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DA 282 - Business Analytics

Final Project Report

**Clothing Inventory & Sales Analysis (2014 - 2025)**

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**1. Introduction:**

Managing inventory has always been a pressing challenge for retailers in general, and for clothing retailers in particular. While necessities can be demanded year-round, demand for clothing is tied closely to trends, seasons, and the timing of consumer purchases. Therefore, when clothing retailers misallocate their inventory, the impact on the retailers is severe. They would face substantial costs related to holding excess inventory, markdown costs, and lost revenue opportunities from unfulfilled inventory.

Research conducted within the clothing industry shows that much of the problems currently facing retailers in terms of inventory are the result of a mismatch between when clothing inventory is being purchased and when consumers are purchasing items. Specifically, according to McKinsey and Company, many retailers increased inventory levels aggressively despite signs of declining consumer demand, thus leading to increased markdowns resulting from excess inventory levels across the industry and a downward trend of margin pressure (McKinsey & Co., 2023).

These industry concerns are also reflected in national retail data. The U.S. Census Bureau Monthly Retail Trade Survey indicates that in addition to the significant fluctuations in Clothing Retail Sales from month to month, there is also slow adjustment to inventories, causing retailers to hold inventories for longer than needed as sales begin to decline (U.S. Census Bureau, 2025). Holding inventories for a long time can increase carrying costs and forces retailers to implement clearance strategies, which erode overall profitability.

These findings together suggest that the problems clothing retailers are experiencing with managing their inventory volume not only from the amount of sales they are generating but also from when the efficiency of decisions surrounding that inventory have been made which are related to demand. While most of the past research and report has focused on the identification of issues, including high inventory, markdown pressure from the retailers, and seasonal demand fluctuations, they do not include specific measures of how inventory behaviour impacts sales performance over time.

This study determines whether the change in level of inventory and inventory efficiency affect the sales performance. Using data from 2014 to 2025 and drawing on the national average, this study provides a quantitative measure as to how the timing and efficiency of inventory activity impacts the sale performance of apparel retailers.

## 2. Purpose and Research Questions:

This research project aims to improve the understanding of how clothing retailers make inventory decisions that impact both sales performance and operational efficiency. Retailers invest a significant amount of money in their inventory, and making poor timing decisions regarding inventory may lead retailers to incur additional holding costs, aggressive markdowns, and lose revenue opportunities due to lack of stock on-hand. The goal of this project is to provide valuable, actionable insight and analysis to clothing retailers on how they can make better informed decisions regarding inventory.

In contrast to simply evaluating whether sales volume is increasing or decreasing, this project will go deeper and evaluate how inventory behaviour influences sales volume. This understanding will help retailers transition from reacting to the market through markdowns to proactively planning their inventory decisions based upon expected demand.

The key research question guiding this analysis is:

**How can clothing retailers adjust their inventory decisions to drive improved sales performance**

**and operational efficiency?**

To answer this question, the analysis will explore several supporting questions:

1.      How does inventory and sales change across the year?

2.      How efficiently is inventory converted into sales over time?

3.      How do changes in inventory levels and inventory efficiency affect sales performance?

Clothing retailers have an operational problem with balancing inventory against highly variable and frequently uncertain demand. The insights from this analysis will help businesses with the decision making. They enable retail managers and operation teams to identify when the growth of inventory is likely to be misaligned with the demand from consumers, marketing teams with better time promotions and clearance strategies, and finance teams with mitigating cash flow pressure due to excess inventory.

**3. Data Description**

This project utilizes data from the U.S. Census Bureau's Monthly Retail Trade Survey, specifically the Clothing & Clothing Accessories Stores category. Data was collected by the U.S. Census Bureau for analyzing and tracking retail activity and supporting economic analysis and policy initiatives.

The dataset includes all January to December monthly observations of Clothing and Clothing Accessories Stores in the U.S. from 2014 to September 2025. The long time horizon provides a full view of typical seasonal patterns of sales and inventory fluctuation, but also allows for examination of other major disruptions that may have occurred such as the COVID-19 pandemic.

**Key Variables**

There are four main variables that will be analyzed:

●      Monthly Sales (USD): Total amount of Sales Revenue generated by clothing retailers.

●      Monthly Inventory (USD): Total value of Inventory held by clothing retailers.

● Inventory-to-Sales Ratio: A measure of the business's efficiency, calculated as inventory divided by sales.

