more USD in circulation than the amount of gold in the Federal Reserve meant that if something went wrong in the global economy and holders of USD wanted to get their equivalent in gold, the U.S. did not have with what to pay. Furthermore, the Nixon administration realized that the USD had become too overvalued by 1971, and devaluation was not an option due to the USD having a fixed value pegged to gold. For the U.S. administration, this meant that it was impossible to pay back the equivalent of gold for the amount of USD in circulation in case of a global economic crisis. As a result, in August 1971, Richard Nixon announced his decision to delink the USD from the gold without warning; Nixon's announcement also meant the end of the Bretton Woods Agreement.

The end of the Bretton Woods system introduced the world to new challenges; 25 years of growth and prosperity have finally ended. The collapse of the Bretton Woods system in the 1970s left the U.S.A and Europe with volatile currencies, low growth, unemployment, inflation, and conflicts in international trade. At the same time, most Asian economies tried to stick to the fixed currency system, which led to the Asian crisis in the 90s (Escrivá et al., 2008).

With the end of the Bretton Woods system, the world faced several crises, and with the effect of internationalization, these effects were felt worldwide. For example, the situation in the Japanese stock market in 1990, the Mexican crisis in 1994, the Asia Pacific and Russia crises in 1997, Brazil's spending crisis in 1999, the international crisis of 2000, Argentina's spending crisis in 2001, the global financial crisis of 2007-2008 are some of the economic problems the world had to face.

Since ancient times, derivatives have been a part of the economy in different forms, whereas active trading of derivative instruments spread in Europe during the seventeenth century (Weber, 2008). After the collapse of the Bretton Woods system, derivatives gained importance, and the number of derivatives traded increased significantly (Sipko, 2011).

Modern derivative instruments trading as we know them today began in 1972 with the opening of the Chicago Mercantile Exchange (CME) (McDonald, 2013). Derivatives were found as financial risk management tools that can be used to hedge investment risks, but due to their nature, derivatives can also be used as speculation tools. If used for hedging risks, derivatives allow an investor to transfer the risk to another party willing to bear the risk (Stankovska, 2017).

4. CONCLUSION and SUGGESTIONS

The world is evolving, and the finance field has become a vital part of this evolution. While technology, globalization, global warming, and crises are changing the world, countries and businesses are allocating resources to keep up with these changes and adapt to the new environment. Our world has been evolving since the beginning, but evolution has gained serious momentum in the last hundred years. Technology and globalization are the main drivers of growth, while crises also play an essential role in shaping the world.

With a constantly changing environment, financial risk management has proven to be one of the most critical areas that require keeping up with the changes and adapting to the new risks and environment. Financial risk management tools are no exception in this changing environment. In the 1950s, new financial risk management models were introduced and used to project and deal with risk. Today, we live in a different world, and in this world, threats and crises are more significant and often. For example, with the Covid-19 pandemic, the global financial system suffered severe damage. In the world, investments slowed down, and production lines were stopped or seriously slowed down due to curfews. Businesses that relied on daily cash flows faced significant losses. Millions of people lost their jobs, and thousands of companies went bankrupt worldwide while countries faced economic downturns.

While facing the effects of the Covid-19 pandemic, a new crisis arose. East Asian countries faced seasonal droughts during this time. Some of the most advanced chip-making factories in the world are based in East Asia, such as Taiwan Semiconductor Manufacturing Company. Clean water is one of the essential materials required for chip-making; the effect of droughts combined with the impact of the Covid-19 pandemic caused chip shortages worldwide, which are still being felt today. Due to chip shortages, the Automotive industry suffered significant losses where each car produced requires hundreds if not thousands of these chips. As a result, the biggest car makers worldwide had to stop or slow down their production due to chip shortages, which caused millions of fewer vehicles in 2021.

As of February 24th 2022, another crisis arose. Russia invaded Ukraine, causing the relocation of millions of Ukrainian citizens to other European countries and increasing natural gas and oil prices worldwide. In addition, Russia's economy was hit with sanctions causing

financial instability for Russia and the rest of the world. Russia is the most significant natural gas provider for Europe. In the short term, the production of the whole of Europe is affected by increasing natural gas and oil prices. With Covid-19 and Russia's invasion of Ukraine, as well as other global factors combined, today, the whole world is facing increasing inflation, and recession is a risk for every country.

Dealing with today's risks requires new models and strategies to project and provide viable solutions for the crises. Today, most financial problems happen for reasons that are not directly related to finance, so using traditional financial risk management models alone is often irrelevant. The financial risk management field requires structural changes to adapt to the new world. New financial risk measurement models and strategies that can project possible outcomes of crises and provide alternative solutions are needed.

The financial risk managers, economists, and policy makers' cooperation play a vital role in creating better, more viable financial risk management tools and strategies. Today, we are facing more advanced crises that can spread fast and cause significant damage. Technology drove our society's advancement but also introduced us to challenges that are harder to deal with.

In this research, we studied the evolution of financial risk management. Most financial risk management models used today were introduced between the 1950s and 1970s, and these models can no longer fully measure and project today's risks. VAR models presented in the 1990s were a big step toward better, more versatile risk management tools, but even these modes cannot fully project today's risks. The world is changing and evolving. The finance field is a part of this evolution. We often face more sophisticated financial crises and need new, flexible and versatile risk management models to protect countries, businesses, investors, and individuals from today's risks.

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