



Arbitrage in the markets

**Behavioral Finance and Development Economics
Association**

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Introduction

Market inefficiency occurs when the prices of assets in a market do not reflect all available information. To explain what all available information includes, it is necessary to mention the three forms of market efficiency. According to the weak-form efficiency, all available information is the information included in past prices. The semi-strong form, instead, asserts that prices in an efficient market reflect all public information. This includes all information available from public sources, but also past prices. Finally, according to the strong form of market efficiency, both private and public information is included in assets' prices.

Hence, in an inefficient market, assets do not trade at their true value. Some assets may be overvalued or undervalued, and this creates an opportunity for arbitrage, i.e. some investors can make excess returns almost without risk. Market inefficiencies can be caused by different factors. For instance, some information that influences assets' prices may take time for the markets to incorporate it into the prices. This delay in the reaction can create an opportunity for minor players to make a profit. The goal of this paper is to analyze arbitrage, its risks, and to provide some examples of types of arbitrage.

Definition of Arbitrage

The notion of arbitrage is crucial to the modern theory of Finance. Arbitrage is an investment or trading strategy which consists in simultaneously buying and selling the same financial instrument or asset in different markets or places in order to exploit price or yield differences between them. The objective of arbitrage is to obtain a profit without risk or with minimum risk since it seeks to take advantage of the opportunities for gain caused by inefficiencies or market dysfunctions (such as cases of different prices for the same product in different places, or interest rate or exchange rate differences). In general, arbitrage is based on the idea of equilibrium in the markets, or rather that trading takes place under optimal conditions. However, the effectiveness of arbitrage depends on the presence of certain conditions, such as the speed of execution of the transactions, the liquidity of the markets, the availability of information, and the ability to manage financial risk. Furthermore, arbitrage opportunities are often temporary and subject to rapid fluctuations, so the investor must be very responsive and ready to adapt to changing situations. Arbitrage can be considered a form of financial speculation but, compared to other speculative strategies (such as derivative trading or investing in risky instruments), it has some advantages, such as risk reduction, greater rationality, and the possibility of achieving consistent returns over the long term. However, arbitrage requires a high degree of knowledge of financial markets, rules, and regulations of each country, as well as a solid ability to analyze and evaluate investment opportunities. Although in this type of investment strategy risks are minimized, it still couldn't be defined as completely safe. In fact, arbitrage has several risks including:

- **Market Risk:** Arbitrageurs are subject to market fluctuations and price changes. If the prices of the assets on which the arbitrage is based move in an unexpected direction, there could be a financial loss.
- **Execution risk:** Arbitrage involves buying and selling multiple assets at the same time, which can make it difficult to execute the trade. If the execution is not carried out correctly, the arbitrageur could incur losses.
- **Counterparty Risk:** Arbitrage requires the cooperation of multiple counterparties, such as intermediaries or brokers. If one of these parties fails to fulfill its obligations, the arbitrageur could be in a difficult situation.
- **Countertrend Risk:** Arbitrage is based on looking for price differences between different markets, but if one of these differences disappears, the arbitrageur could suffer losses.
- **Liquidity Risk:** Arbitrage can involve large sums of money. If the arbitrageur does not have enough liquid money to carry out the trade, he may have to sell other assets or take out expensive loans.

Types Of Arbitrages

As already said before, arbitrage opportunities in the markets can arise due to inefficiencies in pricing, which can be exploited by traders to earn a risk-free profit. However, there are several methods to leverage these pricing discrepancies.

In fact, while some arbitrage strategies rely on contrasts between prices of the same asset or in different markets (“Geographical arbitrage”), others are (“Statistical and Volatility arbitrage”) supported by substantial mathematical and quantitative analysis, often depending on trading platforms and high-frequency trading (HFT). Finally, arbitrage can also be event-driven, following an investment strategy that seeks arbitrage possibilities before or after a political (“Political arbitrage”) or corporate event (“Merger arbitrage”).

In the subsequent paragraphs, three key types of arbitrage will be illustrated: Spatial arbitrage, Triangular arbitrage, and Fixed income arbitrage.

