Forex Triangular Arbitrage:

This was a simpler project. This was primarily done to explore the usage of the fmpcloud.io API & to test if there are actual triangular arbitrage market inefficiencies.

This was a quick project which focused on demonstrating market inefficiencies in the foreign exchange market using R.

The code is on the R file in the same folder.

Summary:

- Pulled all available Forex market data for fmpcloud.io

	ticker	bid	ask	open	low	high	changes	date
	<chr>	<chr>	<chr>	<chr>	<chr>	<chr>	<dbl>	<chr>
1	EURUSD	1.04710	1.04710	1.04837	1.04640	1.04860	-0.00121	2022-06-30 22:20:25
2	USDJPY	135.658	135.658	135.720	135.622	135.989	-0.000457	2022-06-30 22:20:25
3	GBPUSD	1.21498	1.21498	1.21803	1.21452	1.21824	-0.00250	2022-06-30 22:20:25
4	EURGBP	0.86185	0.86185	0.86070	0.86047	0.86208	0.00134	2022-06-30 22:20:25
5	USDCHF	0.95528	0.95528	0.95524	0.95444	0.95588	0.0000419	2022-06-30 22:20:25
6	EURJPY	142.048	142.048	142.279	141.994	142.432	-0.00162	2022-06-30 22:20:25
7	EURCHF	1.00028	1.00028	1.00113	0.99987	1.00156	-0.000849	2022-06-30 22:20:25
8	USDCAD	1.28796	1.28796	1.28750	1.28668	1.28867	0.000357	2022-06-30 22:20:25
9	AUDUSD	0.68867	0.68867	0.69028	0.68786	0.69060	-0.00233	2022-06-30 22:20:25
10	GBPJPY	164.817	164.817	165.274	164.772	165.347	-0.00277	2022-06-30 22:20:25

... with 114 more rows

- Had to clean the data to only keep currencies

- Retrieved all possible currency permutations

(Example)

	Curr1	Curr2	Curr3	exchange1	exchange2	exchange3
1	AUD	CAD	CHF	AUDCAD	CADCHF	CHFAUD
2	AUD	CAD	CNH	AUDCAD	CADCNH	CNHAUD
3	AUD	CAD	CZK	AUDCAD	CADCZK	CZKAUD
4	AUD	CAD	DKK	AUDCAD	CADDKK	DKKAUD
5	AUD	CAD	EUR	AUDCAD	CADEUR	EURAUD
6	AUD	CAD	GBP	AUDCAD	CADGBP	GBPAUD
7	AUD	CAD	HKD	AUDCAD	CADHKD	HKDAUD

- Applied all the rates pulled to the different permutations

	base	new	bidRate	askRate	exchange
	<chr>	<chr>	<chr>	<chr>	<chr>
1	EUR	USD	1.04710	1.04710	EURUSD
2	USD	JPY	135.658	135.658	USDJPY
3	GBP	USD	1.21498	1.21498	GBPUSD
4	EUR	GBP	0.86185	0.86185	EURGBP
5	USD	CHF	0.95528	0.95528	USDCHF
6	EUR	JPY	142.048	142.048	EURJPY

- Created a master dataset with all complete 3-way currency permutations & their associated exchange rates
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	Curr1	Curr2	Curr3	exchange1	exchange2	exchange3	base.x	new.x	bidRate.x	askRate.x	base.y	new.y	bidRate.y	askRate.y	base	new	bidRate	askRate
1	AUD	CAD	CHF	AUDCAD	CADCHF	CHFAUD	AUD	CAD	0.88696	0.88696	CAD	CHF	0.74170	0.74170	CHF	AUD	1.520057154149	1.520057154149
5	AUD	CAD	EUR	AUDCAD	CADEUR	EURAUD	AUD	CAD	0.88696	0.88696	CAD	EUR	0.741498717207219	0.741498717207219	EUR	AUD	1.52055	1.52055
6	AUD	CAD	GBP	AUDCAD	CADGBP	GBPAUD	AUD	CAD	0.88696	0.88696	CAD	GBP	0.639047053034515	0.639047053034515	GBP	AUD	1.76428	1.76428
9	AUD	CAD	JPY	AUDCAD	CADJPY	JPYAUD	AUD	CAD	0.88696	0.88696	CAD	JPY	105.324	105.324	JPY	AUD	0.0107045751354129	0.0107045751354129
12	AUD	CAD	NZD	AUDCAD	CADNZD	NZDAUD	AUD	CAD	0.88696	0.88696	CAD	NZD	1.2465719272002	1.2465719272002	NZD	AUD	0.904355375488352	0.904355375488352
16	AUD	CAD	SGD	AUDCAD	CADSGD	SGDAUD	AUD	CAD	0.88696	0.88696	CAD	SGD	1.07994	1.07994	SGD	AUD	1.04396120640157	1.04396120640157
19	AUD	CAD	USD	AUDCAD	CADUSD	USDAUD	AUD	CAD	0.88696	0.88696	CAD	USD	0.77642162800087	0.77642162800087	USD	AUD	1.45207428812058	1.45207428812058
21	AUD	CHF	CAD	AUDCHF	CHFCAD	CADAUD	AUD	CHF	0.65787	0.65787	CHF	CAD	1.34825401105568	1.34825401105568	CAD	AUD	1.1274465590331	1.1274465590331
25	AUD	CHF	EUR	AUDCHF	CHFEUR	EURAUD	AUD	CHF	0.65787	0.65787	CHF	EUR	0.999720078378054	0.999720078378054	EUR	AUD	1.52055	1.52055
26	AUD	CHF	GBP	AUDCHF	CHFGBP	GBPAUD	AUD	CHF	0.65787	0.65787	CHF	GBP	0.861601027028424	0.861601027028424	GBP	AUD	1.76428	1.76428

