Household income prediction model due to fuel price fluctuation: A review

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Abstract. The world crude oil price has experienced the most volatile period in the beginning of 2007. The increasing trend has led to a significant impact on many economic sectors around the world. Moreover, individual also affected by the increasing in fuel price and deregulation of fuel subsidy around the world. As consequences, their income became insufficient to cover their monthly expenditure. Therefore, this paper gives an overview of the impacts of the fuel price on the economic sectors and individual. Several economic sectors found to be significantly affected namely transportation, manufacturing, agricultural, production and construction. This study also found that the household income significantly affected by the fuel price fluctuation. Hence, this paper reviews several prediction models to predict fuel price and household income. The regression and simulation models are found to be efficient in predicting the fuel price and household income. The review indicates that these models could be used to help individual, especially Malaysian in managing their income in the spike in fuel price. This study could be beneficial to all Malaysian which helps in managing their income and expenditure for better quality of life among Malaysian.

1. Introduction
The increase in crude oil price started from 2005 until 2013 and has experienced the most volatile period in the beginning of 2007. The crude oil price has significantly increased by 36.7% to 94.45 USD per barrel in 2008 (see [1]). Then, the opposite trend has been identified whereby the world crude oil price shows a downward trend, from 96.26 USD per barrel in 2014 to 52.43 USD per barrel in 2015 (see [2]). However, it is still expected to increase in future years to reach USD110 per barrel by 2020 (see [3]).

The increasing trend has led to a significant impact on many economic sectors namely agriculture, manufacturing, construction and production (see [4, 5, 6]). Transportation is identified as the most significantly affected sectors. This sector substantially dependent on fuel consumption, which led to increases in transportation costs, thus reducing the demand of transport (see [7, 8]). The world phenomena on increasing fuel price has also affected Malaysia either the country or individual person. Figure 1 shows the trend of the Malaysia crude oil price per barrel from Jan 2007 to May 2018. The spike in crude oil price in 2007 has doubled from 0.7% in 2001 to 1.4% in 2007 (see [9]). The
percentage is expressed as a share of gross domestic product (GDP). Consequently, the policy on fuel subsidy has been reformed. Malaysia government has increased the fuel price eight times in 2008 (see [1]). However, the fuel price keeps increasing since then. Therefore, in 2017, Malaysia government has stopped the fuel subsidy and now, the fuel price is depending on the world crude oil price. This has been a burden to all Malaysian especially individual. A study found that Malay experienced the most income loss as compared to Chinese and Indians (see [1]). Moreover, the loss of income occurred due to the consumption of products that require a lot of energy which share most of the household budgets. Although many studies have been conducted regarding the impacts of the increasing fuel price on economic sectors, this study focuses on the impacts on individual. This is because individual suffers more due to the increasing of fuel price. Nowadays, Malaysian must spend more than usual on their daily petrol use. Besides that, the increase in petrol price also affected other prices to increase as petrol price plays an important role in determining other prices (see [10]). Hence, their income became insufficient to cover the monthly expenditure. In recent years, the number of bankruptcy cases among individual shows an increasing trend in Malaysia. Malaysia Department of Insolvency (MDI) had reported the increasing trend in personal bankruptcy cases in Malaysia. According to a research done by MDI, about 101,958 cases have been recorded from 2012 to December 2016. Then, from 2014 to Dec 2018, the bankruptcy cases recorded were 95,105. Until December 2018, the bankruptcy cases recorded in Malaysia is more than 300,000 cases. This indicates that the monthly income among individual in Malaysia which is insufficient due to the crisis of increasing petrol price. Therefore, this study undertakes to review literatures on the impacts of fuel price fluctuations on economic sectors and individual. Then, this study also will review the prediction model to help individuals in projecting the fuel price and hence predicting their monthly income that reflects the ups and downs of fuel price. This study could be beneficial to all Malaysian which helps in managing their income and expenditure for better quality of life among Malaysian.

