Simio Spring 2023 Student Problem
BankOfSimio Currency Exchange

BankOfSimio is a global custodian bank that offers currency exchanges for their clients. For example, a client may want to purchase equity in a British company that conducts their business in British Pound Sterlings (GBP), but the client wants to spend United States Dollars (USD). BankOfSimio will take the USD and give out GBP so that client can then purchase the desired equity. BankOfSimio will then take a small percentage on each exchange that it provides. Clients expect their exchanges to happen in a timely manner so that their transactions are not delayed. Therefore, BankOfSimio must hold cash on hand for each type of currency that it will exchange.

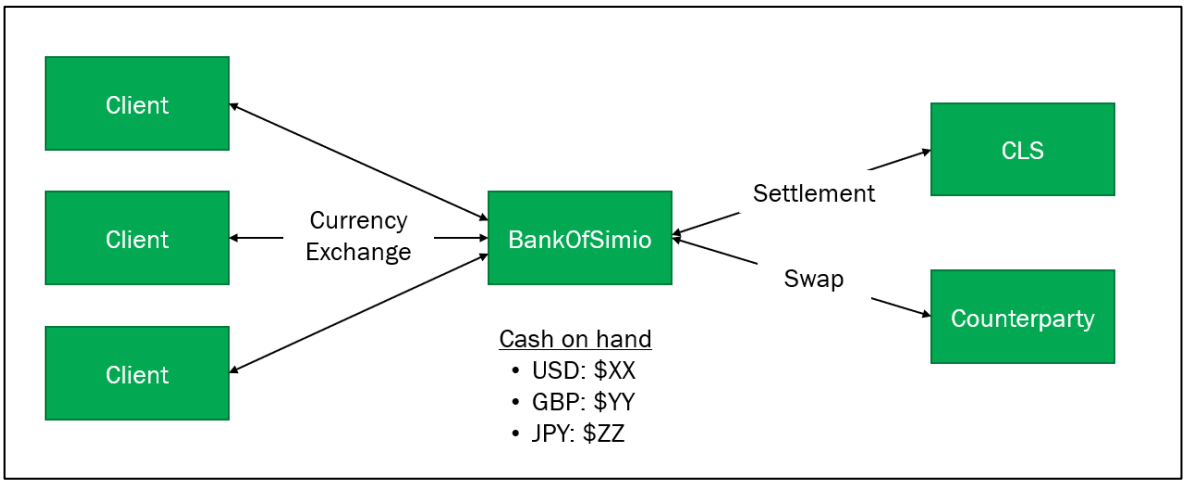
If at the end of the day, BankOfSimio has a net increase in one type of currency and a decrease in another, BankOfSimio will conduct a settlement with CLS (Continuous Linked Settlement Bank International). For a small percentage fee, CLS will take the excess currency that BankOfSimio has and return the equivalent amount in the currency they are lacking. This settlement confines the risk that BankOfSimio has to a single day, which is known as intra-day liquidity risk. If BankOfSimio needs a specific type of currency to support their transactions before the end of the day, they can conduct a midday swap with one of their counterparties. This is the same service that CLS provides but is more expensive and causes a delay in the exchange, which can lead to dissatisfied clients.

As a major bank in global finances, BankOfSimio is legally obligated to manage risk. If they are unable to support client transactions for even a short length of time, it can cause a disruption in the financial market. Accordingly, the government requires that BankOfSimio prove that they have sufficient funds on hand to avoid lengthy delays across a variety of stress tests. Choosing the amount of each type of currency to keep on hand is a difficult problem. Your team will be asked to simulate system activity (e.g., cash flows from transactions, swaps, and settlements) to find the profit maximizing quantities subject to acceptable risk.

These analyses will be completed across a range of scenarios including, but not limited to:

- Business as usual
- Loss of a counterparty (i.e., no ability to swap mid-day)
- Multi-day liquidity

For purposes of this problem, you will be asked to consider 3 types of currency: US Dollar (USD), British Pound Sterling (GBP), and Japanese Yen (JPY). A basic system representation is shown below:



System Information

Your goal is to choose profit maximizing quantities of cash on hand for BankOfSimio, subject to acceptable risk. Specifically, you need to set a target for how much cash in each of the three currencies (USD, JPY, GBP) BankOfSimio needs to start their day. To do this, you will have to model the random client transactions that occur throughout the trading day. Currency markets are open 24/7. However, most currency transactions are the result of movement in financial markets. For the purposes of your model, you can assume that a trading day starts at 8:00 AM and ends at 6:00 PM. At the end of the day, BankOfSimio will conduct a settlement with CLS Bank to reset their cash values to the same amount they started with.

