Project 3: **Regency Bank**

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Problem Statement

Regency Bank has recently acquired a portfolio of clients from Continental Bank. The acquired professional card portfolio consists of 210 clients and was worth almost $10 million in annual revenues at time of acquisition.

The main risk of migrating the corporate clients would be potential defaults on their card account, and each client has a different risk of default associated with their risk rating. Regency is interested in guidelines to help them identify which clients should be migrated.

In this report, we will use a **three-year payback value** (calculated by net profits) to evaluate the selected client portfolios to migrate. We will break the process down into the following:

1. Describe the simulation model process that we will use
2. Results of migrating all clients
3. Results of migrating clients with a risk level cut-off
4. Results of migrating clients with different policies based on risk, complexity, and size

1. Simulation Model

For any potential client, a **one-year simulation** would have the following process:

1 — Simulate spending and card number growth

2 — Simulate the occurrence of default

3 — Calculate respective costs

4 — Calculate respective revenue

5 — Calculate net profit (revenue - cost)

6 — Simulate the chance of attrition

1. Simulation Model

To evaluate the attractiveness of **one potential client over the first three years**, we would have to repeat the process listed in the previous steps three times. More specifically, the simulation model's process would:

1. Update the client data on annual spending and card number growth based on simulation
    a. Annual spending growth is a randomly generated growth with a mean of 8% and standard deviation of 1%
    b. Card number growth is a randomly generated growth with a mean of 10% and a standard deviation of 1%
2. Simulate the occurrence of default (a randomly generated binomial event based on the client's risk of default associated with their risk ranking)
    a. If the client defaulted, we would also calculate the cost of a default using the number of months that would be written off associated with their risk ranking

1. Simulation Model

3. Calculate respective costs for the client:
    a. Annual ongoing costs based on the client's complexity level
    b. Cost to issue cards based on the number of cards growth generated in step 1
    c. Cost to service cards based on the current number of cards the client currently has
    d. Cost of default if the client was simulated to default in step 2
    e. Cost of migration depending on the client's complexity level if in year 1
4. Calculate the respective revenue for the client:
    a. A flat charge of $5,000
    b. 1% of the client's annual spend
5. Calculate the net profit for the client in this year (net revenue - net cost)
6. Simulate the chance of attrition (a randomly generated binomial event with a 10% chance)
    a. The simulation stops if the client is simulated to churn
7. Repeat steps 1-6 for three times for a three-year simulation, and the **three-year sum of net profits will provide us with a metric to evaluate the client's attractiveness**.

2. Three-Year Model in Python

1. Update the client data on annual spending and card number growth based on simulation
    a. new_cards = curr_num_cards * np.random.normal(loc = .1, scale = .01)
    b. new_spend = curr_annual_spend * np.random.normal(loc = .08, scale = .01)
2. Simulate the occurrence of default (a randomly generated binomial event based on the client's risk of default associated with their risk ranking)
    a. df['Default Occurrence'] = df['Risk Rating'].map(lambda x: np.random.binomial(1, risk_data[x]['default_probability']))
3. Calculate respective costs for the client:
    a. ongoing_cost = ongoing_fc + df['Complexity Level'].apply(get_ongoing_cost).sum()
    b. card_issue_cost = new_cards.sum() * card_cost_to_issue
    c. card_service_cost = (curr_num_cards + new_cards).sum() * card_annual_service_cost
    d. default_costs = np.where(df['Default Occurrence'] == 1, (df['Annual Spend Volume'] / 12) * df.apply(lambda row: risk_data[row['Risk Rating']]['default_months'], axis=1), 0)
    e. if (year == 1):
        migration_cost = migration_fc + df['Complexity Level'].apply(get_migration_cost).sum()

2. Three-Year Model in Python

4. Calculate the respective revenue for the client:
    a. revenue = len(df) * flat_charge + spend.sum() * variable_charge
5. Calculate the net profit for the client in this year (net revenue - net cost)
    a. total_profit = total_revenue - total_cost
6. Simulate the chance of attrition (a randomly generated binomial event with a 10% chance) and update the data frame
    a. df["Attrition"] = np.random.binomial(1, attrition_rate, len(df))
    b. new_df = df[df['Attrition'] == 0]
7. Simulate three years
8. Run the three-year simulation 100 times to obtain a distribution