Spatial arbitrage

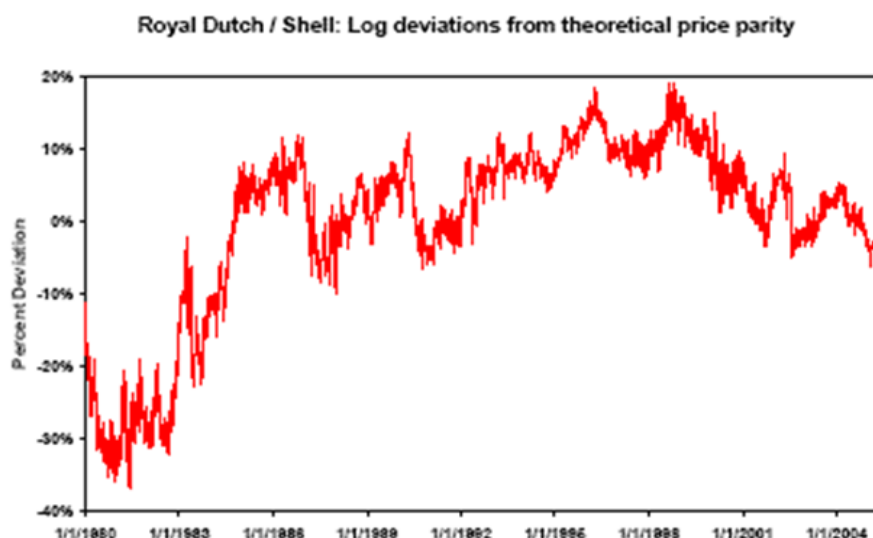
Spatial arbitrage, also known as “Geographical arbitrage”, is the simplest form of arbitrage: it consists in the purchasing of an asset, such as Stocks, bonds or ETF, and the subsequent selling of the same product in a different market in order to exploit a price discrepancy.

For example, there may be a discount broker in Italy selling a bond a 103.5 and a dealer in Canada bidding 103.80 for that same bond: the arbitrageur, who spots the circumstances to make profit, immediately buys the bond to sell it to the Canadian dealer, making 0,3 of profit for every operation made.

Arbitrage and price discrepancy in the case DLC

The topic of cross-board arbitrage has been deeply analyzed in the case of dual-listed companies. A dual-listed company (DLC) structure (also referred to as a “Siamese twin”) is the result of a merger in which both companies in different countries maintain their independence, retaining a separate legal identity and stock exchange listing, while contractually agreeing on combining operations, cash flows and often dividend payments. Barrick Gold (a Canadian gold mining company), being listed on the Toronto Stock Exchange (TSX) as “ABS” and on the New York Stock Exchange (NYSE) as “GOLD”, constitute a clear example of a DLC.

The DLC structure offers a unique opportunity to study market efficiency and the presence of arbitrage in equity markets. Since the dual-listed companies rely on the same cash flows, in integrated and efficient financial markets the stock prices of the Siamese twins should move together. However, it is not always the case: Rosenthal and Young (1990), for instance, found significant mispricing in two Dutch DLSCs, showing how a strong deviation from the theoretical price ratio has occurred over a long period of time.



Why does the possibility of arbitrage not lead to the correction of prices, bringing them back to the efficient and rational level? The answer could be found by looking into other factors, such as currency risks, local market sentiment, and local taxation. Nevertheless, others argue the absence of “fundamental reasons” for mispricing, and the topic of DLCs and arbitrage is still being studied in the academic finance community.

Triangular Arbitrage

When talking about the exchange rates between different currencies, the cross-exchange rate represents the exchange between two currencies expressed in a third different one. Occasions for a Triangular Arbitrage occur when there is a mismatch between the cross-exchange rate and the direct exchange rate of the two currencies in the foreign exchange market. Let’s take into consideration the following currencies: Euro (EUR), US Dollar (USD), and Japanese Yen (JPY). If in the market the following equation is not respected, there are conditions for operating a Triangular Arbitrage:

$$Er_{USD/EUR} = Er_{USD/JPY} Er_{JPY/EUR}$$

Where $Er_{a/b}$ indicates the Exchange Rate between the currency “a” and the currency “b”.

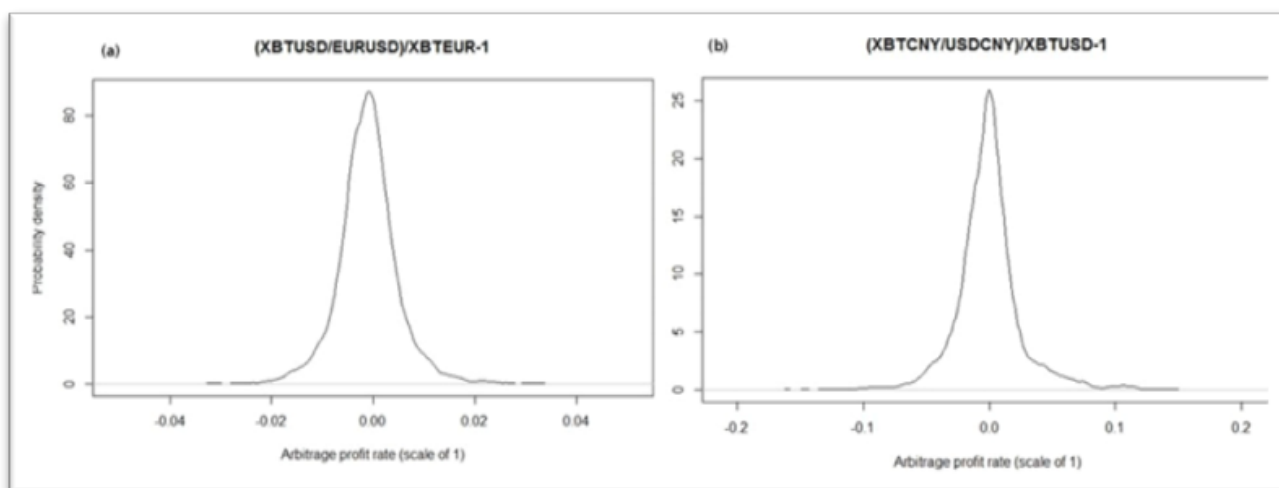
While it is certainly possible to envisage this type of theoretical arbitrage, the practical possibility on the part of an investor is another matter. Academic research shows that there is in fact triangular arbitrage in foreign exchange markets. However, most of them have a short duration and small magnitudes. Moreover, over time there has been a significant decline in the number of arbitrage opportunities, showing how the markets have gained greater efficiency in the pricing system.