● Δ Inventory: Month to month change in Inventory

Summary statistics show that both Sales and Inventory show significant seasonal variation while the Inventory-to-Sales Ratio appears to be relatively constant during normal months.

**Limitations of this study:**

Some limitations of this study need to be brought out:

● The dataset is aggregated at a national level and therefore does not indicate how differences across individual retailers, regions, and business models will affect sales and inventory.

● The current study does not include pricing, promotions, labor costs, and other macroeconomic variables, which could also have an impact on Sales and Inventory.

Despite these limitations, the dataset is suitable for analyzing broad industry level patterns and long-term trends in this project.

## 4. Analytic Methods

This project shows the combination of descriptive and inferential analytic methods.

● Descriptive Statistics and Visual Analysis

Monthly Average Sales and Inventory throughout the years were analyzed to understand seasonal trends and recurring patterns. Line charts were used for visual representation.

● Inventory Efficiency Ratio Analysis

The analysis of the inventory-to-sales ratio over time to assess how efficiently inventory is turned into sales and to identify times of operating difficulty, and it was visualized through a line chart.
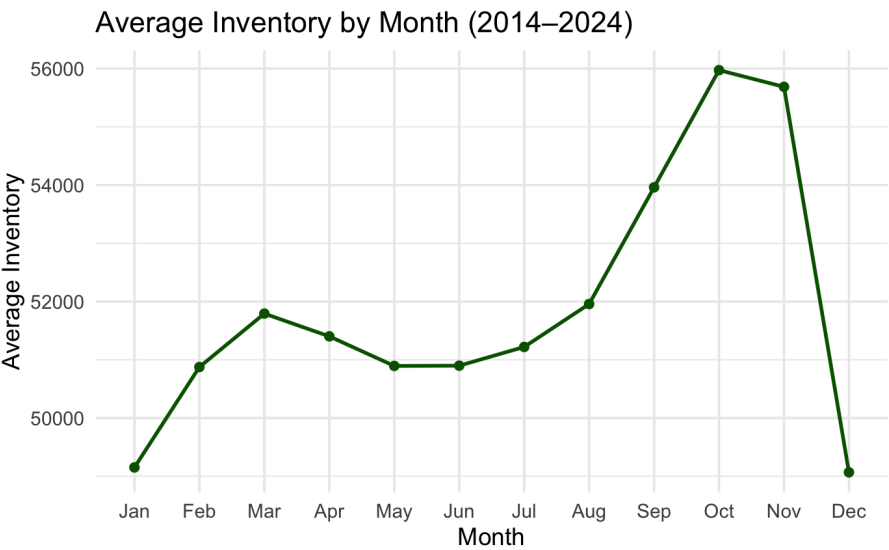
● Linear Regression Modelling and Correlation

A multiple linear regression model with sales as the dependent variable and two independent variables which are the change in inventory, and inventory-to-sales ratio. This model was developed because it

provides insights to quantitatively measure how the behaviour of inventory statistically impacts sales and allows for control of multiple variables at the same time. The correlation was used before doing the linear regression to avoid multicollinearity.
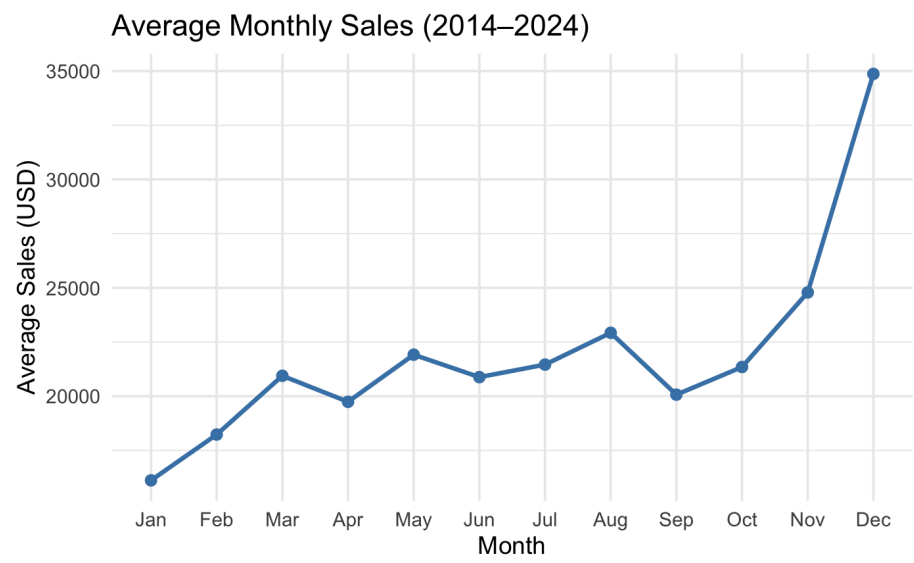
## 5. Analysis and Results

