Case Study Series

Arbitrage in Currency Markets

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Abstract

This case deals with arbitrage opportunities in currency markets. Students will first learn about the meaning of arbitrage. Then, they will learn about a specific form of arbitrage in currency markets, which is called "triangular arbitrage." They will learn the conditions in which a triangular arbitrage is possible. They will design an arbitrage and compute the potential profit with that arbitrage. This case is a hands-on experience for students who want to learn about arbitrage and its steps in international currency markets.

Keywords: currency, arbitrage, foreign exchange

JEL classifications: F30, F31

Introduction

In his International Finance class, Michael learned about "triangular arbitrage." The professor assigned them homework on the topic, but Michael did not understand it. He thought that meeting with one of his classmates would help him. So, he called his friend Laura and now they are in the university's library.

"Laura, thank you so much for coming. I feel like overwhelmed. I already had so many projects from other classes, and now this…"

Laura is glad that they met. She says "No, no. I am very glad that we met. I, too, was looking for someone to work on this homework with. I thought I understood how arbitrage works until I saw these questions. Maybe the wording is not clear, I don't know."

Mike responds "In finance classes, I always start confident and then as weeks pass, I get confused. Do these classes have to be like this? I don't have any problem in management or marketing. Just finance."

"Yes, I know" Laura responds. "It is weird. Maybe there is too much math and that confuses us. Also, I feel like some of the professors do not give us enough examples. Learning finance requires practice, you know. It is the key."

"Yes, it is depressing. But, I think we can do this one if we search the web a little bit and then look at our notes one more time. What do you think?" Michael asks.

"I am sure it is doable. We need to work on it a little bit, I guess. Let's start by searching the web for triangular arbitrage first. What do you think?" Laura asks.

"Great idea. I am sure we can find some examples on the internet. So, let's start" Mike responds.

After the two friends started searching the web, they found some resources that explain arbitrage and triangular arbitrage, and they even found a detailed, numerical example on triangular arbitrage.

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"Arbitrage" and "Triangular Arbitrage"

"Arbitrage" means risk-free profit. Investopedia explains "Arbitrage" as follows:

"Arbitrage is the simultaneous purchase and sale of an asset to profit from a difference in the price. It is a trade that profits by exploiting the price differences of identical or similar financial instruments on different markets or in different forms. Arbitrage exists as a result of market inefficiencies."

"Triangular arbitrage" is a special form of arbitrage in currency markets. Investopedia explains "triangular arbitrage" as follows:

"Triangular arbitrage is the result of a discrepancy between three foreign currencies that occurs when the currency's exchange rates do not exactly match up. Triangular arbitrage opportunities are rare and traders that take advantage of this type of arbitrage opportunity usually have advanced computer equipment and/or programs to automate the process. The trader would exchange an amount at one rate (EUR/USD), convert it again (EUR/GBP), and then convert it finally back to the original (USD/GBP) and assuming low transaction costs, net a profit."

Below is a graphical presentation of "triangular arbitrage":
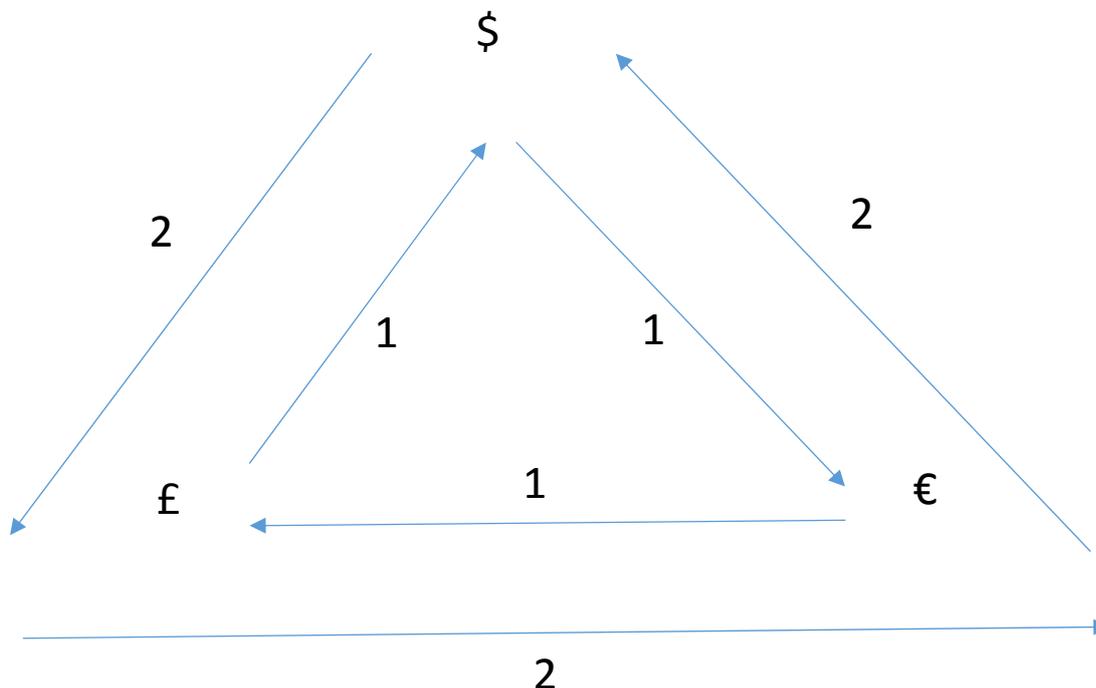
The first direction that we can go is (1), which is dollar into euro first, and then euro into pound, and finally pound back into dollar. After making these three conversions, if we have more money than we started with, then this would be the correct order of conversions. In other words, we have found what conversions to do in the correct order and we have found how much profit we would make if we go in that direction.

