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Investment in art and gold between sustainability and portfolio diversification

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Abstract

In this work, attention was paid to investments in contemporary art, gold and other areas, taking into account two essential factors, namely sustainability and portfolio diversification. Having these two elements as guides, we proceeded with the analysis of investments in the various sectors taken in consideration. Especially with regards to gold, those aspects have been identified that allow sustainable investments. Concrete examples of portfolio diversification were also provided by referring to the Portfolio Selection Theory developed by Harry Markowitz.

Keywords – ESG; Sustainable Investment; Art; Gold; Portfolio Selection: Diversification; Optimal Portfolio.

Paper type – Academic Research Paper

Sommario

Investire in arte e oro tra sostenibilità e diversificazione di portafoglio. – Nel presente lavoro l’attenzione è stata rivolta agli investimenti in arte contemporanea, in oro e in altri ambiti, tenendo conto di due fattori imprescindibili, ossia la sostenibilità e la diversificazione del portafoglio. Avendo questi due elementi come guide si è proceduto all’analisi degli investimenti nei vari settori presi in considerazione. Soprattutto per quanto concerne l’oro sono stati individuati quegli aspetti che permettono investimenti sostenibili. Sono stati, inoltre, forniti esempi concreti di diversificazione del portafoglio facendo riferimento alla Teoria della Portfolio Selection elaborata da Harry Markowitz.

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1 Introduction

An old adage goes: “Learn the art, and put it aside”. If knowing how to invest, in different areas and sectors, is also an art, it is possible to try to understand its characteristics and peculiarities, to the point of assimilating it and making it your own. This ability cannot be lacking in knowledge, and the awareness that only through the diversification of the so-called investment portfolio can one guarantee a certain solidity to one’s financial actions can never be absent.

It is also possible to invest your savings, in various sectors, in an ethically conscious manner, i.e. taking into account the dictates of the so-called “sustainable finance”. The latter is nothing other than that finance that takes in consideration environmental factors (Environmental), social factors (Social), and corporate governance or structure (Governance). These are ESG factors now considered fundamental in investment decision-making processes, since many people feel the need to direct capital towards longer-term sustainable activities and projects.

ESG factors include issues of absolute importance, such as climate change mitigation, the energy transition, the zero-emission economy, issues relating to biodiversity and social issues (inequalities, labor relations, respect for human rights).

Making a financial investment that takes ESG factors into account means investing in companies that make sustainable business choices, consistent with the principles of the United Nations Global Compact.

If art is generally sustainable in itself, and sensitive to the themes indicated, in the case of investing in gold or other areas it is necessary to move with caution and make appropriate choices.

2 Investing in contemporary art

We talk more and more frequently about sustainable economics, or finance. Sustainable finance places environmental, social and corporate governance factors at the center of its actions, i.e. the so-called ESG factors, using an English acronym (Environmental, Social, Governance). This type of finance, therefore, directs capital and investments towards activities that do not damage the environment (i.e., that do not act negatively on global warming and climate change), that respect individuals and human rights, that have a corporate structure clear. Sustainable finance is, therefore, the application of the concept of sustainable development to financial activity.

Given the greater sensitivity towards environmental and social issues, a growing number of individuals are moving towards financial investments that take ESG factors into account. Many seek to

invest in companies that make sustainable business choices, consistent with the principles of the United Nations Global Compact, relating to human rights, labor standards and environmental protection. The underlying idea is that a sustainable economy can help create a better, more livable world.

Savers can choose to invest in certain companies, rather than others, by making very specific choices. They may decide, for example, not to invest their savings in companies that do not respect international conventions on workers' rights or that operate in sectors and areas that do not comply with international treaties.

An investment can be said to be "sustainable" by referring to indicators, the ESG ratings, which express a synthetic judgment on the level of environmental, social and corporate governance sustainability of issuers (companies, states, etc.) of securities and collective investment instruments (UCITS and ETFs). The ratings are assigned by specialized agencies that develop them on the basis of analyzes conducted starting from non-financial information published by companies and obtained from other sources. It must be said, however, that there is a lack of internationally shared standards for assessing sustainability.

Nonetheless, ESG scores are widely used in finance for the selection of financial instruments, for the creation of investment portfolios and for the creation of market indices defined as sustainable.

The Bank of Italy, sensitive to environmental issues, has developed an important Charter of Sustainable Investments, through which the institution wants to define its vision of sustainable finance.

Therefore, in the most disparate fields the need for sustainable finance and development is felt. But how does art deal with these questions? Investment in works of art, in general terms, can be considered sustainable, since the art itself has no implication with those elements that can be considered harmful to the environment and to human rights. Art, indeed, brings spiritual (as well as economic) enrichment which must be considered as an absolutely positive factor for individual growth. Not only. Art has always combined its aesthetic value with a function of stimulation and awareness on certain issues, becoming, in some cases, also a clear denunciation of discrimination and injustices.

Today art can (and often does) take into account issues related to environmental and social sustainability. Many artists, in recent years, have committed themselves to defending the environment, raising awareness of sustainability issues and ecosystem protection.