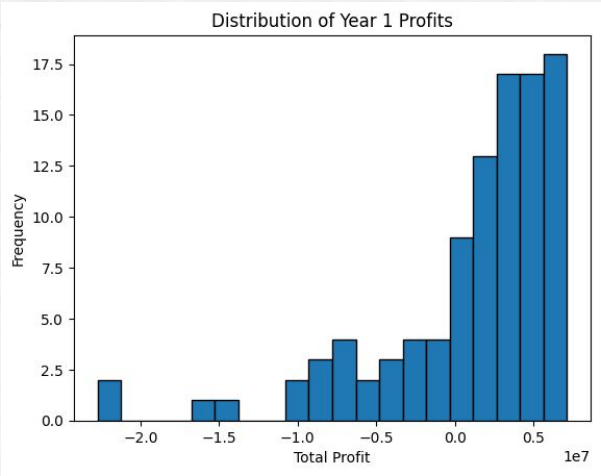
2. Three-Year Model Migrating All Clients

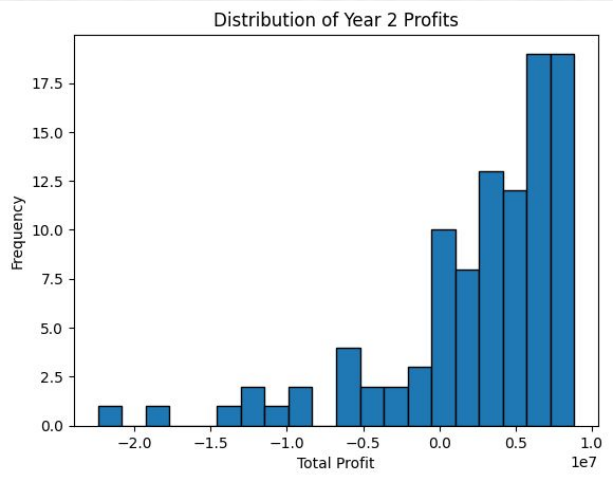
On average of our 100 three-year simulations, the net profit was **$7,153,027.43.**

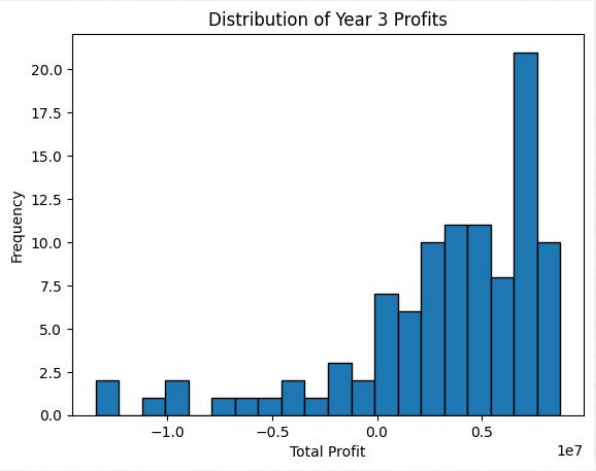
	Year 1	Year 2	Year 3	Three Year Total
Mean Cost	$8,433,294.56	$6,625,729.88	$6,537,189.64	$21,596,214.08
Standard Deviation for Mean Cost	$5,077,721.12	$4,849,681.84	$5,246,142.48	$9,190,429.14
Mean Revenue	$9,907,494.55	$9,583,599.67	$9,258,147.28	$28,749,241.51
Standard Deviation for Mean Revenue	$83,312.34	$483,023.18	$709,705.60	$1,113,334.01
Mean Profit	$1,474,199.99	$2,957,869.80	$2,720,957.64	**$7,153,027.43**
Standard Deviation for Mean Profit	$5,077,500.17	$4,873,583.99	$5,226,594.60	$9,220,941.93

2. Three-Year Model Migrating All Clients

Here is the year 1 to year 3 profit distributions of our 100 simulations:

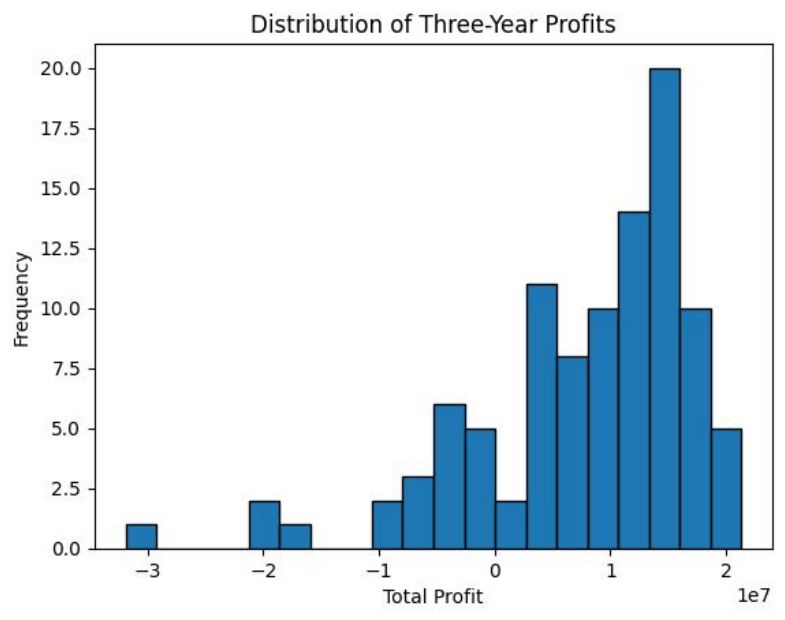






2. Three-Year Model Migrating All Clients

Here is the three-year total profit distribution of our 100 simulations:



2. Three-Year Model Migrating All Clients

Insights from our three-year simulation model migrating all clients:

Over the three years migration plan, we observe a high total cost in year 1, which is attributable to the initial migration costs. The incurring total revenue is otherwise relatively constant at around $9 million per year.

The average net profit of the three-year simulation is $7,153,027.43, which indicates profitability for Regency Bank in three years and is a positive sign for Regency Bank's decision to migrate all of the potential clients. However, the net profit does not offset the $10 million in annual revenues at time of acquisition.

Though with great potential of profits, the high standard deviation for profit still indicates potential risks and uncertainties for this migration plan. This could be associated with the high default risks of some clients, and we believe Regency Bank should investigate further into the risk rankings and its effect on profitability.

3. Optimal Customer Risk Level

Risk Level	# Clients	Year 1	Year 2	Year 3	3 Year Total
7	210	$1,474,199.99	$2,957,869.80	$2,720,957.64	$7,153,027.43
6	200	$2,444,645.07	$3,925,242.83	$3,271,262.02	$9,641,149.93
5	189	$2,723,108.23	$4,183,103.48	$3,882,594.23	$10,788,805.95
4	88	$2,901,965.82	$3,244,815.94	$2,434,204.83	$8,580,986.59
3	27	$1,724,396.60	$2,142,784.59	$2,009,408.73	$5,876,589.93
2	5	$140,717.59	$699,739.68	$656,363.36	$1,496,820.62
1	2	$-100,336.12	$390,644.56	$438,664.45	$728,972.89

The best risk level is Risk Level 4 in Year 1, and Risk Level 5 for Years 2 and 3.
The best risk level overall for the 3 Year Total is **Risk Level 5.**
Risk level 5 (migrate 189 clients) yields the highest total profit of $10,788,805.95 over three years.

3. Optimal Customer Risk Level

Comparison of best risk level and risk level 7 (migration of all customer):

Risk Level	#Clients	Year 1	Year 2	Year 3	Total Profit
7	210	$1,474,199.99	$2,957,869.80	$2,720,957.64	$7,153,027.43
5	189	$2,723,108.23	$4,183,103.48	$3,882,594.23	$10,788,805.95

Difference				
(21)	$1,248,908.24	$1,225,233.52	$1,161,636.59	**$3,635,778.52**

From our outputs, we observe that despite the reduction in the number of clients (21 fewer at risk level 5), the total profit is higher than migrating all clients by $3,635,778. As the main risk for the corporate clients comes from the risk of default, it makes sense for the implementation of a risk level cutoff to increase profits, as the cutoff eliminates some of our most risky clients.

