Mergers and Acquisitions: Labor force and balance sheet optimization

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December 2023

1 Problem statement

The merger of Company A and Company B represents a strategic move to leverage synergies. However, the merger of two distinct corporate entities introduces complexities, particularly in aligning financial assets and effectively integrating diverse human capital. This project aims at deriving an optimization-based approach to labor force retention and asset acquisitions.

2 Relevance

The question of labor force optimization during a merger can be complex, as it requires thoughtful consideration and balance of multiple conflicting factors. Human capital is one of the most critical resources a merged company needs to manage, therefore strategic selection is crucial to ensure stability during transitions. Another important consideration is the company's ability to maximize the worth of its assets while attaining financial objectives. An unsuccessful merger risks eroding shareholder value, diminishing customer trust, and weakening employee commitment, so it is important to put in place a well-planned merger strategy, that balances financial objectives with the human element of business.

3 Data

For this project, we generated synthetic datasets to simulate the financial and employee structure of two merging companies.

- **Employee data** The first dataset contains information about the employees belonging to each company. It includes features like salary, estimated revenue, estimated severance cost, level, department, tenure, age, gender and race.
- **Demand data** The second dataset includes information on the departmental labor needs. It indicates the number of personnel of each seniority level needed in each of the company's departments.
- **Financial data** The third dataset simulates the values of the potential assets the company can stand to acquire after the merger.

4 Methodology

4.1 Model 1: Labor force optimization

We approached this challenge by developing two distinct optimization models, utilizing mixed-integer optimization techniques to ensure a rigorous and comprehensive analysis. The first model is concentrated on the workforce, imposing constraints to retain the most valuable employees whilst keeping to diversity objectives. It takes into account both employee data and departmental demand. Our objective maximizes profits while adhering to constraints like employee count limits, departmental needs, and diversity requirements. The output of the model is an optimized list of employees to keep, aimed at meeting the company's operational and strategic goals effectively. We explored four different cases for our workforce optimization model.

The formulation of the base model is given below:
Decision variables:

- $x_i \in \{0,1\}\, \forall i = 1 \ldots n$: x_i is 1 if employee i is retained, 0 otherwise.

Other variables:

- $r_i \in \mathbb{R}^{+} \forall i = 1 \ldots n$: revenue of employee i
- $c_i \in \mathbb{R}^{+} \forall i = 1 \ldots n$: salary of employee i
- $s_i \in \mathbb{R}^{+} \forall i = 1 \ldots n$: severance of employee i
- $dmax_{jk} \forall j = 1 \ldots m, k = 1 \ldots l$: Maximum number of employees of level k in department j
- $dmin_{jk} \forall j = 1 \ldots m, k = 1 \ldots l$: Minimum number of employees of level k in department j
- D_{jk} Employees of level k in department j
- $\gamma_i \in [1,5] \forall i = 1 \ldots n$: Score of employee i
- a: minimum score
- M: big-M integer, typically 1,000,000
- E_{max} Maximum number of employees

$$
\begin{aligned}
\text{maximize} \sum_{i=1}^{n} r_i x_i - \sum_{i=1}^{n} c_i x_i - \sum_{i=1}^{n} s_i (1 - x_i) \\
\text{s.t.} \sum_{x_i \in D_{jk}} x_i \geq dmin_{jk} \\
\sum_{x_i \in D_{jk}} x_i \leq dmax_{jk} \\
x_i \gamma_i \geq a - M(1 - x_i) \\
\sum_{i=1}^{n} x_i \leq Emax \\
x_i \in \{0,1\}
\end{aligned}
$$

The base model guarantees that the departmental skill needs are met, the selected employees maintain a minimum score of a, and that the total number of employees does not exceed $Emax$. It is then further extended to reflect diversity constraints, by introducting the following cases:

- **Case 1:** Basic optimized model

- **Case 2:** Diversity constraints broken down by race and gender

$$\sum_{i \in Female} x_i \geq 0.4 \sum_{i=1}^{n} x_i$$

$$\sum_{i \in AfricanAmerican} x_i \geq 0.15 \sum_{i=1}^{n} x_i$$

$$\sum_{i \in Hispanic} x_i \geq 0.15 \sum_{i=1}^{n} x_i$$

$$\sum_{i \in Other} x_i \geq 0.05 \sum_{i=1}^{n} x_i$$

- **Case 3:** Diversity constraints by enforcing a minimum ratio of non-caucasian to caucasian, as well as gender diversity

$$\sum_{i \in Female} x_i \geq 0.4 \sum_{i=1}^{n} x_i$$

$$\sum_{i \notin Caucasian} x_i \geq 0.6 \sum_{i=1}^{n} x_i$$

- **Case 4:** Diversity constraints enforcing a minimum ratio of non-caucasian to caucasian, ignoring gender.