Street art has shown itself to be particularly sensitive to all issues related to the environment. There are also sustainable works of art, made with natural elements and recycled, non-toxic materials. Some artists even manage to implement ecological approaches in the marketing of their works.

Furthermore, the anti-smog murals are particularly interesting, made with special paints capable of absorbing the harmful particles of smog. The largest mural of this type, as far as Europe is concerned, is Hunting Pollution by Iena Cruz, it is located in Rome and covers an area of 1,000 square meters. This

work of art on the wall has the ability to absorb a quantity of pollutants equivalent to that which 30 trees could purify. Naples, Milan and Padua also each have a mural made with special anti-smog paints. After all, environmental art is not a recent invention or discovery of recent years. It has existed for more than half a century. It is that art in which the artist actively engages with the environment, interacting with the latter in various ways. The art critic Germano Celant stated that there is a continuous exchange between the work and the context. In fact, starting from the end of the 1960s, the attention of many artists shifted from the particular to the general and from the single object to the space in which the object is immersed. Land Art considers the territory as a gigantic canvas. It takes into consideration vast spaces, within which man leaves his artistic mark. It is the art of Smithson and Christo. Environmental art in some cases negatively impacts the environment, and is therefore not always eco-sustainable.

In any case, with very few exceptions, art always takes the side of the environment and its protection.

The art market has seen a constant increase in recent decades, attracting an ever-increasing number of collectors and investors. Many works of art by internationally renowned artists are considered, like gold, as a true refuge asset. In particular, there has been growing attention towards contemporary art. A Numisma report underlined how modern and contemporary art was the investment that had recorded the highest returns by far between 1995 and 2009.

In recent years there has been a real transformation of the art market, especially following the competition generated by the over 154 fairs held every year all over the world, and also due to the importance of investors and funds investment in this sector.

Investment in art is something delicate and complex at the same time. It is not enough to appreciate a work, to esteem its author. If you want to invest consciously you need to know the market and understand the economic and financial mechanisms on which it is based.

Therefore, to invest in contemporary art it is necessary to take into account many factors and have skills in both the artistic and economic fields. Not only. Even a certain intuition can be valuable. Among the protagonists of Arte Povera, Alighiero Boetti is the artist who is enjoying the greatest success. For a tapestry of 5 letters, which until a few years ago could be purchased for around 30,000 euros, today you have to spend 50,000. Yet, in the 1990s tapestries could be purchased for less than a million lire each. Those who invested in Boetti in those years now own a real capital.

A work of art can be defined as a unique object, made manually with decorative intent, under the direct control of the artist, or directly by the artist himself. The work of art is a luxury good whose possession is a source of social prestige and communicates the refinement of taste of those who purchased it.

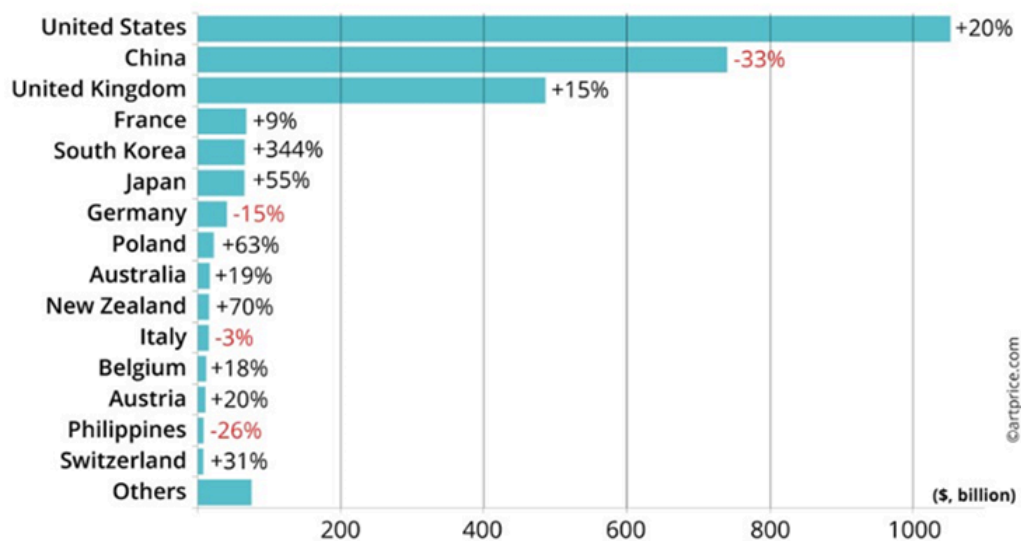
The art market is large and varied; in fact, it offers both works that satisfy more aesthetic needs and works more oriented towards satisfying a cultural and symbolic dimension.

Like the stock market, the art market is also divided into primary and secondary. The primary market is the one in which trade takes place directly between the producer and the first buyer; the secondary is the one which has as its object sales subsequent to the first. The market is then, physically, made up of galleries, auction houses and fairs, although an entire underground market should not be ignored. Furthermore, a private individual can sell a work of art to another private individual, without going through intermediaries. However, it must be said that, especially for modern and contemporary works, the documents relating to them are of absolute importance, i.e. certificates of authenticity, archiving, advertising, etc. Purchasing a work from a private individual, let's say, by Schifano, De Chirico or Morandi, just to give some examples, without the relevant documentation is very risky.