In conclusion, Regency should carefully evaluate its risk tolerance and operational capabilities. It was mentioned in the case that Regency normally accept only those accounts with a max risk rating of 5 and preferred accounts with a rating of 4 or below. However, if Regency can afford to take on the additional risk, **accepting customers at risk level 5 or lower could be a strategic move to enhance profitability**.

4. Optimizing for Risk, Complexity, and Annual Spend Minimum

See appendix for full simulation results.

Risk Level	Complexity	Annual Spend Min	# Clients	Year 1	Year 2	Year 3	3 Year Total
5	3	$100,000	170	$3,101,478.04	$3,790,720.24	$4,149,461.04	$11,041,659.32
5	3	$150,000	162	$3,702,013.92	$4,500,714.05	$3,962,933.49	$12,165,661.46
5	3	$200,000	156	$3,140,251.43	$3,512,451.09	$3,849,071.62	$10,501,774.14
5	3	$250,000	148	$3,382,437.08	$3,852,208.72	$4,380,956.99	$11,615,602.79
5	No max	No minimum	189	$2,723,108.23	$4,183,103.48	$3,882,594.23	$10,788,805.95

Risk Threshold 5, Complexity Threshold 3 (no effective maximum), and Annual Spend Minimum of $150,000 is a more optimized migration strategy for Regency Bank.
Only customers with a risk rating <= 5 and an annual spend >= $150,000 should be migrated.
Migrating these 162 specific clients generates a 3 Year Total profit of **$12,165,661.46**.

4. Optimizing for Risk, Complexity, and Annual Spend Minimum

Comparison of optimized strategy and risk level 5 strategy from question 3:

Risk Level	Complexity	Annual Spend Min	# Clients	Year 1	Year 2	Year 3	3 Year Total
5	No max	No minimum	189	$2,723,108.23	$4,183,103.48	$3,882,594.23	$10,788,805.95
5	3	$150,000	162	$3,702,013.92	$4,500,714.05	$3,962,933.49	$12,165,661.46

Difference				
(27)	$978,905.69	$317,610.57	$80,339.26	**$1,376,855.51**

In comparison to optimizing only for risk, the more thorough optimization performs better.
The more detailed strategy results in a **$1,376,855.51** increase in profits, compared to only filtering by risk rating <= 5.

The complexity threshold is not used; limiting complexity to those <= 3 will include all customers.
However, implementing a minimum annual spend limits migrating customers to those that generate more revenue.

4. Optimizing for Risk, Complexity, and Annual Spend Minimum

Intuition:
Similar to question 3, Regency Bank must seek to avoid the most risky customers in order to maximize profit. Question 4 optimization confirms the results of question 3. Because most losses come from defaults, Regency Bank should limit migration of customers to those with a risk rating of 5 or less.

Additionally, the cost associated with complexity of an account is relatively small when compared to defaults. There is not enough reduction in profit to justify limiting migration to accounts with a lower complexity level.

Finally, some accounts do not generate enough revenue to justify migration from a profitability standpoint. By limiting migration to accounts with an annual spend volume of over $150,000, Regency Bank can ensure that these accounts will produce enough revenue to overcome the risk of default loss.

Only 162 customers meet the optimized criteria for migration, as opposed to 189 or the full 210. Despite this, migrating these 162 customers is more profitable for Regency Bank.

Consider Customer Relations:
Failing to migrate accounts simply because they are not profitable could hurt relations with customers. These corporate clients may be potential customers in other lines of business. Profits from elsewhere in the bank could offset the risk associated with migrating their card account.