**Inventory Patterns**

Average Inventory by Month (2014–2024)



There is a consistent seasonal pattern of inventory levels in the clothing retail industry. Retailers tend to increase their inventory during the period of September to November to prepare for the increased sales in the holiday season. This indicates a structured and planned inventory management system as they develop long-term plans to see the amount of inventory should be stocked, rather than based on short-term fluctuations in demand levels or prices.

In contrast, December and January showed significant reduction in the volume of inventory available due to the high volume of sales in the holiday season. In order to maximize profits and minimize costs associated with holding merchandise that has low demand, retailers maintain inventory after the holiday season at a very low level. This minimizes the holding costs and avoids excess stock in the weak demand months.
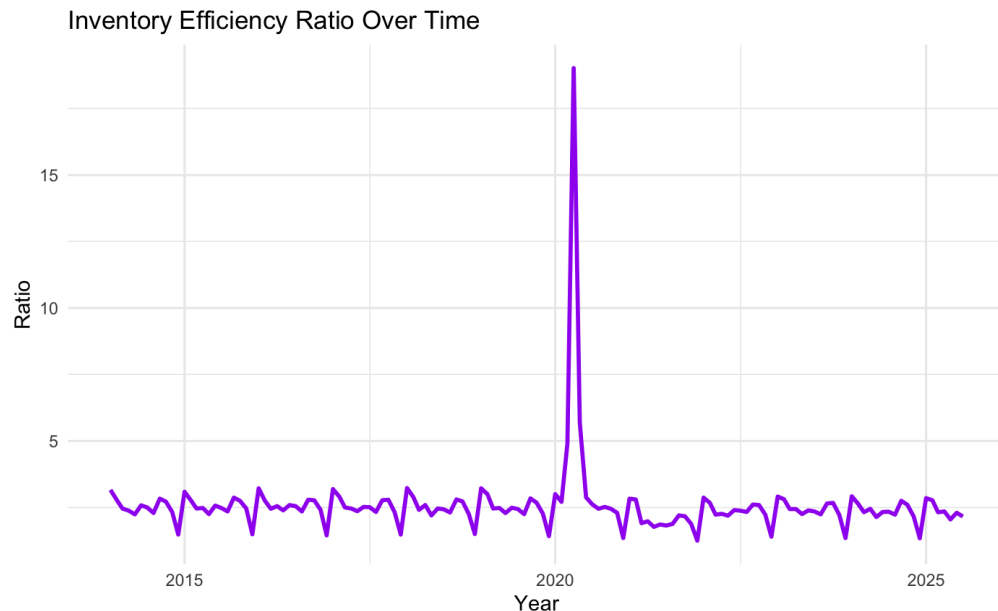
**Sales Trends**

### Average Monthly Sales (2014–2024)



Seasonal sales of clothing generally follow strong, predictable, and consistent patterns. The highest increase of sales is shown in October to December. December is the highest sales month for clothing retailers on average with sales typically ranging from 40% to 70% above the average annual sales, indicating the significant impact of the holiday shopping season on the overall clothing market. As a result of both the post-holiday spending hangover and less demand for new clothing due to previously purchased new items during the holiday season, January and February tend to see the lowest levels of sales activity.

Between March and September, clothing sales tend to stay fairly stable and moderate with only a small amount of month-to-month sales growth, and it only has large increases in sales in the fall months. The patterns show that the demand for clothing comes from many seasonal events, such as promotions, holiday shopping, and gift giving, rather than from continually purchasing clothing on an ongoing basis.

**Inventory Efficiency**

Inventory Efficiency Ratio Over Time



Through most of the time period from 2014 to 2025, the inventory-to-sales ratio is relatively stable as it usually has a range between 2 and 3. This shows that clothing retailers generally keep the balance between inventory and sales volume throughout most of the time period.

In 2020, this ratio between inventory and sales experienced a dramatic jump due to huge drop in sales, but the inventory levels did not decrease. The pandemic caused an immediate decrease in consumer demand, creating a surplus of inventory, and therefore, causing an extremely high ratio for 2020.