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On the other hand, it is possible to find a loss. If we find a loss when we go in that direction, then we need to try the other direction (i.e. direction (2)), which is dollar into pound first, then pound into euro, and finally euro back into dollar. If we have found a loss in direction (1), it means that direction (2) would definitely give us a profit. In other words, if one direction loses money, the other direction makes money.

It is important to remember that we may not have an arbitrage opportunity at all if the rates match up perfectly. For example, we can try direction (1) and find zero profit or loss. That would mean that there is no arbitrage opportunity (i.e. it is not possible to make money by making conversions). If direction (1) gives zero profit or loss, there is no need to try direction (2) because it would also give us no profit or loss.

In the next section, a numerical example on triangular arbitrage is presented.

Triangular Arbitrage Example

Here is a numerical example for triangular arbitrage:
Bank A gave me the following two rates:
$1.5/£
$1.4/€
Bank B gave me this rate:
€1.1/£

I can borrow up to $1 million. Is it possible for me to make a risk-free profit (arbitrage) by doing some conversions?

I can either convert $s into £ first, then convert those £s into €s, and then finally convert those €s back into $s; Or I can convert $s into €s first, then convert those €s into £s and then finally convert those £s back into $s.

One of the directions may give me a profit (which means the other direction would make me lose).

1) If I try the second direction first (convert $s into €s first, then convert those €s into £s and then finally convert those £s back into $s), I will lose money:
$1 million/1.4 = €714,285.71
€714,285.71/1.1 = £649,350.65
£649,350.65*1.5 = $974,025.97
My loss would be 1 million – 974,025.97 = $25,974.03

Notice that when we converted from left to right (in $1.4/€, we converted $1 million into euro first), we did a division: 1,000,000/1.4 = €714,285.71

In the second step, in €1.1/£, we converted €714,285.71 into pounds, so we went from left (euro) to right (pound), so we again did a division: €714,285.71/1.1 = £649,350.65

In the third step, in $1.5/£, we converted from right (pound) to left ($), so we did a multiplication: £649,350.65*1.5 = $974,025.97 (the loss is $25,974.03 since we started with $1 million.

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2) Since we are losing money if we follow the $, £, €, $ order, we know that we need to go in the other direction, which is $, €, £, $:

$1 million/1.5 = £666,666.67
£666,666.67*1.1 = €733,333.33
€733,333.33*1.4 = $1,026,666.67
My profit would be 1,026,666.67 – 1,000,000 = $26,666.67

This is the correct direction. We need to convert our dollars into euro first. The, we can convert euros into pounds, and then finally convert back into dollars. After we repay our $1 million loan, we make a profit of $26,666.67.

The Decision

Michael is trying to answer the following questions:

1. What is the meaning of "arbitrage?"

2. What does "triangular arbitrage" mean?

3. Two currency dealers gave me the following rates.

    Dealer A: 0.80 pounds/euro

                   1.50 dollars/pound

    Dealer B: 0.85 euro/dollar

    I can borrow up to 5 million British pounds. If I borrow the full amount (5 million pounds) and first convert them into euro, then convert my euros into dollar, and then finally convert my dollars back into pounds, will I make money (ignoring commissions)?

4. In a triangular arbitrage, if following one direction (for example pound, then euro, then dollar, then back into pound) creates a loss, would going in the opposite direction (for example pound, then dollar, then euro, then back into pound) create a profit?

5. In a triangular arbitrage, if following one direction (for example pound, then euro, then dollar, then back into pound) gives no profit or loss, what would happen if we go in the opposite direction (for example pound, then dollar, then euro, then back into pound)?

6. If instead, after borrowing the 5 million pounds, if I first convert into dollar, then into euro, then back into pound, what will happen? Will I make money in this case (ignoring commissions)?

7. When I make money, is it risk-free or not?

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8. If instead of borrowing pounds, I borrow $7.5 million, and then convert first into euro, then into pound, and then back into dollar, what will be my profit/loss (ignoring commissions)?

9. If instead, after borrowing the $7.5 million, if I first convert into pound, then into euro, then back into dollar, what will happen? Will I make money in this case (ignoring commissions)?

10. If I am making money, is it risk-free or not?

References

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Triangular Arbitrage Definition | Investopedia
 http://www.investopedia.com/terms/t/triangulararbitrage.asp

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