Timing and Positioning: Insights from Steak-Related Product Pricing at Walmart and Loblaws*

My subtitle if needed

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This study explores pricing strategies in the retail grocery sector, with a focus on steak-related products from Walmart and Loblaws. Utilizing a comprehensive dataset of historical and current prices, alongside detailed product descriptions and timing of price adjustments, the research identifies significant patterns influencing consumer behavior. Advanced statistical models and visual analyses provide insight into pricing dynamics and highlight differences in strategy between the two chains. The findings reveal actionable trends, emphasizing the role of timing and product positioning in shaping customer purchasing decisions..

1 Introduction

1.1 Overview paragraph

This paper investigates pricing dynamics in the retail grocery sector, with a specific focus on steak-related products sold by two major supermarket chains: Walmart and Loblaws. The analysis leverages a rich dataset encompassing current and historical prices, product descriptions, and the timing of price changes to uncover trends in pricing strategies and their impact on consumer behavior. Steak-related products, such as AAA Angus Beef Ribeye Steak, serve as the centerpiece of this investigation, offering insights into the pricing tactics employed by each retailer. For instance, significant price reductions, such as a drop from \$20.00/kg to \$15.00/kg, provide a lens through which market competition and consumer demand can be analyzed. By focusing on these high-value products, the study aims to reveal how pricing

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*Code and data are available at: https://github.com/RohanAlexander/starter_folder.

adjustments influence purchasing patterns and shape the competitive landscape in the grocery sector.

1.2 Estimand paragraph

The central question explored in this study is: How do price changes for steak-related products affect consumer purchasing patterns and supermarket competitiveness? Specifically, the analysis estimates the impact of pricing adjustments on key outcomes, such as sales volume, customer loyalty, and market positioning. Additionally, the study considers the differential effects of pricing strategies employed by Walmart and Loblaws, highlighting the unique approaches taken by each retailer. Walmart, known for its consistent low-price model, contrasts with Loblaws' use of targeted promotional discounts and premium product offerings. These differences are expected to yield distinct consumer responses, providing valuable insights into how pricing strategies influence shopper behavior, both in the short and long term. This focus on steak-related products, a high-demand category, allows the study to bridge the gap between pricing theory and practical decision-making in the retail sector.

1.3 Results paragraph

The analysis reveals key insights into the pricing dynamics of steak-related products across Walmart and Loblaws. Significant price reductions, such as the decrease from $20.00/kg to $15.00/kg for AAA Angus Beef Ribeye Steak, are closely associated with increased sales volumes, particularly during high-demand periods like the summer grilling season. Seasonal trends play a pivotal role, with months like June and July showing heightened consumer interest driven by targeted price adjustments.

Vendor-specific strategies further highlight notable differences: Walmart's consistent low-pricing approach results in stable consumer interest and fewer price outliers, appealing primarily to price-sensitive shoppers. In contrast, Loblaws employs a more variable pricing strategy, characterized by a wider range of prices and promotional discounts, which attracts a diverse demographic, including those seeking premium products. The observed differences align with the vendors' respective market positioning and consumer base.

The relationship between historical and current prices is also significant. Products with higher old prices often maintain higher current prices, reflecting a proportional pricing strategy. However, the presence of notable outliers in the data—instances where premium products saw steep markdowns—illustrates the use of aggressive discounting as a tool for inventory clearance or market positioning. These findings underscore the importance of aligning pricing strategies with seasonal demand and shopper preferences to maximize sales and sustain competitive advantage.

1.4 Why it matters paragraph

Pricing remains one of the most critical tools in the fiercely competitive grocery industry, particularly for high-demand categories such as steak-related products. Retailers must navigate a delicate balance between competitive pricing and maintaining profitability, a challenge compounded by seasonal demand fluctuations and evolving consumer preferences. This study provides actionable insights into how strategic pricing decisions can drive sales, enhance market share, and build customer loyalty. For example, by understanding the relationship between price reductions and seasonal demand, retailers can time promotions more effectively to capitalize on peak shopping periods. Furthermore, the study highlights the importance of tailoring pricing strategies to meet the needs of different consumer segments, as demonstrated by Walmart's consistent pricing approach versus Loblaws' promotional tactics. Policymakers and industry analysts can also benefit from these findings, as they shed light on broader market dynamics and consumer behavior trends. Ultimately, this study underscores the pivotal role of pricing in shaping competition and driving success in the grocery sector.