$$\sum_{i \notin Caucasian} x_i \geq 0.6 \sum_{i=1}^{n} x_i$$

4.2 Model 2: Financial health optimization

The second model makes two key decisions: which assets the merged company should acquire, and the proportion of the funding that is secured through debt versus investors. The model aims to maximise the total value of assets, while maintaining a liquidity ratio ($\frac{\text{Total assets}}{\text{Total liabilites}}$) of at least 1 and a solvency ratio($\frac{\text{Total liabilites}}{\text{Total equity}}$) smaller than 1.

Decision variables:

- $x_i \in \{0,1\} \, \forall i = 1 \ldots n$: x_i is 1 if asset i is acquired, 0 otherwise.
- $d_i \in \mathbb{R}^{+} \forall i = 1 \ldots n$: portion of cost of acquiring asset i funded through debt
- $s_i \in \mathbb{R}^{+} \forall i = 1 \ldots n$: portion of cost of acquiring asset i funded through shareholder equity

Other variables:

- $v_i \in \{0,1\} \, \forall i = 1 \ldots n$: value of asset i
- E: maximum amount of shareholder equity that can be issued

$$\text{maximize} \sum_{i=1}^{n} v_i x_i$$

$$\sum_{i=1}^{n} v_i x_i \geq \sum_{i=1}^{n} l_i$$

$$\sum_{i=1}^{n} l_i \geq \sum_{i=1}^{n} s_i$$

$$l_i \leq M x_i \forall i = 1 \dots n$$
$$s_i \leq M_s x_i \forall i = 1 \dots n$$
$$x_i \in \{0, 1\} \forall i = 1 \dots n$$
$$l_i, s_i \geq 0 \forall i = 1 \dots n$$

We test this model under different values of M_s, which stands for the maximum amount of shareholder equity that can be issued.

5 Key Findings

5.1 Model 1

The analysis of the four cases in the workforce optimization model reveals that diversity constraints significantly influence both racial and gender composition. When specific diversity targets are set (Cases 2 and 3), there's a noticeable improvement in the overall average score, indicating a positive impact of these constraints on performance. The introduction of a non-Caucasian ratio constraint, particularly in Cases 3 and 4, significantly enhances the representation of minority groups. This approach also leads to a slight increase in gender diversity, demonstrating the effectiveness of non-explicit diversity policies. Interestingly, the allocation of employees between Company A and B shifts slightly across the different cases, suggesting that diversity initiatives might also affect organizational structure and employee distribution. However, the changes in average scores are moderate, suggesting that factors other than diversity also play a crucial role in employee performance.

Overall, our analysis of different scenarios reveals varied impacts of diversity constraints on financial performance. A case without explicit diversity policies, achieved substantial profit, serving as a baseline for comparison. In contrast, scenarios with specific diversity targets showed a decrease in profit, indicating a possible trade-off between targeted diversity measures and short-term financial performance. The case focusing solely on a non-Caucasian diversity ratio, without gender-specific targets, yielded the highest profit. This suggests that broader, less restrictive diversity policies focusing on ethnic inclusivity might offer a more effective balance between fostering workforce diversity and achieving optimal financial results. Our baseline model selects the employees based on seniority within each department and level, resulting in a profit of -26.46 million.

Table 1: Diversity breakdown by case

Case	**Hispanic**	**African American**	**Caucasian**	**Other**	**Asian**	**Male**	**Female**
Case 1	16%	19.5%	20.5%	21.7%	21.4%	49%	51%
Case 2	16.3%	18.2%	21.2%	22.1%	22.3%	48.8%	51.2%
Case 3	16.7%	19.2%	20.6%	21.9%	21.5%	48.8%	51.2%
Case 4	17.1%	19.7%	20%	22.1%	21.1%	48.1%	51.9%

Table 2: Metric breakdown by case

Case	**Company A (%)**	**Company B (%)**	**Average Score**	**Profit**
Case 1	49.4	50.6	3.4984	17.327 million
Case 2	49.6	50.4	3.5161	16.465 million
Case 3	49.8	50.2	3.5237	15.690 million
Case 4	49.8	50.2	3.5066	18.230 million

An analysis of the employees that were never selected for retention in any of the four cases indicates that the key drivers behind employee retention are salary, severance and revenue, as seen in the box-and-whisker plots shown in Figure 1.