Executive Summary

- **Migrating all clients:** This migration plan led to a net profit of $7,153,027.43, indicating the plan's initial success for Regency Bank, but the high standard deviation from our simulations indicates potential risks and uncertainties.
- **Optimization of risk level:** Focusing on customers at risk level 5 or below, with 189 migrated clients, Regency Bank could increase profit by $3,635,778.52, totaling $10,788,805.95. Adopting a risk level cutoff strategy to include customers only at risk level 5 or below will reduce the default risks and therefore the cost of default, contributing to our observation in increased profits.
- **Optimization by risk, complexity, and size**: Risk level and minimum annual spend are binding thresholds. To optimize profit, Regency Bank should mitigate risk by only migrating customers who are less likely to default and also generate enough revenue. In our experimentation, we found that an additional size constraint would lead to a further increase in profits by $1,376,855.51 than optimizing only by risk level, leaving a total profit of **$12,165,661.46**.

Appendix

Simulation Results for Question 4: (part 1)

risk_threshold	complexity_threshold	annual_spend_threshold	year1	year2	year3	profit	clients
4	1	100000	(265350)	247256	283961	265867	22
4	1	150000	(467708)	272159	302732	107183	20
4	1	200000	(314025)	141700	190043	17717	19
4	1	250000	(392055)	135553	243025	(13477)	17
4	2	100000	1092941	2219182	1942495	5254617	58
4	2	150000	1681746	2243638	1748423	5673808	56
4	2	200000	1659020	1923900	2277749	5860670	54
4	2	250000	1641406	2129101	1536045	5306551	52
4	3	100000	3021723	3277770	3695531	9995023	79
4	3	150000	2106572	3120545	2299088	7526205	75
4	3	200000	2532962	3723609	3477002	9733573	73
4	3	250000	2138178	3726835	3539309	9404322	71
5	1	100000	(57499)	228719	402491	573710	59
5	1	150000	(169294)	507047	267633	605385	56
5	1	200000	(123858)	278838	215748	370728	54
5	1	250000	(299694)	324607	363034	387946	48

Appendix

Simulation Results for Question 4: (part 2)

risk_threshold	complexity_threshold	annual_spend_threshold	year1	year2	year3	profit	clients
5	2	100000	873357	3034224	2059060	5966640	129
5	2	150000	1769241	2711598	2520618	7001457	124
5	2	200000	1850899	2021380	2652436	6524715	119
5	2	250000	1492056	2030662	1966592	5489309	112
5	3	100000	3101478	3790720	4149461	11041659	170
5	3	150000	3702014	4500714	3962933	12165661	162
5	3	200000	3140251	3512451	3849072	10501774	156
5	3	250000	3382437	3852209	4380957	11615603	148
6	1	100000	(332829)	194528	66465	(71836)	61
6	1	150000	(275686)	362713	236962	323988	58
6	1	200000	(289164)	146610	33758	(108796)	56
6	1	250000	(233902)	566932	(23974)	309057	50
6	2	100000	1237628	2210398	1786141	5234168	136
6	2	150000	1492016	2484233	2123880	6100130	131
6	2	200000	1360233	2208764	1950476	5519473	126
6	2	250000	1165031	2401514	2050886	5617431	118

Appendix

Simulation Results for Question 4: (part 3)

risk_threshold	complexity_threshold	annual_spend_threshold	year1	year2	year3	profit	clients
6	3	100000	2991224	3515877	3325535	9832636	179
6	3	150000	2988713	4538750	3865738	11393202	171
6	3	200000	2222136	3902383	3304658	9429177	165
6	3	250000	2469593	3349212	3112209	8931015	156
7	1	100000	(400345)	264826	359986	224467	62
7	1	150000	(148900)	293485	138633	283219	59
7	1	200000	(325171)	295461	192445	162735	57
7	1	250000	(378522)	(100335)	111509	(367348)	51
7	2	100000	1587157	1877477	2131032	5595666	141
7	2	150000	1687207	1896151	1937734	5521092	136
7	2	200000	1398277	1953583	1929452	5281311	131
7	2	250000	778433	2001628	2350882	5130944	123
7	3	100000	1343655	4123854	2657921	8125430	188
7	3	150000	2101854	3289623	2285774	7677251	180
7	3	200000	1901754	3354127	2394405	7650287	174
7	3	250000	1304214	2869574	1797286	5971074	165