As regards sales, the sector that has seen a growing increase is above all that of auctions. The United States continues to be the hub of the art market.

Figure 1 shows us the geographical distribution of the turnover of contemporary art auctions.

Figure 1 – Geographical distribution of the turnover of contemporary art auctions



The art market has proven to be strong and dynamic even in the midst of the pandemic. In fact, in 2020/2021, 119,400 contemporary works changed hands, with an increase of 12% compared to the previous year. The number of works sold for over one million euros is also increasing. In 2022, works

were sold for exorbitant prices. The work sold for the highest price that year was a “sage blue Marilyn Monroe” by Andy Warhol, at Christie’s in New York, sold for the record price of 195 million dollars.

In addition to private collecting, there is corporate collecting. An ever-increasing number of companies and banking foundations are investing large sums in the purchase of works of art.

Furthermore, many banks, believing in investing in art, have organized themselves to offer their customers the possibility of investing a portion of their savings in works of art. A fundamental figure is that of the art advisor. This is an expert art consultant, usually active within an art banking structure. Aside from specific skills in art history and criticism, the art advisor must have a good knowledge of the rules of the international market and the prices of artistic goods. He must be able to advise his clients in the best way, both in the case of valuations of art assets and in the case of buying and selling works of art. As with all investments, naturally, even in this sector there are risk factors that need to be evaluated. Contemporary art is subject to unpredictable ups and downs. For this reason it is necessary to know, study and rely, if necessary, on competent and scrupulous professionals. Never follow trends. Every now and then we rediscover forgotten, marginal artists who are artfully inflated (so to speak), and who then just as willingly deflate, with a sudden significant decrease in the prestige and value of their works. We need to focus on historicized artists, recognized by critics and art history. It is also good practice not to focus on just one name, but to acquire works by multiple artists, even very different ones.

The choice of artists to invest in is dictated by more traditional criteria, such as artistic value and potential appreciation. Certainly, one can also follow the criterion of sustainability and sensitivity to certain themes with regards to artists still active.

Finally, it is necessary to refer to art investment funds. There are different ways of investing in art. The traditional system, which is still the most practiced (and, ultimately, the most correct) consists in the direct purchase of a work of art. The investor, however, can also decide not to participate directly in the sale of a work of art, but to intervene indirectly, through participation in art investment funds. *Art funds* are financial products specialized in the buying and selling of works of art, with a mechanism similar to that of mutual investment funds. They contain a set of works, often by different artists, so as to offer some diversification.

The limit of “art funds”, however, lies in the fact that the investor-collector does not own the works, does not have them in his home, cannot observe them, appreciate them. In this way the work of art is treated like any financial product and its purchase is a mere economic speculation.

3 How to invest in gold sustainably

Gold, as is known, is a rare and precious metal. It has always been associated with complex symbols that refer either to the divine realm, or to the supernatural, or to perpetuity. In different cultures and eras gold symbolizes divinity, power, royalty, the sun, light. For the pharaohs of ancient Egypt, gold was the substance of which the immortal gods were made. The Bible says that the pillars of Solomon's temple were covered with gold.

Symbol of beauty, uniqueness, splendor, gold is not only a rare metal, but also resistant to both air and most chemical agents, and, despite its high specific weight, it is extremely ductile and malleable. For all these characteristics it has always lent itself to the creation of refined and precious objects.

Gold was such a valuable and desired commodity that from the Middle Ages to the dawn of modernity, alchemists tried to transform base metals into pure gold.

For gold, the ancient Arabic measurement of carats, equivalent to carob seeds, is still used to indicate its purity, while the troy ounce, an ancient English medieval measurement, is used to determine its weight. Thanks to its low melting point, gold allows for easy reuse, so it is possible to transform jewelry into coins and coins into jewelry. Therefore, gold, with its scarcity or abundance, has always influenced the history of men.

Furthermore, gold has historically represented a means of measuring the value of goods and was used as a payment instrument in almost all ancient civilizations. Numismatists know the value of ancient Roman gold coins well.

Since ancient times, gold has always represented a fundamental commodity of exchange. It continues to represent an effective hedging tool in times of crisis and against adverse events. The price of the yellow metal, in fact, tends to rise when financial operators perceive a high level of risk. It is no coincidence that the price of gold increased in 2020, that is, in the middle of the pandemic, and in March 2022, immediately after Russia's invasion of Ukraine, when it exceeded 2,050 dollars an ounce.

Furthermore, gold has always guaranteed protection against excessive increases in inflation, precisely because of its ability to preserve its value over time. In currency crisis situations, a central bank can dispose of gold, as well as foreign currency reserves, to preserve confidence in its currency. The United States is the world's largest holder of gold reserves with more than 8,000 tons, followed by Germany, which has 3,377.9 tons, Italy, which has 2,451.8 tons and France, which is quota 2,435 tons. The Bank of Italy is the fourth largest holder of gold in the world, if we also take into account the International Monetary Fund, the third in the ranking of central banks.