BankOfSimio has 30 major clients. They range in size from $750 billion to $1500 billion in terms of assets under management (AUM). Below is a sanitized list of the clients and the size of their AUM:

Client	Total Assets Under Management (USD)
1	$755,909,805,368
2	$760,808,067,001
3	$768,073,357,503
4	$788,134,098,958
5	$795,784,078,521
6	$800,542,239,784
7	$841,173,089,403
8	$866,600,203,526
9	$917,353,221,490
10	$928,816,646,813
11	$963,778,285,541
12	$991,386,206,459
13	$999,568,964,044

14	$1,000,981,782,776
15	$1,027,473,386,500
16	$1,037,054,748,058
17	$1,063,714,855,490
18	$1,076,477,658,972
19	$1,085,728,528,284
20	$1,112,391,866,531
21	$1,118,736,888,952
22	$1,141,972,142,431
23	$1,187,845,522,703
24	$1,268,178,532,506
25	$1,334,987,753,807
26	$1,403,263,240,909
27	$1,404,142,928,986
28	$1,407,696,238,426
29	$1,449,671,861,973
30	$1,499,586,350,219

You've conducted interviews with experts from the bank and learned that clients will typically move an average of approximately 1.5% of their AUM in a normal day. This movement occurs over hundreds of transactions which vary in size and in currency. BankOfSimio has provided you with two weeks' worth of real transaction data for you to analyze and use in your model.

Exchange Transaction Data

The data includes the time the exchange request was received, the client who initiated the transaction, the currency the transaction arrived in, the amount to be exchanged (in the currency it was received in), the currency type to be given out, the amount to be given out, and the fee that BankOfSimio collected on the transaction. BankOfSimio charges a small fee for each transaction that occurs. The amount of the fee is dependent on the amount (in USD) of the transaction. The fee is in addition to the transaction amount, so it does not reduce the transaction size in any way. BankOfSimio is a US company, so their revenue should always be denominated in USD. The same is true for any swaps and settlements.

The exchange rate between currencies has small, continuous shifts throughout the day, with larger trends occurring over weeks. Below are some graphs from earlier this year that show how exchange rates have fluctuated.

For the purposes of your model, you can assume the BankOfSimio will use the exchange rate at the top of the hour for all transactions that occur within the hour. Let's say that at 8:00:00 AM the exchange rate between USD and GBP is 0.84. Any exchange that is performed between 8:00:00 and 8:59:59 AM will use 0.84. At 9:00:00, the exchange rate may change but will be constant throughout that hour. The same is true for all swaps and settlements.

BankOfSimio stops all currency exchange requests at 6:00 PM. At 6:30 PM, BankOfSimio settles with CLS Bank. This means that all currency exchange requests from clients must be completed by 6:30 PM. The purpose is to reset the cash on hand for each currency to the target value. If, for example, BankOfSimio has accumulated $1 billion USD above their target and has given out the equivalent amount of GBP, they will give the excess USD to CLS. CLS gives back the equivalent amount of GBP, resetting BankOfSimio to their target values. CLS charges BankOfSimio 0.01%, or 1 basis point, for this service.

BankOfSimio also has a counterparty called WorldBank. If BankOfSimio runs low on cash anytime during the day, they can conduct a swap with WorldBank. This is like the end of day

settlement, except that BankOfSimio does not necessarily want to reset cash values to their start of day target. It will be up to you to determine the triggering threshold for a swap for each currency type, the swap amount for each currency type, and the currency that should be traded in in exchange for the desired currency. Somebody first recognizes that cash is low and flags it to a BankOfSimio director. The director contacts WorldBank to make a deal. Once the deal has been agreed upon, the swap occurs. Therefore, the trigger needs to occur with enough time to complete the swap before cash runs out in order to avoid BankOfSimio being unable to support exchanges. Swaps help mitigate risk, but they are also expensive. WorldBank charges 0.5%, or 50 basis points, per swap.

The final cost to consider is opportunity cost. BankOfSimio could carry lots of extra cash and avoid expensive swaps. However, this strategy would leave cash stranded. On average, the rest of their business has a return on investment (ROI) of 8% per year. For example, if BankOfSimio carries $1 billion USD more than they need for a year, they are losing an $80 million opportunity. Even though opportunity cost does not technically cause cash to leave their system, it is still an important factor to consider.

