Multi-Factor Pricing Optimization Framework

E-Commerce Catalog Strategy Case Study

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1. Executive Summary

This project presents a structured pricing optimization framework for an e-commerce catalog containing multiple SKUs with varying cost structures, demand patterns, inventory levels, and competitive pressures.

The objective was to design a scalable, data-driven pricing system that:

- Protects profitability
- Responds to demand signals
- Adjusts for inventory risk
- Aligns with competitive market conditions

Instead of reactive pricing, a rule-based analytical framework was implemented to generate SKU-level recommended prices while maintaining margin discipline.

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2. Business Problem

The catalog exhibited inconsistent pricing decisions due to:

- Rapid stock-outs in high-demand SKUs
- Overstock accumulation in slow-moving products
- Misalignment with competitor price bands
- Margin erosion in high-competition segments

The company required a repeatable pricing logic that balances:

- Growth
- Profitability
- Operational stability

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3. Data Sources & Signals Used

The pricing model integrates multiple business signals:

3.1 Cost Structure

- Product Cost

- FBA Fee
- Storage Fee
- Handling Cost
- Minimum & Target Margin %

3.2 Demand Metrics

- Sessions
- Units Ordered
- Conversion Rate

Demand classification:

- STRONG (above-average conversion rate)
- WEAK (below-average conversion rate)

3.3 Inventory Health

- Days of Supply
- Sell-through metrics

Inventory classification:

- LOW_STOCK (< 30 days)
- HEALTHY (30–90 days)
- OVERSTOCK (> 90 days)

3.4 Competitive Positioning

- Average Competitor Price
- Lowest Competitor Price
- Highest Competitor Price
- Competitor Count

These define the market pricing envelope.

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4. Pricing Framework Logic

The pricing engine follows a structured sequence:

Step 1: Profitability Floor

Total Unit Cost =
Product Cost + FBA Fee + Storage Fee + Handling Cost

Minimum Price =
Total Unit Cost / (1 − Minimum Margin)

This ensures no SKU is sold at a loss.

Step 2: Target Margin Price

Target Price =
Total Unit Cost / (1 − Target Margin)

This establishes profitability objective.

Step 3: Inventory-Based Adjustment

- LOW_STOCK → Increase price (+10%)
- OVERSTOCK → Decrease price (−10%)
- HEALTHY → No change

Purpose: Balance stock pressure and capital lock-in risk.

Step 4: Demand-Based Adjustment

- STRONG demand → Increase price (+5%)
- WEAK demand → Reduce price (−5%)

Purpose: Capture willingness to pay while supporting slow movers.

Step 5: Competitive Alignment

If adjusted price:

- Exceeds 110% of lowest competitor → reposition to 105%
- Falls below 90% of average competitor → reposition to 95%
- Otherwise → maintain adjusted price

Purpose: Avoid price wars while staying market-relevant.

Step 6: Margin Protection Rule

Final Recommended Price =
MAX(Competition_Adjusted_Price, Minimum_Price)

This guarantees profit protection across all SKUs.

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5. Analytical Findings

5.1 Inventory Has Strong Pricing Influence

Low-stock SKUs supported price increases without harming competitiveness.

Overstocked SKUs required margin sacrifice to improve inventory velocity.

5.2 Demand Signal Improves Precision

Conversion rate effectively differentiated pricing power across SKUs.

High-demand products tolerated moderate price increases.

5.3 Competitive Pressure Limits Aggression

High competitor density constrained upward pricing flexibility.

Low competition SKUs allowed improved margin capture.

5.4 Margin Discipline Maintained

No SKU was recommended below minimum viable pricing threshold.

Profit integrity was preserved across the catalog.

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6. Business Impact Simulation (Framework-Based)

Using historical sales volumes:

Estimated outcomes include:

- Improved margin capture in strong-demand SKUs
- Reduced capital lock in overstocked items
- Controlled competitive drift
- Standardized pricing governance process

The framework enables consistent decision-making rather than manual reactive adjustments.

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7. Strategic Insights

- Pricing must integrate operational signals, not just cost
- Inventory risk and demand elasticity are interconnected
- Competitive benchmarking must be guided, not blindly followed
- Structured pricing improves scalability in growing catalogs

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8. Limitations & Future Enhancements

Future improvements could include:

- Demand elasticity modeling
- Predictive demand forecasting
- Weighted scoring models
- Dynamic ad-performance integration
- Scenario simulation dashboards

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9. Conclusion

This project demonstrates the development of a multi-signal pricing optimization framework combining financial discipline with operational intelligence.

The model is:

- Scalable
- Transparent
- Data-driven
- Business-aligned

It provides a structured foundation for evolving toward more advanced predictive pricing systems.

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10. Appendix

10.1 Formula Logic (Very Important)

Put your core formulas clearly written.

Example:

Total Unit Cost

= Product Cost + FBA Fee + Storage Fee + Handling Cost

Minimum Price

= Total Unit Cost / (1 - Minimum Margin %)

Target Price

= Total Unit Cost / (1 - Target Margin %)

Final Price

= MAX(Competition_Adjusted_Price, Minimum_Price)

This shows transparency. Recruiters love that.

10.2 **Demand Classification Logic**

Explain how you defined STRONG vs WEAK demand.

Example:

Conversion Rate = Units Ordered / Sessions

Demand Flag = IF(Conversion Rate >= Average Conversion Rate, STRONG, WEAK)

Or explain percentile logic if you upgrade it later.

10.3Inventory Categorization Rules

Show this clearly:

- LOW_STOCK → Days of Supply < 30
- HEALTHY → 30–90
- OVERSTOCK → > 90

This proves your decision thresholds are intentional.

10.4 **Competition Adjustment Rules**

Document your guardrails:

- Price > 110% of Lowest Competitor → Reduce
- Price < 90% of Average Competitor → Increase

This shows structured reasoning.

10.5 **Assumptions**

This is powerful. Many students skip it.

Example:

- Demand elasticity assumed constant
- Historical sales assumed representative
- No seasonality adjustment applied
- Advertising impact not directly modeled in final price

This makes you look like someone who understands model limitations.

10.6 **Dataset Overview (Optional but Strong)**

Add a small summary table:

Dataset	**Purpose**	**Key Fields Used**
Pricing_Data	Cost & margin baseline	Cost, Fees, Margins
Historical_Sales	Demand signal	Sessions, Units
Inventory_Health	Stock risk	Days of Supply
Competitor_Data	Market benchmarking	Avg Price, Lowest Price