The reserves of the Bank of Italy, equal, as mentioned, to 2,451.8 tonnes, have a value of approximately 90 billion euros. Referring to 2016, this is just over 5% of Italian GDP, which that year

was equal to 1,672 billion euros. It must also be said that, for various reasons, approximately 55% of Italian gold is kept outside national borders.

Gold is found on Earth in primary and secondary deposits. The former consist of rocks or gold-bearing veins, while the latter consist mainly of alluvial deposits, deriving from the erosion of gold-bearing rocks and the sedimentation of gold. Although it usually occurs in the form of dust, flakes or grains, alluvial gold is also sometimes found in the form of larger agglomerates called nuggets.

Gold is still being extracted today, especially from mines. This is an aspect to keep in mind if you want to make an eco-sustainable investment. In fact, gold mining is quite harmful to the environment. It is estimated to be the cause of 38% of all mercury emissions in ecosystems. Mercury, a highly toxic substance, easily enters the human food chain from ecosystems due to its chemical characteristics. Not only. If we refer to atmospheric emissions dangerous for the environment, on an annual basis gold mining emits more greenhouse gases than all the passenger flights of all European states combined, and this data only concerns the extraction, not the processing of gold. The yellow metal is extracted causing serious damage to nature. Large quantities of water are needed, which are contaminated by chemicals. Furthermore, the opening of mines corresponds to large deforestations. In certain cases (think of Brazil and Peru) gold mines cause irreparable damage to complex and fragile ecosystems, such as that of the Amazon forest. Therefore, the path of this coveted raw material, from the mines to the transformation into a luxury good, is anything but golden.

Gold used for medical, industrial and technological purposes is only 7% of that mined each year. The remaining 93% is used to create jewelry and for banking activities, i.e. the production of coins and ingots. Can we stop mining gold? According to many, yes. The solution would be the recycling, or reuse, of gold already in circulation. In fact, gold is already one of the most recycled materials in the world today. In fact, a quarter of the global supply comes from reuse, while the remaining three quarters come from extractive activities. The amount of gold coming from recycling could increase further, so much so that 45% of all the gold used by jewelry companies could come from the metal already in circulation. With the reuse of this precious metal, the emissions associated with it would be reduced by 99%. And gold, however, would continue to play its role in the world economy, considering that, with less gold mined, its value would increase. Therefore, even in the case of a total cessation of mining, the stability of the banks and nations that have their own gold reserves would be preserved.

Recycled gold, that is reused, can also be defined as “ethical gold”. This recently coined expression refers to a type of gold extracted and processed in harmony with the surrounding ecosystem and in collaboration with the communities involved. In the case of ethical gold, chemical components that are incompatible with the environment cannot be used during the extraction phase. Furthermore, working conditions must comply with minimum safety standards.

Those who invest their savings in gold have various choices: many collect ancient precious gold objects (think of gold boxes, often enriched with micromosaics or miniatures); in this case, since it is ancient gold, the question of sustainability does not arise at all (as happens with ancient gold or silver coins). There is, therefore, the possibility of investing in gold and, at the same time, in antiques, which can never lose their value.

Anyone who buys physical gold in ingots or bars must verify the quality of the purchased good. The gold must be certified, with the LBMA (London Bullion Market Association) good delivery certificate.

In recent decades the market has changed profoundly, with the birth of the so-called financial or paper gold. The so-called metal accounts, partly similar to traditional current accounts, but denominated in gold, are divided into “allocated”, a type of investment in physical gold for which the account holder is the owner of some ingots, identifiable by the number, and “unallocated”, in which the account holder is the owner of a certain quantity of financial gold, not directly associated with specific ingots.

Exchange Traded Funds, commonly referred to by the acronym ETFs, are investment instruments traded on regulatory markets. They have the objective of replicating the underlying, i.e. gold, to which they refer. ETFs do nothing but replicate the price trend of gold. This replication can be physical or through “futures” contracts. In the case of physical replication, the invested amount is allocated by the issuer of the ETCs (Exchange Traded Commodities) in ingots, kept in armored vaults. Various investment options are available in “futures” replication. It is possible, for example, to take bullish (long) or bearish (short) positions.

Like ETFs, also ETCs are traded on exchanges but are specifically designed to provide exposure to commodities. While ETFs can cover a variety of assets (they track the performance of market indices, sectors, bonds, currencies or commodities), ETCs focus exclusively on individual commodities or baskets of commodities (such as gold, oil, natural gas, and so on), offering a simple and transparent way to invest in these markets. ETCs may be physically backed by commodity reserves or by derivative contracts that track the price of commodities.

From a practical point of view, physically replicating ETCs are more suitable for a traditional investor, who perhaps aims to build financial positions gradually, with multiple subsequent purchases. “Futures” tracking ETCs are more suitable for a dynamic investor, who does not want to wait too long for feedback, but who takes advantage of upward and downward fluctuations. Such an approach, however, entails quite a few risks.

Gold, whether in the form of precious objects, coins, ingots, or in the form of ETCs, certainly cannot be missing from an investment portfolio, for the various reasons mentioned above.