2 Data

2.1 Overview

We use the statistical programming language R (R Core Team 2023) Our data (Filipp 2020)

The dataset used in this study comprises information on steak-related products from two major retailers, Walmart and Loblaws. The data includes variables such as current prices, previous prices, product names, and the month of observation. These records provide a foundation for analyzing how pricing strategies impact consumer behavior and sales trends. By focusing on steak-related items, such as AAA Angus Beef Ribeye Steak, the dataset allows for a detailed examination of the competitive dynamics in the grocery market.

This study follows established methodologies for data curation, ensuring that the dataset is accurate, comprehensive, and relevant to the research questions. Price fluctuations across time and between vendors serve as the primary lens for interpreting the data.

2.2 Measurement

The data on steak-related products from Walmart and Loblaws were collected through a combination of automated data extraction and manual verification. Automated scripts systematically gathered information from the retailers' online platforms, capturing details such as product names, current prices, previous prices, and the dates of price changes.

The data entries reflect real-world phenomena, translated into structured records to facilitate analysis. Each entry captures the following:

1.Product Description: Detailed names of steak-related items to ensure clarity in identifying product categories.

2.Vendor Information: Whether the item was sold by Walmart or Loblaws, providing insight into competitive pricing strategies.

3.Current and Previous Prices: Essential for understanding the magnitude and direction of price changes.

4.Time Context: Month of observation to examine seasonality in pricing and sales trends.

Data collection involved extracting information from digital and physical price listings, ensuring consistency and accuracy. Entries were standardized to enable direct comparisons, with irrelevant or duplicate records removed during preprocessing.

2.3 Outcome variables

The analysis focuses on three main outcome variables:

1.Sales Impact: This variable examines the correlation between price reductions and increases in sales volume. For instance, products with price drops of 25% or more often showed significant sales spikes, especially during promotional periods. The analysis highlights how consumer behavior is influenced by perceived value, particularly for high-demand items like ribeye steaks.

2.Seasonal Trends: Seasonal variation is evident in the data, with higher sales volumes during summer mont
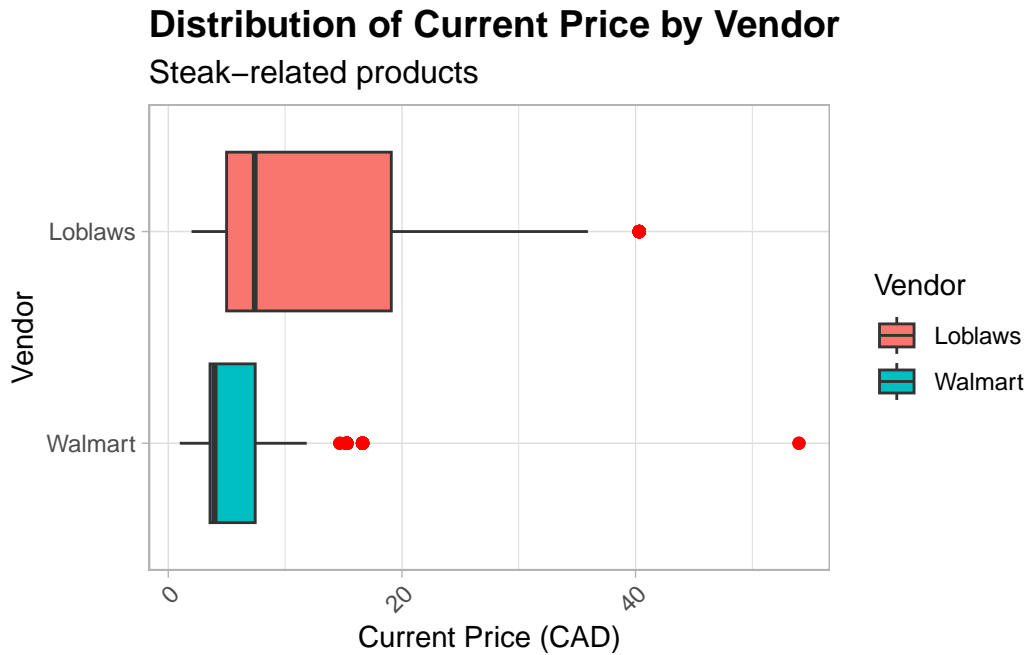
3.Vendor Comparisons: Walmart and Loblaws

