

FORECASTING FOOD COMMODITIES PRICES FLUCTUATION WITH ISLAMIC CALENDAR EFFECT: THE CASE OF BANDUNG

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Abstract. Food service industry in Indonesia has been growing over the years. Indonesia is the largest market of food service industry in the whole ASEAN region. One of the major risks for food service businesses is food commodities prices fluctuation. It reduces profitability and even threatens survivability. To mitigate that risk, an accurate forecast result can be used to anticipate price fluctuation. This research analyses the Islamic calendar effect towards food commodities prices fluctuation in Bandung, the capital city of West Java, Indonesia. Islamic holidays and holy Islamic months ensure a seasonal demand increase for food due to culture and tradition. This research forecast food commodities prices by using Facebook Prophet model. This research develops forecast models that apply Islamic seasonality. The food commodities prices that are forecasted are rice, chicken, white shallot, small chili, and cooking oil. This research generate Forecast result is pretty accurate. Therefore, the forecast result can be used for food service business in Bandung better anticipate food commodities prices fluctuation.

Keywords: Food Service Businesses; Food Commodities Prices; Forecast; Islamic Calendar Effect

INTRODUCTION

Culinary industry in Indonesia has been growing over the past years. According to BEKRAF (Creative Economy Agency) and BPS (Indonesia Statistic Bureau) (2018), the culinary industry is the biggest gross domestic product (GDP) contributor at 41.40% in 2016. Food service industry is also expected to grow CAGR at 7.06% between 2018 and 2023 (Przybylski, 2018). Indonesia, with a population of approximately 267 million, is the largest market for the food service industry in the ASEAN region.

In food service business, the Cost of Goods Sold (COGS) is the amount of money that is spent on food commodities such as rice, meats, vegetables, fruits, seasonings, spices, etc. When COGS increase, food service business increases its prices in order to pass the cost on to customers. However, increasing price should not be done instantly in order to avoid decrease in demand (Deloitte Consumer Insights, June 2017). Therefore, knowing when and how much will food commodities prices increase or decrease beforehand become important. Forecasting result can give better basis in making decision in time the uncertainty of future price (Gujarati & Porter, 2010).

From the graph below, it can be concluded that food inflation rate in Indonesia is volatile and always in positive value. It means that food commodities prices keep increasing for this past 10 years in Indonesia. One of the highly significant determinants of food inflation in Indonesia is seasonal event (*Eid al-Fitr* and *Eid al-Adha*) (Ismaya & Anugrah, 2018).



Figure 1 Food Inflation Rate in Indonesia from 2010 to 2019. Source: *Tradingeconomics.com*.

This research is based on food commodities prices fluctuation risk that is exposed to food service industry every year. This research aims to give business insights and recommendation to food service business owners and managers. Data and result of this research are expected to be used as basis in anticipating food price fluctuations. To achieve that, first this research identifies on how food commodities prices in Bandung fluctuates over one Islamic calendar year. Second, this research finds what Islamic calendar effect trigger food commodities price fluctuation in Bandung.

However, Indonesia is an archipelagic country. It is a cluster of islands with total of 34 provinces. Daily food commodities prices in each province is different (PIHPS Nasional, 2019). Bandung has 40 traditional markets. Food commodities are traded daily in every traditional market. This research analyses and forecast food commodities price fluctuation using daily food commodities price data of Kiara Condong traditional market. Because of data and time limitation, this research assumed that daily food commodities prices of Kiara Condong traditional market is representative to Bandung's daily food commodities price.

Food commodities that are forecasted in this research are rice, chicken, white shallot, small chili, and cooking oil. Each food commodities grades and brands are not forecasted individually. The food commodities prices data that is used to forecast are the result from averaging all available price of the food commodity's grades and brands.

LITERATURE REVIEW

Islamic Calendar Effect

There are four Islamic months that are often investigated for existence of Islamic calendar effect. There are *Muharram*, *Ramadan*, *Shawwal* and *Zul Hijja* (Shah *et al.*, 2017, 58). Furthermore, in *Shawwal* and *Zul Hijja*, there are two very important festivals which are *Eid al-Fitr* and *Eid al-Adha*. Other than that, there are other festivals like Isra Mi'raj, Mawlid Nabi, and Muharram Festival or Islamic New Year. In Indonesia, these festivals become national public holidays.