It is also suggested to combine the investment in gold with that in contemporary art. These are different areas (although there are points of contact), but for this very reason they can be perfect for portfolio diversification.

Moreover, gold has little correlation with the main market assets, with the exception of precious metals, the currencies of gold-producing countries and stock prices.

It, therefore, always represents a valid tool for risk diversification, having a trend largely unrelated to both the stock and bond markets.

At this point it is necessary to delve deeper into a very important aspect, namely portfolio diversification, which has been mentioned several times.

4 Portfolio diversification

A portfolio is a collection of different financial assets. The portfolio may contain shares, bonds, raw materials, liquidity, funds, policies and may also consist of non-negotiable securities, such as works of art or private investments. Each asset that makes up the portfolio will have its own return and risk, and the return and risk of each asset will influence the overall return and riskiness of the portfolio.

In investment choices, it is very common to find that individuals tend not to concentrate their investments in a single security but in portfolios made up of multiple securities. The choice to diversify your investments derives from the fact that this allows you to reduce the overall risk of the portfolio.

One of the main finance theories is Harry Markowitz's portfolio selection model, published in the *Journal of Finance* in 1952. Markowitz, through the publication of "Modern Portfolio Theory", introduced a new perspective on portfolio analysis. His goal was to develop a scientific approach to optimal portfolio construction, considering how different assets could be combined together to obtain the maximum expected return for a given level of risk or the minimum risk for a given level of expected return. Markowitz, in fact, has demonstrated that through diversification, investors can reduce the overall risk of the portfolio without compromising, and in some cases, improving the expected return.

4.1 The Markowitz model

In Modern Portfolio Theory, Markowitz states that investors generally prefer portfolios that offer higher returns with as little uncertainty or risk as possible. This preference reflects the rational nature of investors, who seek to maximize expected return for a given level of risk or minimize risk for a given level of expected return.

In this theory Markowitz defined the concept of expected value (or average) of the rate of return as a key measure to quantify the expected profit that investors expect to obtain from their investment portfolio, and the variance or standard deviation of expected returns as measure of the risk associated with an investment portfolio.

Investors use the Markowitz model to identify all possible combinations of portfolios that maximize the expected return for a given level of risk or that minimize the risk for a given level of expected return and which are on the so-called “efficient frontier”. Investors are considered rational when they try to allocate their capital along the efficient frontier, choosing portfolios that best satisfy their personal preferences in terms of risk and return. The objective of Portfolio Selection is, in fact, precisely to provide investors with a rational and mathematical way of making investment decisions, taking into account both fundamental aspects: return and risk. The process of building the efficient frontier involves optimization that aims to find the optimal combination of financial assets in order to maximize the expected return for a given level of risk or minimize the risk for a given level of expected return. It is therefore a question of solving an optimization problem which consists in finding weights which minimize the variance or which maximize the expected return. To solve this optimization problem, two constraints are imposed on the variance minimization or expected return maximization equation: the first establishes that the investor wishes to reach a specific level (target) of expected return or risk in the portfolio; and the second is that the sum of the asset weights within the portfolio must equal 1. The solution to this optimization problem returns optimal weights assigned to each asset within the portfolio. These weights represent the proportion of total capital invested in each asset. Once the optimal weights have been obtained, it is possible to build the optimal portfolio. This optimal portfolio will be on the efficient frontier that represents the optimal trade-off between risk and return. The choice of the optimal portfolio among those present in the efficient frontier (which represents a series of optimal portfolios that offer the best possible combination of expected return and risk), as has already been said, is up to the investor and depends on his risk tolerance and personal preferences.

Investor preferences can vary greatly. Some investors may be willing to take higher risks to seek higher returns, while others may prefer a portfolio with a lower level of risk, even at the cost of a slightly lower expected return.

Furthermore, another key concept in Markowitz’s approach to portfolio management is so-called “diversification”. Through diversification it is possible to spread investments across a variety of financial assets or assets to reduce the overall risk of the portfolio. The reasoning behind portfolio diversification is that financial assets may behave differently in response to market events or economic conditions. By allocating capital across a variety of assets with lower or even negative correlations, you can reduce exposure to specific risks tied to a particular stock or sector. In this way, if one asset suffers a

decline, the others could compensate for the losses, helping to maintain greater stability of the overall portfolio. Portfolios made up of a few securities, in fact, may be subject to high levels of risk because they may not be diversified. Therefore, the variance within a portfolio can be reduced by adding a greater number of assets to the portfolio and avoiding investing in securities with high covariances or correlations between them. Markowitz demonstrates, in fact, that the risk of an investment portfolio, a set of shares, for example, depends more on the relationship between the shares that compose it than on the risk of the individual shares. He was the first to rigorously quantify the benefits of diversification, i.e. the advantages of not putting all your eggs in one basket, demonstrating how it is possible to reduce the overall risk of the portfolio without penalizing the return until reaching the optimal portfolio, i.e. the one with the highest return for the same risk or with the lowest risk for the same return.

4.2 Critical issues and limits of Modern Portfolio Theory

Although Markowitz's Modern Portfolio Theory represented a milestone in financial theory and investment management, it is essential to recognize that this model is not immune to limitations and criticisms.