Staffing

All transactions at BankOfSimio require a bank employee to approve the transaction to confirm that there is enough cash on hand for the swap and to prevent fraud. There are three different types of employees: entry-level, senior-level, and director. Entry-level employees handle exchanges below $75,000,000 (in USD) that do not require any additional information or authentication. Senior-level employees can handle any type of exchange transaction but focus on exchanges at or above $75,000,000. Directors handle all counterparty swaps during the day and the CLS settlement that occurs at the end of the day.

The types of transactions, who can handle them, and the distributions of time the transactions take are listed in the table below.

Transaction type	Staff Member	Processing Time (minutes)
Exchanges below $75,000,000 (in USD)	Entry-level	Uniform(2,5)
Exchanges above $75,000,000	Senior-level	Pert(3,5,7)
Counterparty swap	Director	Triangular(25,30,45)
CLS settlement	Director	Triangular(4,5,8)

Clients start getting frustrated if there are significant delays in their transactions. The bank should be staffed to reduce waiting times for clients without having excessive idle time for entry and senior-level staff members.

Analysis

BankOfSimio is federally regulated because any failure to support client transactions can cause a major disruption in the global financial market. Accordingly, they must prove to the government that they have sufficient cash on hand to avoid disruptions. This is accomplished through stress tests. Interestingly, the government does not write or conduct the test. It is up to BankOfSimio to test themselves and then explain both the test and the outcome. BankOfSimio has a few scenarios they would like you to test but would also like you to recommend and conduct additional tests that you believe will help prove their case when presenting to the government.

Part of your model must include tracking the minimum levels of cash on hand in each type of currency. Zero risk means that if the cash drops to zero in any of the replications, the test is failed. It is up to you to determine the appropriate number of replications to run. As a reference point, if you can show that the probability of running out of cash is less than 0.01% the government will accept your results.

As mentioned above, your objective is to choose profit maximizing quantities of cash on hand subject to the risk constraints as well as appropriate staffing levels. This will require a handful of important decisions:

- Cash on hand to start each day (use increments of 1 billion)
  - USD
  - GBP
  - JPY
- Swap policy (use increments of 0.5 billion)
  - Trigger point for each type of currency
  - Swap amount for each type of currency
- Staffing levels
  - Entry-level
  - Senior-level
  - Director

You will need to determine and present relevant outcome metrics to assess the performance of your recommendations. BankOfSimio recommends considering both metrics for the entire run time but also for specific time periods in order to analyze the impacts of differing demand over time. These metrics should be presented clearly using tables, graphics, and/or dashboards.

Below is a list of scenarios that BankOfSimio requests that you consider.

<u>Business as usual (BAU)</u>

Given the system information above, determine the profit maximizing cash on hand and swap policy. Be sure to discuss the key outcome metrics.

The bank does not currently have a model like the one you've built. They choose the amount of cash on hand by looking at the largest net change in currency caused by a single client at any point throughout the day. The bank multiplies this number by 30 to approximate the worst-case

scenario accounting for all clients. Using this method, BankOfSimio determined that it should hold $3.25 trillion in USD, $2.75 trillion in GBP, and $420 trillion in JPY. How does this answer compare to yours? Why are they different? What would you tell the bank to convince them to adopt your method?

Additionally, BankOfSimio does not have much appetite for risk. They would also like to know how much extra cost is incurred to make sure they have at least $1 billion on hand at any time in each type of currency. What would you tell them?

Loss of counterparty

WorldBank is BankOfSimio's counterparty that is also a commercial entity, unlike CLS. Like all commercial entities, they can go bankrupt. When it happened to Lehman Brothers in 2008, many banks were not prepared. When a counterparty files for bankruptcy, BankOfSimio loses the ability to conduct midday swaps until they can form a partnership with another counterparty. For this stress test, turn off the ability to swap with WorldBank. How does the cash on hand differ compared to business as usual? Which values would you recommend to BankOfSimio and why? Should the staffing makeup change under this scenario?

End of day settlement policy

The scenarios listed above require the bank to reset their cash at the end of each day. The bank has always operated that way despite it not being a requirement to do so. Instead of forcing the bank to reset at the end of each day, allow their balance to carry over to the next day. This will require choosing a settlement trigger point and a settlement quantity, like the swap trigger and swap quantity. What values maximize profit for the bank? How does this system design compare to the others in terms of revenue, cost, and profit? Should the staffing makeup change under this scenario?

Additional stress tests

In addition to the above scenarios, you should also create your own stress tests that you think would be helpful. For example, things may happen in the global financial market that shift the likelihood of exchanging certain currencies.