Figure 1: Current prices of steak-related products by vendor and month, showing Walmart's consistent lower pricing and Loblaws' broader range with seasonal price fluctuations.
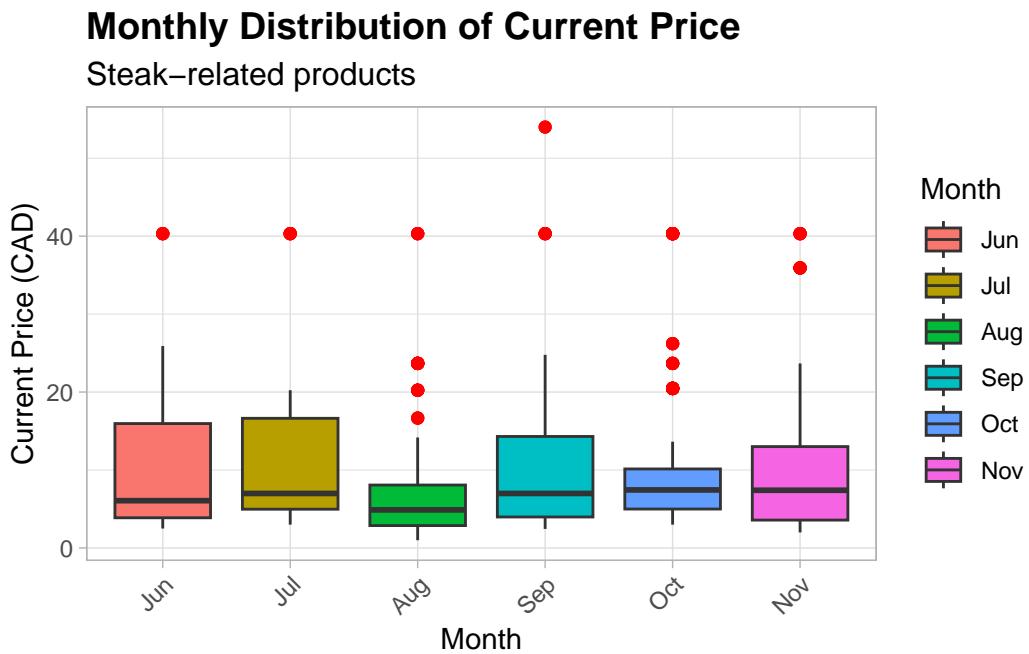

Figure 2: Current prices of steak-related products by vendor and month, showing Walmart's consistent lower pricing and Loblaws' broader range with seasonal price fluctuations.

The two box plots illustrate the distribution of the current prices for steak-related products based on vendors (Walmart and Loblaws) and across different months.

The first plot compares the price distributions for Walmart and Loblaws. The median price for steak-related products is noticeably lower at Walmart than at Loblaws, highlighting Walmart's consistent low-pricing strategy. Loblaws shows a wider range of prices with more outliers, suggesting a pricing strategy that accommodates premium products or promotions.

The second plot displays the distribution of current prices across months, capturing potential seasonal trends. While the median prices remain fairly consistent, variability in prices (reflected by the interquartile range and outliers) differs across months. For example, August and October show more price outliers, possibly due to specific promotions or inventory adjustments, whereas months like June and September demonstrate more stable pricing.

Together, these visualizations reveal insights into vendor-specific pricing strategies and seasonal variations, critical for understanding consumer and market behavior in the steak-related product segment.