Over the years, Markowitz's approach has contributed significantly to the understanding of risk diversification and the construction of optimal portfolios, introducing key concepts such as frontier efficiency and variance of returns.

Founded on diversification and the balance between risk and return, Modern Portfolio Theory has provided investors with a solid conceptual framework for optimizing the composition of their portfolios to maximize expected returns and minimize overall risk. Despite its indisputable contributions to financial theory, it is important to carefully examine the critical issues and limitations of the Markowitz model, as these can influence its practical applicability and its ability to provide reliable results in a dynamic financial market context.

We will explore these critical issues in detail below, highlighting the challenges that can influence the practical application and effectiveness of Modern Portfolio Theory within modern financial markets:

- *Simplified hiring.* Modern Portfolio Theory is based on some unrealistic simplifications, such as the normal distribution of returns and the absence of transaction costs. These assumptions do not take into account the real-world complexity of financial markets which can result in non-normally distributed returns and significant transaction costs.
- *Lack of consideration of macroeconomic factors.* Modern Portfolio Theory treats assets as isolated entities, without adequately considering the macroeconomic and geopolitical factors

that can influence the entire market. For example, events such as changes in monetary policy or political instability can have a significant impact on all financial assets.

- *It ignores the behavior of markets during crises.* During periods of financial crises or high volatility, markets may experience sudden and substantial changes in investor behavior. In such circumstances, diversification based on Modern Portfolio Theory may not be effective in reducing overall portfolio risk.
- *Sensitivity to historical data.* Modern Portfolio Theory uses historical data to estimate expected returns and covariance between assets. However, past performance may not be predictive of future performance, especially in times of economic change or evolving markets.
- *Liquidity problems.* Modern Portfolio Theory may suggest the inclusion of illiquid assets in optimal portfolios, which may not be practical for investors who need immediate liquidity. Illiquid assets can be difficult to sell quickly without incurring large losses.
- *It does not take into account investor behavior.* Modern Portfolio Theory is based on the hypothesis that investors are rational and make decisions based on expected utility and risk. However, investors can be influenced by emotions, irrational behavior and imperfect information, which can lead to suboptimal decisions and deviations from the principles of Modern Portfolio Theory.
- *Difficulty in practical application.* Implementing Modern Portfolio Theory in practice can be complex due to the need for accurate parameter estimates and portfolio allocation. Furthermore, it requires ongoing monitoring and adjustments of portfolios which can be costly and require considerable time and resources.
- *Systematic risk not considered.* Modern Portfolio Theory focuses on asset-specific risk, neglecting systemic risk or market risk that can affect all investments simultaneously. Macroeconomic or geopolitical events that affect the entire market can make diversification based only on Modern Portfolio Theory ineffective in mitigating risk.
- *Efficient markets assumption.* Modern Portfolio Theory assumes that markets are efficient and that all participants have access to the same information. However, this assumption does not take into account market inefficiencies that can arise from asymmetric information, price manipulations or herding behavior, affecting the validity of Modern Portfolio Theory models.
- *Asset valuation models.* Modern Portfolio Theory relies on asset pricing models, such as the Capital Asset Pricing Model (CAPM), to estimate expected returns. However, these models may be limited in their ability to capture market complexity, and estimates of expected returns may be subject to significant errors.

- *Overestimation of predictive ability.* Modern Portfolio Theory may overestimate investors' ability to predict future returns and mitigate risk through diversification. In reality, the predictability of returns and the ability to manage risk can be limited by the complexity and uncertainty of financial markets.

While Modern Portfolio Theory provides a useful framework for building diversified portfolios, it is important to recognize its limitations and consider other factors and approaches when managing investments to achieve more robust results tailored to market conditions. It becomes clear that Modern Portfolio Theory is a simplified model that provides useful guidance for building diversified portfolios, but it is important to integrate it with other approaches and considerations for more comprehensive and resilient investment management.

In conclusion, while recognizing the value of Modern Portfolio Theory as a guide for portfolio construction, it is important to integrate this theory with other approaches and considerations for more comprehensive and resilient investment management. It is essential to understand its limitations and adopt a flexible and informed approach to investment decisions. Integrating Modern Portfolio Theory with other perspectives and methodologies can contribute to investment management that is more comprehensive and adaptable to changing market conditions.