Time Series Forecasting

Time series forecasting is predicting future values by understanding past time series data using mathematical, economical, or statistical models (Adhikari & Agrawal, 2013, 9). Time series data are collection of past values of the variable being predicted. There are four patterns of time series data, such as: trend, cyclical, seasonal, and irregular (Adhikari & Agrawal, 2013, 12). Forecasting results are not fully accurate. There will always be error. Error usually rises up if we forecast further into the future.

Prophet Model

Prophet model is an open-source business forecasting tool for strong seasonal time series data (Taylor & Letham, 2017). It was developed by Facebook's Core Data Science team. Prophet model is available in R and Python language. "Prophet model is robust enough to address missing data, shifts in the trend, and typically handles outliers well" (Rodriguez *et al.*, 2018, 6). Non-linear trends can be fit into yearly, monthly, weekly, daily seasonality, and holiday effects.

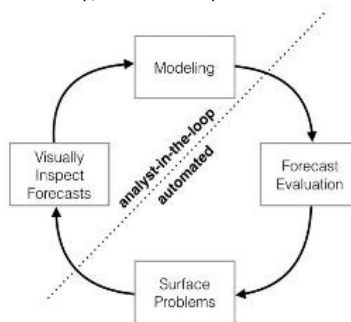


Figure 2 Prophet Model Forecast Flow. Adapted from Taylor & Letham (2017, 3).

Prophet model uses decomposable time series model by Harvey & Peters (1990) with three main model components: trend, seasonality, and holidays. It is combined in the equation:

$$y(t) = g(t) + s(t) + h(t) + \epsilon t$$

Where:

- $y(t)$: time series of interest
- $g(t)$: linear or logistic growth curve trend
- $s(t)$: periodic changes of weekly seasonality using dummy variables or yearly seasonality using Fourier order
- $h(t)$: effects of important irregular holidays or events provided by analyst
- ϵt : error term accounts for any unusual changes that not accommodated by the model

Previous Research

Flukeria *et al.* (2016) had done a research about how *Ramadan* affect the retail prices of key food commodities in Indonesia. There were 10 food commodities that were analyzed such as rice, chicken meat, chicken egg, beef meat, red chili, small chili, sugar, cooking oil, flour, and condensed milk. The data used was monthly price series from January 2000 until December 2014. The result was that *Ramadan* significantly affects several food commodities' retail prices in Indonesia.

METHODOLOGY

Research Methods

This research explores the Islamic calendar effects towards food commodities prices in Bandung. It is a correlational and quantitative research. This research also forecast future food commodities prices for the next 1 Islamic year or 354 days. The dataset is daily food commodities prices of Kiara Condong traditional market. This research uses Prophet model by Facebook as it is fast and automated but still can be adjusted by the analyst.

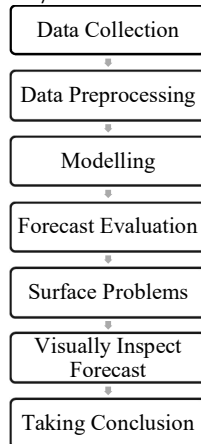


Figure 3 Research Methods

Data Collection

The dataset is from Indonesia National Strategic Food Prices Information Center or Portal Informasi Harga Pangan Strategis Nasional (PIHPSN). The dataset contains daily food commodities prices of Kiara Condong traditional market from July 25, 2016 to June 24, 2019 (three whole Islamic years) or 1,065 data values.

Data Preprocessing

The raw dataset is preprocessed to meet the requirements for further data analysis.

Modelling

After installing prophet package in R studio, the forecasting flow can begin. The first flow is modelling. It begins with setting up specified parameters such as holidays, seasonality, and a smoothing parameter called fourier order.

Forecast Evaluation

The components of forecast which are trend, holidays, and seasonality are plotted in graphs. The Mean Absolute Percent Error (MAPE) is selected as the measure of accuracy of the model

Surface Problems

Problems that can occur are poor forecast performance, minor coding error, and overfitting or underfitting. Prophet model and R studio can surface these problems to the analyst.