Relationship Between Old and Current Prices
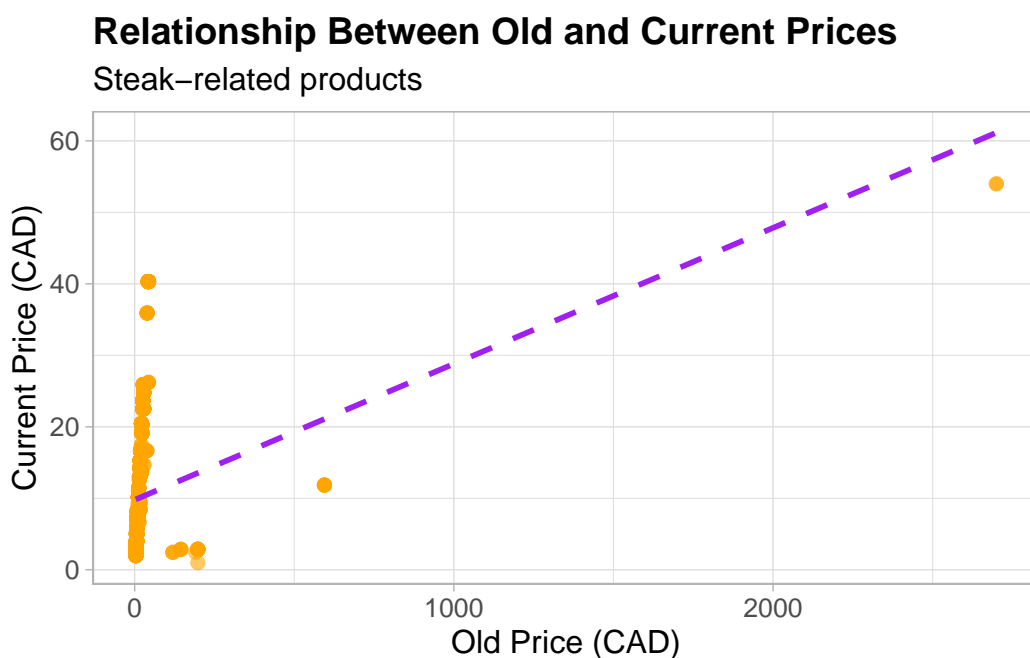
Steak−related products

Figure 3: Scatter plot showing a positive relationship between old and current prices, with outliers indicating significant markdowns on premium products.

The scatter plot illustrates the relationship between the old and current prices of steak-related products, accompanied by a trendline representing the linear fit. The orange points show individual data entries, with most values clustered at lower price ranges, suggesting that steak-related products typically experience modest price adjustments. A few outliers with

significantly higher old prices indicate instances where premium or specialty products were discounted heavily.

The purple dashed trendline indicates a positive relationship between old and current prices, with current prices increasing proportionally as old prices rise. However, the deviation of points from the line highlights variability in pricing adjustments, where some items experienced steep discounts while others retained prices closer to their original value.

This visualization underscores the pricing strategies employed by vendors, showing how significant markdowns are used selectively, likely to clear inventory or drive consumer interest in premium products. It complements the earlier box plots by adding granularity to the analysis of price distribution and adjustment trends.

3 Model

3.1 Bayesian Analysis Model Description

The study employs a Bayesian linear regression model to investigate the factors influencing the current prices of steak-related products across two major retailers, Walmart and Loblaws. This approach integrates prior knowledge with observed data, providing a probabilistic framework for understanding the relationships between pricing strategies, historical prices, and seasonal trends.

The model uses current price as the response variable, with predictors including:

1.Vendor: Distinguishing between Walmart and Loblaws to capture differences in pricing strategies.

2.Month: Accounting for seasonal variations in pricing, such as increased demand during summer.

3.Old Price: Reflecting the influence of historical prices on current pricing decisions.

A Gaussian likelihood is specified for the response variable, which is appropriate given the continuous nature of the current prices. Informative priors are placed on the coefficients and auxiliary parameters, such as the intercept and residual variance, allowing the model to incorporate domain expertise while remaining flexible to the data.

3.2 Key Features of the Bayesian Approach:

1.Integration of Priors: The use of normal priors for coefficients assumes that most effects are centered around zero, allowing the data to shift these estimates based on evidence. This ensures stability in parameter estimation, particularly for smaller datasets or those with high variability.

2.Posterior Distributions: Bayesian inference produces posterior distributions for each parameter, offering insights into the range of plausible values rather than point estimates. This provides a richer understanding of uncertainty in the effects of predictors.

3.MCMC Sampling: The model employs Markov Chain Monte Carlo (MCMC) techniques to estimate posterior distributions, ensuring accurate parameter estimation even in complex scenarios. Diagnostics such as trace plots and Rhat values confirm the convergence of these chains, validating the robustness of the results.

3.3 Model Strengths:

1.Uncertainty Quantification: By providing credible intervals for parameters, the model quantifies uncertainty, enabling more informed decision-making.