- Ran a loop which calculated the currency-to-currency exchanges & applied IBKR transaction costs

- Returned an ordered dataset with the most profitable exchanges (All starting/ending points based in USD)

	Curr1	Curr2	Curr3	exchange1	exchange2	exchange3	exhange1base	exhange1new	exhange1bid	exhange1ask	exhange2base	exhange2new	exhange2bid	exhange2ask	exhange3base	exhange3new	exhange3bid	exhange3ask	Reutn2Original
1	TRY	USD	JPY	TRYUSD	USDJPY	JPYTRY	TRY	USD	0.05986698	0.05986698	USD	JPY	135.37200000	135.37200000	JPY	TRY	0.12342631	0.12342631	10002.25
2	USD	JPY	TRY	USDJPY	JPYTRY	TRYUSD	USD	JPY	135.37200000	135.37200000	JPY	TRY	0.12342631	0.12342631	TRY	USD	0.05986698	0.05986698	10002.25
3	JPY	TRY	USD	JPYTRY	TRYUSD	USDJPY	JPY	TRY	0.12342631	0.12342631	TRY	USD	0.05986698	0.05986698	USD	JPY	135.37200000	135.37200000	10002.25
4	EUR	JPY	TRY	EURJPY	JPYTRY	TRYEUR	EUR	JPY	141.64800000	141.64800000	JPY	TRY	0.12342631	0.12342631	TRY	EUR	0.05721236	0.05721236	10001.89
5	JPY	TRY	EUR	JPYTRY	TRYEUR	EURJPY	JPY	TRY	0.12342631	0.12342631	TRY	EUR	0.05721236	0.05721236	EUR	JPY	141.64800000	141.64800000	10001.89
6	TRY	EUR	JPY	TRYEUR	EURJPY	JPYTRY	TRY	EUR	0.05721236	0.05721236	EUR	JPY	141.64800000	141.64800000	JPY	TRY	0.12342631	0.12342631	10001.89

Very hard to read, I apologize.

But in summary, the most profitable arbitrage opportunity was the following.
USD -> JPY -> TRY
United States Dollar -> Japanese Yen -> Turkish Lira
Then back to United States Dollar.

If we were to “invest” $10,000 USD to start and complete this single arbitrage opportunity – we would profit $2.25.

This is a minuscule amount, which means the market is generally quite efficient. But there are still market inefficiencies.

The key would be to repeat this action as many times as possible until…
The price moves & another opportunity provides better returns.

If we kept repeating this action & the prices stayed somewhat stable a single $2.25 profit could turn into $255.00 after 100 iterations.

However, this is very unrealistic given time constraints.
But if we were to automate this function & provide an online brokerage resource with X dollars to continuously find & exploit these opportunities, then it becomes quite realistic.

One might ask, “Is this even legal?”

The answer is yes. Arbitrage is encouraged in the forex market because it helps solve the market inefficiencies demonstrated in this project.

If done enough, the demand/supply of each currency would eventually shift & the arbitrage opportunity would disappear.

This supports the old saying “it takes money to make money”. As we can see, to only make a $2.25 profit in one instance, you would have to be willing to put down $10,000.