Taking Conclusion

The first conclusion is food commodities prices fluctuation on Islamic holidays. The second conclusion is food commodities prices fluctuation on Islamic year. Last but not least is the forecasted future food commodities prices trend and values.

FINDINGS AND ARGUMENT

Food Commodities Price Fluctuation on Islamic Holidays in Bandung

Food commodities price fluctuation on Islamic holidays in Bandung is present. The significance of each Islamic holiday to food

commodities price is different. On Eid al-Fitr (Fitr), food commodities prices tend to decrease significantly except cooking oil. On Eid al-Adha (Ad), only chicken price tends to increase significantly. On Isra Mi'raj (Isra), only white shallot price tends to increase significantly. On Mawlid Nabi (Ma), only cooking oil price tend to increase significantly. Lastly, on New Year (Isla), chicken and cooking oil prices tend to decrease.

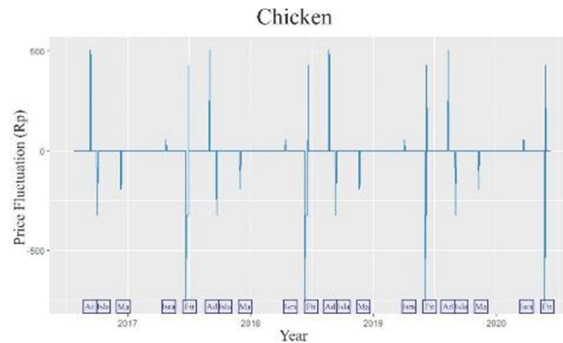


Figure 4 Chicken Price Historical and Future Fluctuation Trend on Islamic Holidays

Chicken price fluctuations are significant on several Islamic Holidays. The highest increase is on *Eid al-Adha* (Ad) as it increases on average by Rp500. The lowest decrease is on *Eid al-Fitr* (Fitr) as it decreases on average by Rp750. However, at the last days of *Eid al-Fitr*, the price increase on average by 400. Other Islamic holiday that should be mentioned is Islamic New Year (Isla) as the price decrease on average by Rp300.

Food Commodities Price Islamic Yearly Fluctuation in Bandung

Food commodities prices Islamic yearly fluctuation in Bandung is generated from analyzing 3 years daily price data. The significance of each month to food commodities price is different.

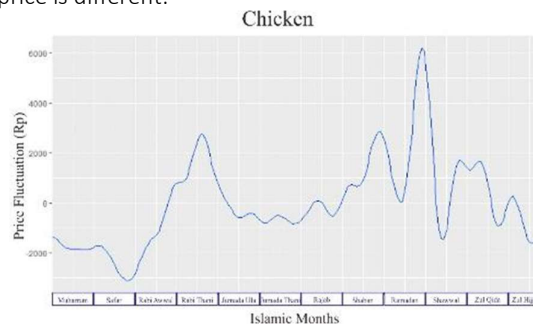


Figure 5 Chicken Price Islamic Yearly Fluctuation Trend

Chicken price significantly increase on several Islamic months. First significant increase start on the end of Safar month and through the whole Rabi Awal month until the middle of Rabi Thani month. Second significant increase start on the end of Rajab month until the end of Shaban month. Last significant increase start on the middle until the end of Ramadhan month.

Forecast Models Performance

Table 1 Forecast Models Performance Summary

Commodity	MAPE		
	Highest	Lowest	Average
Rice	5.77%	0.01%	0.56%
Chicken	9.26%	0.01%	2.23%
White Shallot	106.98%	0.01%	11.20%
Small Chili	69.14%	0.01%	11.93%
Cooking Oil	8.47%	0.01%	0.83%

CONCLUSIONS

The forecast models that are developed to forecast food commodities prices are pretty accurate. The most accurate forecast model with an average 0.56% MAPE is for forecasting rice and the least accurate forecast model with an average of 11.93% MAPE is for forecasting small chili. The forecast model for white shallot and small chili have not been able to perform accurately. The

MAPE is above 11%. Future research needs to develop forecast models with different seasonality or calendar effect to forecast white shallot and small chili. Other than that, forecast models for rice, chicken, and cooking oil are all below 3% MAPE. Therefore, the forecast models can be used by food service businesses to anticipate the prices fluctuation.

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