2. Literature review

2.1. Impacts of fuel price fluctuation on economic sectors

Many studies have been conducted to investigate the impact of fluctuations in fuel price on economic sectors. The impacts can be seen significantly affects many economic sectors, namely transportation, manufacturing, construction, production and agricultural. There are various models that have been used to investigate the effects of fluctuation in fuel price on several economic sectors.
Alper and Torul [5] applied the Vector Autoregressive Model to study the relationship between the increasing fuel price and manufacturing sector in Turkey. This study found that the increase in fuel price influences the real production growth rate of several manufacturing sectors such as wood products, furniture, chemical products, rubber, plastic products, electrical machinery and communication device. The same method is applied by Rodriguez and Sanchez [11]. This study investigates the impacts of the increasing fuel price of real economic activities of OECD countries. The results showed that an increase in fuel price negatively affects the economic growth in the United Kingdom but there is a positive relationship in Norway. Again, the same model is employed by Peterson et al. [12] to examine the effect of a rise in fuel price on the construction sector in Texas. The results found that the factors such as oil prices, tax laws and interest rate significantly affect the construction sector.

Another study by Riaz et al. [13] was conducted in Pakistan to investigate the impact of the fluctuation of fuel price on the manufacturing sector. This study used EGARCH model. The results show that the manufacturing sector is non-linearly related to fuel price fluctuation but after a threshold level manufacturing production starts declining with the increase in oil price uncertainty. Aimer [14] investigated the sensitivity of different economic sectors to volatility of the price in the long run. The results showed that agriculture, construction, manufacturing and transportation sectors have a long run relationship.

Another method that commonly used in investigating the effects of fuel price shocks on the economic sectors is an input-output model. In United States, Hanson et al. [6] used the input-output model to examine the fuel price shocks in agricultural sector. This study found that an increase in fuel price does have an impact on agricultural production and hence reduce the income of the sector. Setyawan [8] employed the same model to investigate the impact of increase in fuel on economic sectors. This study examines the increase of 10%, 20% and 30% in fuel price and the results showed a shocking impact on the transportation sector.

Taghizadeh-Hesary et al. [15] conducted a study in Japan to investigate the impact of fluctuations in fuel price on economic sectors. This study used a VAR model and found that the most affected sectors are industrial and transport. Then, Aimer [14] studies the long-term relationship of fuel price with several economic sectors namely agriculture, construction and manufacturing. The results show that the increase in fuel price is not significant in the manufacturing sector. The same result also found in Mahboub and Ahmad [16].

2.2. Impacts of fuel price fluctuation on individual

Apart from affecting the economic sectors, the increasing fuel price also hitting almost everyone. It can be seen on how Malaysian nowadays start taking alternative method on how they commute from one place to another. A study by Rohani and Pahazri [17] found that there was a reduction in the frequency of personal vehicle usage. The reduction is about 2 – 7%, which based on the trip frequency observed. This study also showed that the number of respondents using the public transport has been increased when the fuel price increased. Another study by Ahmat [18] showed that individual had changed their travel patterns because of income insufficiency, which is due to the increase in fuel price.

Moreover, another consequence on the increment in fuel price is the income loss among Malaysian. Saari et al. [1] conducted a study on the impact of fuel price fluctuation across various ethnic in Malaysia. This study found that Malay faced the biggest impact as compared to Chinese and Indians. At the same time, another study by Roslan et al. [19] also investigated the impact of increasing fuel price on three different income groups in Malaysia. This study found that the middle-income group is significantly affected by the increased in fuel price. In Indonesia, Oktaviani et al. [20] study the impact of fuel subsidy elimination on macroeconomic, sectoral and poverty. This study also found that the removal of subsidy has resulted in reduction of household income in Indonesia. Moreover, a study by Coady et al. [21] stated that when the fuel prices increased by 50% on average, the average real income decreased by 4.6%. This is in line with study by Godek and Murray [22] that showed the
overall expenditure is reduced as resulted from the decrease in income due to the increased in the fuel price. Furthermore, Moshiri [23] also showed heterogeneous response to energy price and income changes in different income groups. All these previous studies successfully identified the significant impact of fuel price fluctuation on household income. However, these previous studies do not suggest or formulate any model to help individual in predicting and managing their income. This action could be beneficial in helping individual to plan their future income which reflects the ups and down of the fuel price. Since the fluctuation in fuel price significantly affected household income, the predicting of real income or increase in income is urgently needed to maintain a good lifestyle. Moreover, the prediction models for forecasting the fuel price also been reviewed.