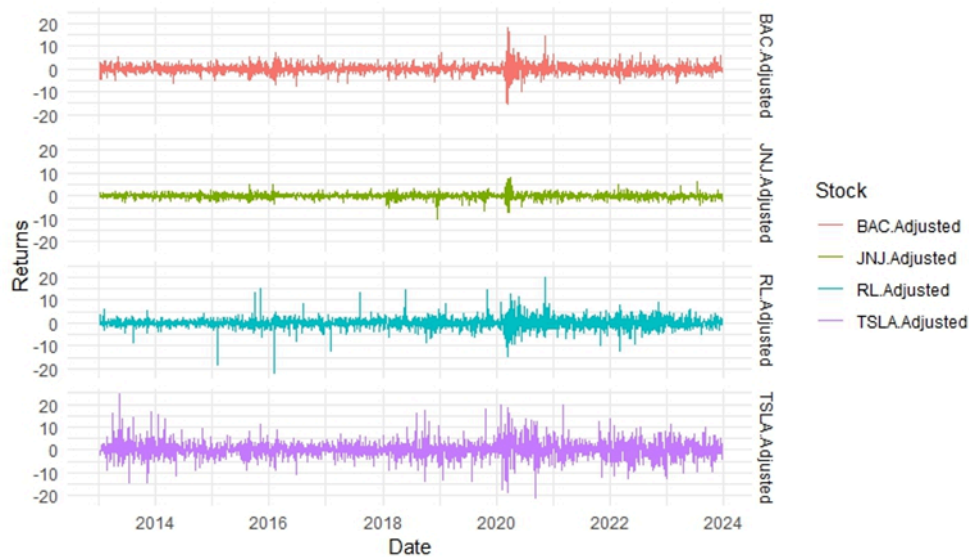
4.3 Construction of the optimal portfolio

In this last part of the thesis we have dealt, through the use of the RStudio programming language, with simulating the construction of an optimal portfolio, setting the objective of minimizing risk for a given level of expected return and taking into consideration the investor preferences. The choice of the optimal portfolio among the optimal ones present on the efficient frontier was made by taking into consideration a multi-asset portfolio made up of four stocks.

The stocks examined and which make up the multi-asset portfolio are: the stock of the multinational bank of America, the stock of the US pharmaceutical company Johnson & Johnson (which produces drugs, medical equipment and personal care products such as shampoo and creams), the action of the US company Ralph Lauren Corporation (active in the clothing, marketing and distribution of products in four categories: clothing, home, accessories and perfumes), and the action of the US company Tesla (specializing in the production of electric cars, photovoltaic panels and energy storage systems). These are equity securities belonging to different areas and sectors and which finance activities that contribute to environmental protection, to ensure portfolio diversification and therefore reduce the overall risk of the portfolio.

The first step, in RStudio, was to import the daily prices of the four shares from Yahoo Finance in the period from 2 January 2013 to 22 December 2023. Subsequently we proceeded to create the returns of the four shares in order to plot them of returns in order to evaluate the performance of the shares.

Figure 2 – Adjusted returns of the four stocks

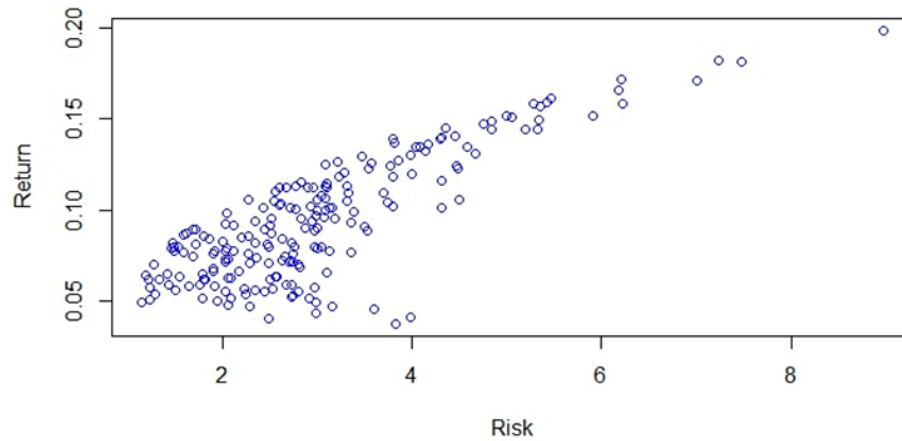


Source: our elaboration

Looking at Figure 2, what we can notice is that there are evident fluctuations in the returns of the four stocks both in 2020, i.e. during the Covid crisis period, and in 2022 following the invasion of Ukraine by Russia.

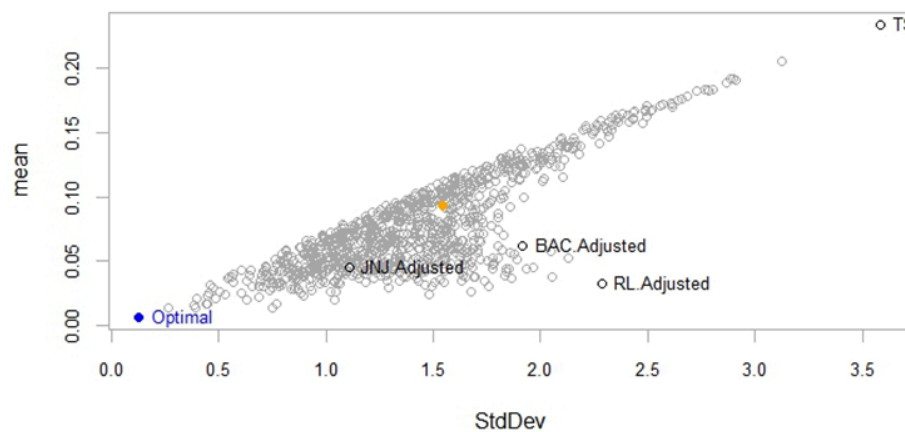
The next step was to create random portfolios and calculate their weights. The expected returns of these portfolios were then calculated (using the weights assigned to the assets) and the variance-covariance matrix which in the context of Modern Portfolio Theory is used to quantify the risk produced by a portfolio made up of multiple securities.