However, the inventory efficiency ratio was back to being within the normal range for this industry shortly after 2020. This indicates the quick return of efficient inventory management practices after the pandemic caused a temporary disruption to the industry. Hence, while retailers experienced a short-term disruption of the supply chain, they were able to manage their inventory levels and restore the efficient flow of commerce once demand stabilized.

**Regression and Correlation Results**

|  | Estimate | p-value |
|---|---|---|
| **Intercept** | 26806.96 | <0.001 |
| **Change in Inventory** | -1.36 | <0.001 |
| **Ratio** | -1787.78 | <0.001 |

**Adjusted R-squared:** 0.6671

Correlation analysis was conducted prior to performing regression analysis on sales. A moderately strong negative correlation between sales and changes in inventory with $r = -0.64$ and inventory to sales ratio with $r = -0.58$ indicates that excess inventory and rapid inventory growth are negatively correlated with sales. Additionally, the correlation between the two inventory predictors is weak with $r = 0.13$ indicating limited potential for multicollinearity so they can both be included in the regression analysis together.

As this provides evidence related to the relationship between the behaviours of inventories having an impact on sales, multiple linear regression analysis was utilised to analyse whether the behaviours of inventories have a direct effect on sales. The regression model has two predictors: the change in inventory and the inventory to sales ratio. Both prediction variables were statistically significant with the p-value < 0.001, indicating that inventories impact the outcome of sales. The model also has an adjusted $R^2$ of 0.6671, suggesting that approximately 66.7% of the variation in sales is explained by these two variables, providing a strong explanation of sales variation.

The results from the regression analyses support the conclusion that when inventories are increasing greater than average, sales will be decreasing, showing that retailers over-predict demand. The higher the inventory to sales ratio of a retailer will negatively affect sales, which means that holding too much inventory in relation to demand will negatively affect the performance of that retailer. Therefore, we can conclude that the actual amount of inventory held by retailers is not really a concern, but when inventory should be stocked in alignment with demand of consumers is of more concern.

**6. Conclusion and Future Work:**

This project analyzed the effect of inventory behaviour on US clothing retailers using national data from 2014 to 2025. Our research indicated that the way retailers manage their inventories greatly affects how much sales they will get, with a strong emphasis on when and how efficiently retailers maintain their inventories relative to consumer demand. In particular, retailers who add inventories at inappropriate times and do not match the consumer demand would experience more significant declines in sales.

Our analysis also provides evidence that the clothing retail sector has great seasonal sales patterns, which peak around the holidays, and increasing inventory prior to the holiday season and a reduction in inventory afterward. Consequently, while it is anticipated that retailers will sell more during the holiday season than during other times of the year, the regression and correlation findings demonstrate that when an increase in inventory occurs faster than the increase in demand for clothing, it can negatively impact clothing sales. Therefore, excess inventory is an indication of misalignment with consumer demand and is not indicative of an opportunity for additional revenue for retailers.

The results of this study can be applied in various ways with the business impacts. By aligning inventory planning with anticipated seasonal demand, operations teams are able to develop better schedules for purchasing products, while marketing teams can time promotions and clearances. In addition to assisting the operations and marketing departments, finance departments will benefit from having less inventory on hand that is not generating sales, and therefore, less risk associated with markdowns. To manage inventory effectively, it is essential for all departments to work together to develop a coordinated approach to inventory management and make proactive data-driven decisions.

To enhance future sales forecasting accuracy, additional studies should focus on enhancing sales forecast accuracy by utilizing more sophisticated forecasting methodologies that can accommodate seasonal demand patterns. Research conducted by Industry analysts indicate that it is preferred to broaden

the forecasting model beyond historical sales trends. McKinsey & Co. (2023) notes that greater accuracy in retail demand forecasting occurs when the retailer incorporates promotional prices, thereby providing an opportunity to measure short-term sales fluctuations to consumer response to discounts and promotional campaigns. In addition, enhancing the forecasting models with a more granular retailer-level analysis of purchasing behavior is likely to improve the predictive accuracy and support in developing better inventory plans.

Additionally, I would want to include different variables besides seasonal demand in sales forecasting models. Stock and Watson (2003) concluded that incorporating macroeconomic indicators such as inflation rate, interest rate, and consumer confidence increase the model's performance by reflecting the larger economic environment impacting consumer spending over and above seasonal demands. In addition, these macroeconomic variables can be beneficial for explaining demand changes experienced during periods of economic expansion or contraction.

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