5.2 Model 2

The results of the second optimization problem show that the highest objective value was achieved in the case with 3 million as the maximum equity issued, which led to almost every asset being selected. When increasing the maximum equity issued, we see that the objective value also increases. However, the model's emphasis on managing equity limitations reflects the real-world necessity of not diluting stock-value, and allows us to examine the trade-off between imposing this limitation and achieving a higher objective value. The baseline model's objective value for the balance sheet optimization was 4469000.0, simply selecting the most valuable assets with a liquidity ratio of one and unconstrained shareholder equity that can be issued. While this objective value is higher than our model, this solution can not be maintained in the short or long term due to an unrealistic expectation of company stock that can be issued.

Table 3: Model 2 Results

Case	Equity Max	Objective Value	Chosen Assets
Case 1	2000000	3999653.0	[1, 2, 3, 6, 9, 11, 12, 14, 16, 19, 20]
Case 2	1000000	1999890.0	[1, 2, 9, 12, 14, 17]
Case 3	3000000	5999812.0	[2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20]

6 Impact

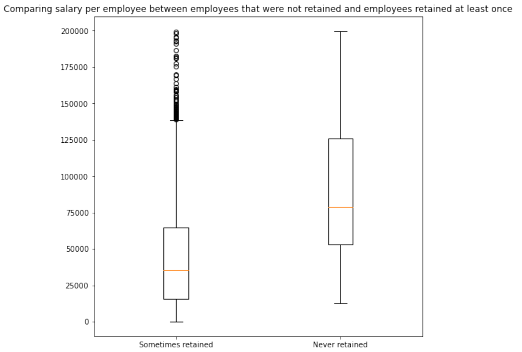
These models developed to optimize labor force and financial health showcase the benefits of an optimization-based approach over heuristics. In the case of labor optimization, we see a clear improvement over the baseline method of employee selection. The model enables decision-makers to perform employee selection in a way that meets departmental skill needs, maximizes employee revenue, and minimizes costs related to salary payments and severance. Furthermore, it allows companies to prioritize various goals regarding the diversity of the workforce.

The second model, while reaching a lower objective value than the baseline in two cases, allows stakeholders to understand the trade-off between maintaining key performance indicators, such as liquidity, solvency, and shareholder equity, and achieving a higher objective value. We observe that at optimally, the models find solutions that provide a liquidity and solvency rate of one, thus balancing the two constraints. This model allows the company to achieve the maximum value of acquired assets while maintaining healthy liquidity and solvency ratios and avoiding per-share price dilution through over-issuance of shareholder stock.

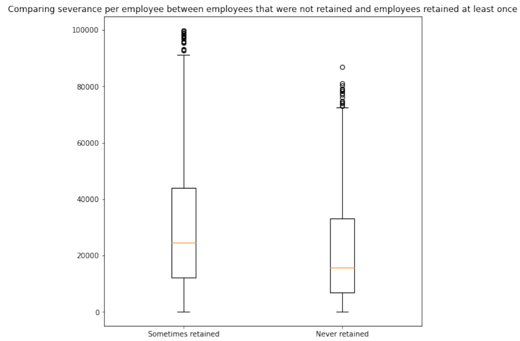
7 Conclusion

This merger optimization project showcases the power of data-driven decision-making in corporate strategy. By leveraging optimization models, we can not only anticipate the challenges of merging two companies but also proactively devise strategies to overcome them. The outcomes of this project will not only serve immediate integration goals but also lay the groundwork for continuous improvement and strategic growth in the newly merged company.

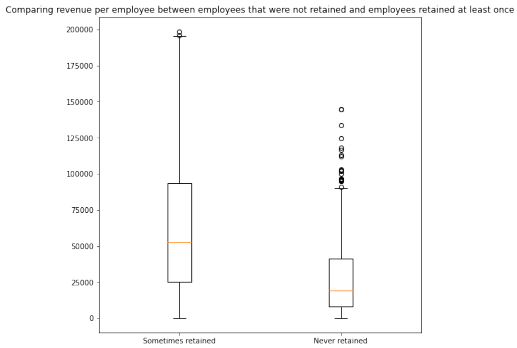
8 Appendix



(a) Salary Comparison



(b) Severance Comparison



(c) Revenue Comparison

Figure 1: Analysis of employees who were never retained