Problem Deliverables

BankOfSimio's objective is to maximize profit while mitigating risk and minimizing time clients are waiting for their exchange. They hope to achieve this by determining the appropriate cash on hand at the start of the day for each currency type, midday swap policies for each currency type, and staffing levels. The bank is interested in understanding the process that you used to create your model and conduct your analysis. Make sure to include information on your input analysis and modeling decisions for your interarrival times, transaction sizes, proportion of transactions in each type of currency, and exchange rate. This will help BankOfSimio trust and understand your results and recommendations.

In addition to the input analysis and modeling decisions, BankOfSimio is interested in policies and understanding how the system performs under the current state of the system, the two scenarios presented, and any additional tests that you determine could be relevant. You should determine and present key performance metrics using dashboards and graphics.

You will present your methodology and analysis to BankOfSimio in a 10-minute video and 2-page executive summary, including your solutions to the challenge problems below.

Challenge Problems

Floating Staff Members

In order to increase their flexibility and employee utilization, BankOfSimio would like to explore a different type of staffing where senior-level employees and directors will help with all types of currency exchanges when the queue gets to a pre-determined length. While it is not their intention to overload the upper-level employees with lower value exchanges, they believe it may improve customer satisfaction and keep entry-level employees from being overwhelmed. Since the senior-level employees and directors have more experience, the currency exchanges that don't require additional authentication (< $75,000,000) take them less time. The authentication for exchanges over $75,000,000 is what takes most of the time so both senior-level employees and directors take approximately the same amount of time. The processing time by employee type is summarized below.

Transaction type	Staff Member	Processing Time
Exchanges below $75,000,000 (in USD)	Entry-level	Uniform(2,5)
	Senior-level	Uniform(1.6,4)
	Director	Uniform(1.4,3.5)
Exchanges above $75,000,000	Senior-level	Pert(3,5,7)
	Director	

BankOfSimio would like you to provide the new staffing levels along with policies that dictate when the senior-level employees and directors step in to help with the exchanges.

24/7 Operations

BankOfSimio is considering moving to a 24/7 operation since currency exchanges take place to support transactions that are happening all over the world. BankOfSimio would like you to answer a few questions to help them understand if they should increase their hours and how they might implement that change.

1. There is an opportunity to do a morning settlement at 6:30:00 AM EST either in addition to or in place of the evening settlement. How should BankOfSimio change its' settlement policy? Does the counterparty swap policy need to change as well?
2. What would the staffing model look like with a 24/7 operation? How many of each type of worker should they have at each shift?

BankOfSimio has never operated outside of its normal business hours before and does not have any historical data. However, they have provided some information they have gained through their market analysis for you to use in your Model.

1. BankOfSimio already has 5 additional clients who they have preliminary deals with to manage their assets if the switch to 24/7 is made. The total assets of the new clients are listed below.

Client	Total Assets Under Management (USD)
A	$904,593,676,672
B	$1,012,054,244,910
C	$1,117,669,112,905
D	$1,257,773,521,612
E	$1,274,500,328,569

2. In general, the Japanese financial markets operate between 6:00 PM EST – 4:00 AM EST and the British financial markets operated between 3:00 AM EST – 1:00 PM EST. Market research suggests that there will be a shift in transactions occurring from 8:00 AM EST – 6:00 PM EST to account for new transactions occurring overnight. Below is a table that details the expected average number of client exchanges per hour for different time periods, based on which financial markets are operating at any given time.

Start Time	End Time	Average Number of Transactions per Client per Hour
12:00 AM	3:00 AM	10
3:00 AM	4:00 AM	25
4:00 AM	8:00 AM	10
8:00 AM	1:00 PM	25
1:00 PM	6:00 PM	20
6:00 PM	12:00 AM	15

3. Market research also suggests that the percentage of exchange requests for the different currency types will vary at different times of day based on which financial markets are open. Below is a table with the estimated impact.

Start Time	End Time	Percent requests USD	Percent requests JPY	Percent requests GBP
12:00 AM	3:00 AM	30%	60%	10%
3:00 AM	4:00 AM	30%	40%	30%
4:00 AM	8:00 AM	30%	20%	50%
8:00 AM	1:00 PM	60%	10%	30%
1:00 PM	6:00 PM	70%	15%	15%

6:00 PM	12:00 AM	30%	60%	10%

BankOfSimio would like for you to Model these changes based on the expected impact of the additional clients, the number of exchanges throughout the day, and the percentage of types of currency being exchanged.

Notes

The absolute link to the exchange transaction data referenced above is cdn.simio.com/StudentCompetition/202305/2023_Spring_BankOfSimio_TransactionData.xlsx.

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