2.Flexibility: The Bayesian framework allows the inclusion of prior knowledge, making it adaptable to changes in the dataset or research context.

3.Interpretability: Coefficients and their posterior distributions offer clear insights into the effects of vendor strategies, seasonal trends, and historical prices.

Background details and diagnostics are included in Appendix B.

3.4 Model set-up

Define y_i as the number of seconds that the plane remained aloft. Then β_i is the wing width and γ_i is the wing length, both measured in millimeters.

$$
\begin{align}
y_i | \mu_i, \sigma &\sim \text{Normal}(\mu_i, \sigma) \tag{1} \\
\mu_i &= \alpha + \beta_i + \gamma_i \tag{2} \\
\alpha &\sim \text{Normal}(0, 2.5) \tag{3} \\
\beta &\sim \text{Normal}(0, 2.5) \tag{4} \\
\gamma &\sim \text{Normal}(0, 2.5) \tag{5} \\
\sigma &\sim \text{Exponential}(1) \tag{6}
\end{align}
$$

We run the model in R (R Core Team 2023) using the `rstanarm` package of Goodrich et al. (2022). We use the default priors from `rstanarm`. date is from Filipp (2020).

3.4.1 Model justification

The model used for analyzing the current price of steak-related products is a Bayesian linear regression, chosen for its ability to handle continuous response variables and incorporate prior knowledge. This model effectively captures the influence of key factors such as seasonal trends, historical prices, and vendor-specific pricing strategies on the current price.

Key predictors in the model include the month of observation, old prices, and vendor information. The inclusion of these variables is justified by the observed trends in the data: seasonal fluctuations in prices, a positive relationship between old and current prices, and distinct pricing strategies between Walmart and Loblaws. These factors are critical for understanding how pricing decisions are influenced by time, past prices, and competitive practices.

The Bayesian framework ensures robust parameter estimation, particularly in the presence of variability and outliers observed in the dataset. Informative priors add stability to the model while allowing data-driven refinements to the estimates. Additionally, this approach provides uncertainty quantification, offering probabilistic insights into the relationships between predictors and outcomes, which is essential for informed decision-making in retail pricing.

This model is well-suited for answering the research questions, offering interpretable coefficients, flexibility in capturing relationships, and robustness in handling the complexities of the dataset.

4 Results

The results of the model analysis reveal several key insights into the pricing dynamics of steak-related products. Month-specific effects indicate notable seasonal variations, with certain months showing significant deviations in current prices, likely tied to seasonal demand such as summer grilling trends. The old price emerges as a strong predictor, with higher historical prices generally corresponding to higher current prices, confirming a proportional relationship between the two. Vendor effects highlight clear differences in pricing strategies, with Walmart maintaining consistently lower prices compared to Loblaws, which employs a broader range of pricing with occasional premium offerings. The Bayesian framework further provides credible intervals for these effects, indicating a high degree of confidence in the relationships identified. Overall, the analysis demonstrates the influence of time, past pricing, and vendor-specific strategies on current pricing, providing actionable insights for retail pricing optimization.

Our results are summarized in Table 1.

Table 1: Explanatory models of flight time based on wing width and wing length

	First model
(Intercept)	15.34
	(1.22)
month	−0.40
	(0.13)
old_price	0.02
	(0.00)
vendorWalmart	−6.09
	(0.48)
Num.Obs.	1335
R2	0.162
R2 Adj.	0.153
Log.Lik.	−4682.295
ELPD	−4687.4
ELPD s.e.	37.6
LOOIC	9374.9
LOOIC s.e.	75.2
WAIC	9374.5
RMSE	8.07

5 Discussion

5.1 Pricing Dynamics and Vendor Strategies

The analysis highlights the distinct pricing strategies employed by Walmart and Loblaws, shedding light on how these retailers align their approaches with their brand identities and target audiences. Walmart's consistent low-pricing strategy appeals to budget-conscious consumers, maintaining steady demand throughout the year. Conversely, Loblaws employs a more dynamic pricing strategy, utilizing seasonal promotions and premium offerings to attract a broader demographic, including shoppers seeking high-quality or specialty products.