Bitcoin-based triangular arbitrage

An innovative example of triangular Arbitrage is represented by mismatches in exchange rates between fiat currencies (Government-issued currency non-backed by a physical commodity) and cryptocurrencies, which have gained notable relevance in recent years, with Bitcoin having a market cap of 543 bln USD at the moment of writing (April 2023).

Defining Bitcoin as a traditional currency is somewhat imprecise (it would be better to speak of digital assets), nevertheless the high volatility of these cryptocurrencies allows both trading and speculation as well as possible arbitrage windows.

Lukáš Pichl and Taisei Kaizoji (2017) present an in-depth analysis of arbitrage opportunities with XBT/EUR, XBT/USD, XBT/CNY, and the foreign exchange rates EUR/USD and USD/CNY, highlighting substantial arbitrage windows for BTC/USD-BTC/CNY (Figure below).



Long-Term Capital Management

Long-Term Capital Management was a large hedge fund funded in 1994 by John Meriwether (before head of bond trading at *Salomon Brothers*), whose BoD included Nobel Prize-winning economists Myron Scholes and Robert Merton. After an initial success (40% annualized return in the first years), in 1998 LTCM lost a substantial amount of equity capital and was on the brink of default.

LTCM's business model was based on the exploitation of arbitrage opportunities in debt securities. Particularly, its main strategy was characterized by convergence trades. These trades involved finding securities that are mispriced relative to one another and taking long positions in the cheap ones while shorting the expensive ones, with the underlying assumption that the market price of the securities would eventually adjust to their "fair value". The main types of trades were: convergence among US, Japanese, and European sovereign bonds; convergence between on-the-run and off-the-run US sovereign bonds; long positions in emerging markets sovereigns, hedged back to dollars. However, due to the tight spreads between securities prices, LTCM had to take on a lot of leverage in order to reach a considerable profit (as of 1998: \$5 bn equity, \$125 bn debt).

In 1998, Russia defaulted on its sovereign debt, creating a widespread panic in financial markets. LTCM believed it had somehow hedged the position in GKOs (Russia sovereign bonds) by shorting Rubles. In fact, if Russia defaulted, the value of the Ruble would collapse, thus leading to a profit in this position. Nevertheless, as the value of the Russian Ruble fell, the banks providing the hedge were shut down, and the Russian government prevented further trading in its currency. Although this resulted in large losses for LTCM, these losses were nowhere near sufficient to bring the hedge fund to its knees. Instead, the subsequent flight-to-liquidity, which is covered in more detail in the next section, was what ultimately led to its destruction.

The "flight-to-liquidity" experienced by the world's fixed-income markets was the root cause of the LTCM disaster. Fixed-income portfolio managers started moving their holdings to more liquid assets as Russia's problems grew worse. Particularly, a large number of investors switched their holdings to the U.S. Treasuries market. In fact, the panic was so severe that investors rushed their funds not just into Treasuries but specifically into the most liquid segment of the U.S. Treasury market (i.e.: the most recently issued securities), also known as "on-the-run". Although the U.S. Treasury market is generally rather liquid, this worldwide flight-to-liquidity hit the fleeing Treasury market like a freight train. Although the off-the-run bonds were theoretically cheaper than the on-the-run bonds, the disparity between the yields on on-the-run and off-the-run Treasury bonds expanded considerably (on a relative basis). What LTCM had overlooked was the fact that a sizable chunk of its balance sheet was vulnerable to an overall shift in the "price" of liquidity. Its short positions would cost more than its long positions if liquidity increased in value (as it did after the crisis). Essentially, this represented a significant unhedged exposure to a single risk factor. Aside from that, the size of the fresh issuance of U.S. Treasury bonds has decreased during the previous few years, which has made the problem worse. As a result, the Treasury market's liquidity has actually decreased, increasing the possibility that a flight to liquidity may cause a market disruption.

Finally, the US government was forced to step in creating a loan fund, granted by Wall Street banks, to bail out LTCM, enabling it to liquidate its assets without spreading financial contagion. The amount of the loan was \$3.65 bn in exchange for 90% of equity, and enabled LTCM to liquidate in an orderly manner in 2000.

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