2.3. Prediction models for fuel price

The forecasting techniques commonly divided into three, namely heuristic methods, econometric models and machine learning techniques. The heuristic methods in prediction rely on the survey and professional knowledge, judgements, opinion and intuition. Another heuristic approach uses the current price of fuel as the best prediction of future fuel price. This approach, called no-change model. This approach has several advantages such as simple and provide a good baseline approach for fuel prediction. (see [24]).

The popular and most widely used prediction model for fuel prediction is econometric models. The econometric models include autoregressive moving average (ARMA) models and vector autoregressive (VAR) models (see [25, 26]). These econometrics model provide a better prediction as compared to the no-change model at some time horizons (see [24, 27]). Recently, Baumeister and Kilian [27] proposed a new approach that combines several prediction models which include both econometric models and no-change model. Even though the econometric models widely used, these models are linear and not be able to capture the non-linearity in the time series data such as fuel price data.

Nowadays, a new technique was proposed for prediction fuel price known as machine learning techniques. Some of the machine learning techniques were artificial neural networks (ANN) (see [28, 29]) and support vector machine (SVM) (see [30]). These models produce more accurate predictions when the data strongly non-linear and hence, outperform the econometric models (see [31]). Recently, Goa and Lei [32] propose a novel approach called stream learning approach in predicting fuel price. This new approach achieves highest accuracy in predicting fuel price. However, these machine learning techniques also have weaknesses. These techniques still rely on a fixed set of training data to train machine learning model and then apply the model to a test set. These techniques also work well for stationary data but not effective for non-stationary time series data such as fuel price data (see [32]).

2.4. Income prediction models

The forecasting techniques discussed in earlier section also can be used in predicting household income. Here, we focused on some of the literatures that discussed on specific models used in predicting household income. Benin and Randriamamonjy[33] used a regression model to predict and analyse changes in household income per capita in African countries from 1985 to 2006. The predictions are consistent with observed trends in poverty and hunger, suggesting that the methodology is useful for tracking household incomes to support monitoring and evaluating public investment programs. Yu [34] also used a regression model to predict median household income at country level in the United States.

Uygur [35] conducted a study to predict household disposable income and consumption expenditure by household composition, asset ownership and other human capital variables using the Generalised Least Squares Estimation method. The model performance is much higher for disposable income as compared to the total expenditure. Chen and Yang [36] proposed a quasi-stepwise
regression variable selection method to forecast rural household net income. This study found that this method has lower error and high validation, which could be efficient in forecasting other issues. Then, Francisco et al. [37] develop an income predicting geographic weighted regression (GWR) model using electricity consumption as an independent variable. The finding revealed that it was a useful indicator for predicting income under geographical effects as compared to the normal linear regression. Other research by Kibekbaev and Duman[38] studied 16 different techniques in predicting income of bank customers, which combine multiple techniques. This study found that the traditional linear regression performed well among other techniques. Recently, a new approach in predicting household income and expenditure distributions based on the subsample informative using simulation has been introduced (see [39]). However, the simulation approach in predicting income probably has been first introduced many decades ago by Birkin and Clarke [40]. This simulation method is simple and can be applied using any software packages such as for R, SAS or S-plus. Moreover, this method presents a rather powerful and handy tool for practitioners and empirical researchers nowadays.

3. Summary
The review of previous studies found that several economic sectors are significantly affected by the increased in fuel price. The affected economic sectors are transportation, manufacturing, agricultural, production and construction. But only few studies that concern on the impact of fuel price fluctuation on individual have been conducted. However, these studies found that the household income is significantly affected by the fuel price fluctuations. Following that, household income prediction models are reviewed in this study. The previous studies by Saboohi[41] and Silva et al. [42] found that the household in lower quantiles of the income distribution suffer more due to higher budget share of fuel expenditure. Thus, we find that the income prediction models that include the fluctuation of fuel price is vital in this current situation. The prediction models such as regression model and simulation approach can be proposed and formulated by researchers for helping an individual in Malaysia to sustain in the spike in fuel price. Moreover, this research also will be benefits society that helps in improving their quality of life and wellbeing, hence better in managing their income as well as expenditure.

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