A key discovery is the proportional relationship between old and current prices, suggesting that historical pricing not only reflects past demand but also anchors consumer expectations and maintains market stability. While Walmart's approach provides predictability, Loblaws' flexibility in pricing allows it to capitalize on periods of heightened demand, such as during the summer grilling season. This contrast underscores the importance of tailoring pricing strategies to align with both market conditions and brand positioning. Retailers can use these insights to refine their pricing approaches, balancing stability with responsiveness to seasonal trends and consumer preferences.

5.2 Seasonal Trends and Consumer Behavior

Seasonality emerged as a major driver of pricing adjustments, with notable fluctuations in months such as June and July, aligning with peak grilling periods. The data reveal that pricing strategies during these months capitalize on increased consumer demand for steak-related products, demonstrating the importance of timing in retail pricing decisions. For Walmart, steady pricing minimizes seasonal volatility, while Loblaws uses targeted promotions to drive seasonal sales spikes. This finding emphasizes the importance of aligning pricing strategies with consumer behavior, allowing retailers to maximize revenue during high-demand periods.

A new insight from the data is the interplay between promotional pricing and consumer psychology. Significant markdowns, such as steep discounts on premium products like ribeye steak, drive temporary demand spikes, indicating that perceived value plays a critical role in consumer purchasing decisions. This suggests that well-timed promotions not only boost short-term sales but also create opportunities for customer engagement. Retailers should explore the thresholds at which discounts maximize consumer response without eroding long-term profitability. ## Implications, Limitations, and Future Directions

This study provides actionable insights into retail pricing, but it also highlights areas for further exploration. The model effectively integrates prior knowledge with observed data, offering robust predictions and uncovering key trends. However, limitations include the inability to fully capture outlier behaviors, such as aggressive discounting on high-value products, and the

reliance on historical prices, which may oversimplify the influence of real-time factors like advertising or supply chain disruptions. Addressing these limitations through non-linear models or incorporating external variables, such as competitor pricing or macroeconomic trends, could enhance the model's precision.

Future research should focus on refining models to account for regional and demographic differences, offering more granular insights into consumer behavior. Additionally, exploring the long-term impacts of pricing strategies on customer loyalty would provide valuable guidance for balancing short-term revenue boosts with sustainable growth.

Overall, this study underscores the critical role of pricing in shaping competitive dynamics in the retail grocery sector. By leveraging insights into vendor strategies, seasonal trends, and consumer behavior, retailers can optimize their pricing decisions to drive sales, build loyalty, and maintain a competitive edge in an ever-evolving market. ## Weaknesses and next steps

Weaknesses and next steps should also be included.

Appendix

A Additional data details

B Model details

B.1 Posterior predictive check

In Figure 4a we implement a posterior predictive check. This shows The posterior predictive check assesses how well the model represents the observed data by comparing the predicted data distribution to the actual data. The analysis shows that the model captures the main features of the observed price distribution, including its central tendencies and variability. The close alignment between simulated and actual data distributions indicates that the model is robust and reliable in representing the pricing trends of steak-related products. However, minor deviations at the extremes suggest potential opportunities for model refinement, particularly in handling outlier cases. Overall, the predictive check confirms that the model is well-suited to capture the key pricing dynamics in the dataset.

In Figure 4b we compare the posterior with the prior. This shows The comparison between posterior and prior distributions demonstrates how the data influences the model's parameter estimates. Key parameters such as vendor-specific effects and historical prices show significant shifts from their prior distributions, indicating that the data strongly informs these estimates. This aligns with findings that vendor-specific pricing strategies and historical prices are critical factors in determining current prices. Conversely, parameters such as the intercept show minimal deviation, reflecting limited evidence from the data to adjust initial assumptions. This balance underscores the model's ability to incorporate prior knowledge while letting the data drive meaningful updates.

Together, these analyses validate the model's capability to capture real-world pricing trends, providing actionable insights into how vendors, historical prices, and seasonal factors influence current pricing strategies. These results reinforce the model's value for guiding competitive pricing decisions in the retail grocery market.

B.2 Diagnostics

Figure 5a is a trace plot.The trace plot, shown in Figure 1, visualizes the Markov Chain Monte Carlo (MCMC) sampling process for each parameter across four chains. The chains mix well and converge toward a stationary distribution, indicated by the consistent overlap of the sampled values over time. This pattern suggests that the sampling process has stabilized, providing reliable parameter estimates. Additionally, the absence of irregularities or trends in the trace lines confirms that the model has reached convergence.

