Example: Foreign currency trading

Suppose you have 1 million US dollars to invest in currency markets. The cross-currency rates are showed in the Excel file "Currency Trading.xlsx". Develop an LP (linear programming) model to determine whether there are any arbitrage opportunities with the given currency rates.

An example to help understand *cross currency rates*:

Cross currency rates (from along side, to along top)					
	US Dollar	**British Pound**	**Euro**	**Japanese Yen**	**Brazilian Real**
US Dollar	1	0.60639	0.88363	118.27	2.9092
British Pound	1.6491	1	1.45751	195.07	4.79931
Euro	1.1317	0.6861	1	133.77	3.29496
Japanese Yen	0.008455	0.005126	0.007476	1	0.02462
Brazilian Real	0.34374	0.20836	0.30349	40.62285	1

- 0.20836 in the cross currency rate table means that 1 Brazilian real can purchase 0.20836 pound.
- If you purchase 1 million Brazilian real with British pounds, then converting it back to pounds:
  Pounds required to purchase: 1,000,000/4.79931 = 208363
  Pounds obtained by selling back: 1,000,000*0.20836 = 208360
  Difference (In – Out): 208360-208363 = -3

An example to help understand *conversion amounts*:

- Suppose you spend 100 US dollars to purchase British Pound and 100 US dollars to purchase Japanese Yen. Fill out the following conversion table.

Conversion amounts (from along side, to along top)						
	US Dollar	**British Pound**	**Euro**	**Japanese Yen**	**Brazilian Real**	Total out
US Dollar	0	100	0	100	0	200
British Pound	0	0	0	0	0	0
Euro	0	0	0	0	0	0
Japanese Yen	0	0	0	0	0	0
Brazilian Real	0	0	0	0	0	0
Total in	0	60,639	0	11,827	0	
Total out	200	0	0	0	0	
Final net in	-200	60,639	0	11,827	0	

Excel Model Setup:

	A	B	C	D	E	F	G
1	**Foreign currency trading**						
2							
3	Cross currency rates (from along side, to along top)						
4		**US Dollar**	**British Pound**	**Euro**	**Japanese Yen**	**Brazilian Real**	
5	**US Dollar**	1	0.60639	0.88363	118.27	2.9092	
6	**British Pound**	1.6491	1	1.45751	195.07	4.79931	
7	**Euro**	1.1317	0.6861	1	133.77	3.29496	
8	**Japanese Yen**	0.008455	0.005126	0.007476	1	0.02462	
9	**Brazilian Real**	0.34374	0.20836	0.30349	40.62285	1	
10							
11	**Opportunity for arbitrage?**						
12	Conversion amounts (from along side, to along top)						
13		**US Dollar**	**British Pound**	**Euro**	**Japanese Yen**	**Brazilian Real**	Total out
14	**US Dollar**						=sum(B14:F14)
15	**British Pound**						↓
16	**Euro**						
17	**Japanese Yen**						
18	**Brazilian Real**						
19	Total in	=sumproduct(B5:B9,B14:B18) →					
20	Total out	=transpose(G14:G18)		ctrl+shift+enter			
21	Final net in	=B19-B20 →					
22				≥			
23	Nonnegative	0	0	0	0	0	
24							
25	Final net $ in	=B21	≤ or =	$ 1.00			

Specify Solver:

Set Objective: B25

To: X Max ○ Min ○ Value of: _____

By Changing Variable Cells: B14:F18

Subject to the Constraints:

B21:F21 ≥ B23:F23

B25 ≤ D25 (= works too)

X Make Unconstrained Variables Non-Negative

Select a Solving Method: Simplex LP

Solution to the Foreign Currency Trading model:

	A	B	C	D	E	F	G
1	**Foreign currency trading**						
2							
3	Cross currency rates (from along side, to along top)						
4		**US Dollar**	**British Pound**	**Euro**	**Japanese Yen**	**Brazilian Real**	
5	**US Dollar**	1	0.60639	0.88363	118.27	2.9092	
6	**British Pound**	1.6491	1	1.45751	195.07	4.79931	
7	**Euro**	1.1317	0.6861	1	133.77	3.29496	
8	**Japanese Yen**	0.008455	0.005126	0.007476	1	0.02462	
9	**Brazilian Real**	0.34374	0.20836	0.30349	40.62285	1	
10							
11	**Opportunity for arbitrage?**						
12	Conversion amounts (from along side, to along top)						
13		**US Dollar**	**British Pound**	**Euro**	**Japanese Yen**	**Brazilian Real**	Total out
14	**US Dollar**	0.00	978.10	0.00	0.00	0.00	978.10
15	**British Pound**	0.00	0.00	593.11	0.00	0.00	593.11
16	**Euro**	0.00	0.00	0.00	0.00	864.46	864.46
17	**Japanese Yen**	0.00	0.00	0.00	0.00	0.00	0.00
18	**Brazilian Real**	2848.36	0.00	0.00	0.00	0.00	2848.36
19	Total in	979.10	593.11	864.46	0.00	2848.36	
20	Total out	978.10	593.11	864.46	0.00	2848.36	
21	Final net in	1.00	0.00	0.00	0.00	0.00	
22		>=	>=	>=	>=	>=	
23	Nonnegative	0	0	0	0	0	
24							
25	Final net $ in	1.00	<=	$ 1.00			

Based on the above results, what's your best currency trading strategy?

US Dollar → British Pound → Euro → Brazilian Real → US Dollar