Figure 3 is a scatterplot of random portfolios and is a common practice in Modern Portfolio Theory and in the construction of the efficient frontier. This chart is used to visualize the variety of portfolios that can be formed by combining different financial assets randomly. Each point in the graph represents a different portfolio. Portfolios that are at the bottom and left have lower risk and return, while portfolios that are at the right and top have higher risk and return. The disposition of the portfolios seems to follow the trend of the efficient frontier.

Figure 3 – Frontier portfolios

Source: our elaboration

In order to proceed with the identification of the optimal portfolio among the efficient portfolios present on the efficient frontier, the optimization of the weights of these random portfolios was carried out by imposing as a first constraint the minimization of risk for a given level of return and as a second constraint that the sum of asset weights must equal 1 (this ensures that the investor is fully allocating his capital and leaving no resources unused).

Figure 4 – Mean-variance portfolios

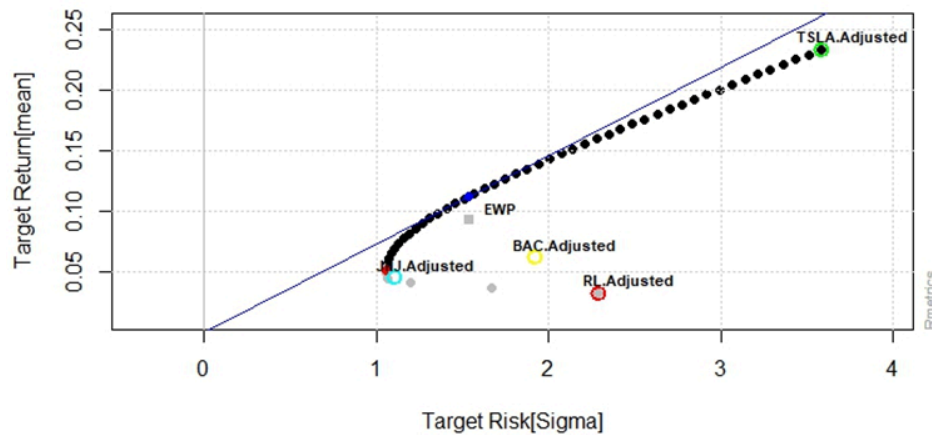
Source: our elaboration

In Figure 4 we can see that each point represents a portfolio and that the positioning of each point is determined by the risk-return trade-off. The blue dot called “Optimal” positioned at the bottom and left of all the others represents the optimal portfolio and is characterized by minimal variance.

Finally, the graphical representation of the efficient frontier was carried out.

Investors can select the optimal portfolio on the efficient frontier based on their risk-return preferences. Portfolios that are on the efficient frontier represent the best combinations of risk and return. The efficient frontier, as has already been said several times, represents all the possible portfolio combinations that minimize the risk for a given level of expected return or that maximize the expected return for a given level of risk. What is interesting to note in the graph of the efficient frontier is the presence of a red dot which represents the optimal portfolio, that is, the one which among all the optimal portfolios that are on the efficient frontier is the best of all because it is characterized by a minimum variance for a given expected level of return.

Figure 5 – Efficient frontier



Source: our elaboration

5 Conclusions

Investing well and carefully, whatever the chosen area, is not easy and requires knowledge, application and intuition. The indications provided in this article are not conclusive and absolute, since everyone, based on their own experience and tastes, will be able to make choices in certain directions and areas.

However, two elements are clear and must be reiterated and underlined. It is right, for the protection of the environment and fundamental human rights, to move towards a sustainable economy that embraces the principles attributable to the so-called ESG factors. In deciding how to invest capital, savers and the financial intermediaries who manage their savings can play a fundamental role in better allocating capital towards financing positive investments for society. You can choose to invest in businesses that generate a positive environmental and social impact.

Art, as has been said several times, is very often a means of reflecting on contemporaneity and its many contradictions. Collecting works of art is a unique experience, capable of enriching individuals both from a spiritual and aesthetic point of view, and from a material point of view.

You can choose to invest in a specific area (Poor art, Conceptual, Informal, ...) or in multiple areas at the same time.

Investing in gold can also be very profitable. In this case the investor can purchase antique gold objects, or choose so-called recycled gold or ethical gold.

The other element that cannot be ignored is that relating to the diversification of the investment portfolio. In their investment choices, individuals tend not to concentrate on a single security but build portfolios made up of multiple securities. Diversifying your investments means: reducing risk, improving the risk-return trade-off and mitigating the impact of specific events linked to a company or sector on a single security. From this point of view, the reference to Harry Markowitz's Portfolio Selection Theory is essential. In fact, it shows that it is necessary to identify the so-called "optimal portfolio" on the efficient frontier, characterized by the minimum risk for a given level of return or the maximum return for a given level of risk. This optimal portfolio represents the best possible trade-off between risk and return, given the set of investment opportunities available.

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