(a) Posterior prediction check

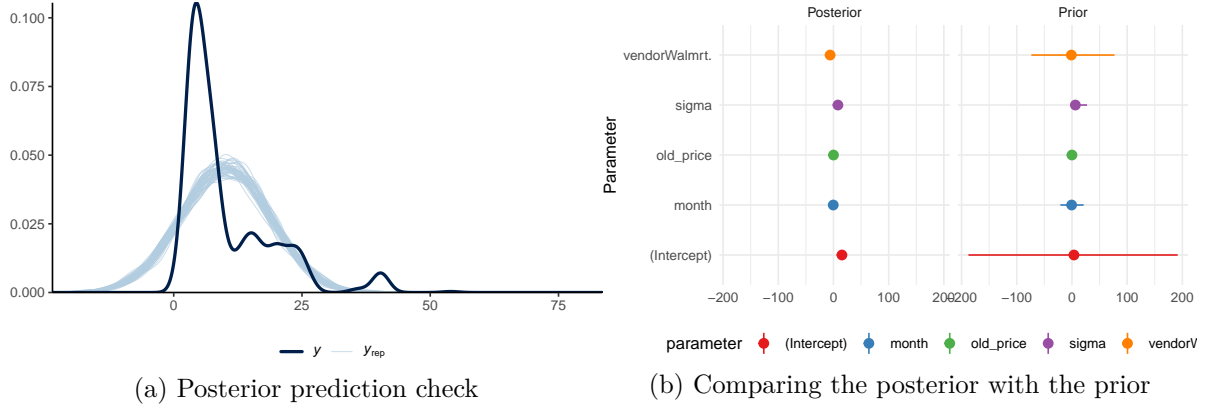(b) Comparing the posterior with the prior

Figure 4: Examining how the model fits, and is affected by, the data

Figure 5b is a Rhat plot. It shown in Figure 2, assesses the convergence of the MCMC algorithm by comparing within-chain and between-chain variability for each parameter. All Rhat values are very close to 1, indicating that the chains have converged, and the posterior estimates are stable. There are no signs of divergence or poor mixing across chains, confirming the validity of the model's MCMC sampling process.

Together, these diagnostics demonstrate that the MCMC algorithm has successfully converged, ensuring that the parameter estimates are robust and suitable for inference.
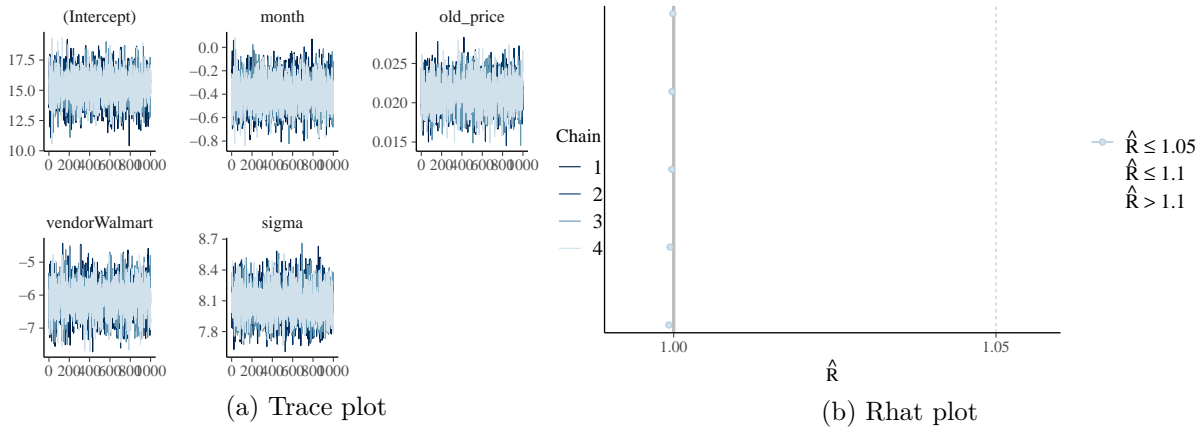

(a) Trace plot

(b) Rhat plot

Figure 5: Checking the convergence of the MCMC algorithm

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