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Article

The Impact of Premium Gasoline Price and Income Per Capita on Traffic Accidents: An Evidence from Panel Data Regression

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Abstract: Accident and safety cannot be separated due to their trade-offs by an individual when carrying out activities. Accident and safety issues are global issues and are being investigated. This study examines the impact of premium gasoline prices and per capita income on traffic accidents in 21 districts and cities in Aceh Province of Indonesia. This study used panel data from five years and 21 districts/cities. This research model uses a random effect model. The results showed that premium gasoline prices negatively affect income per capita and traffic accidents positively. These results fit theoretically. The effect of the price of 0.13 percent and income of 0.96 percent if there is an increase of 1 percent. The impact of income per capita is 7.38 times compared to premium gasoline prices. Then, the elasticity of income approach is elastic while the price is inelastic. The increase in per capita income causes people to buy more private vehicles, so the government needs regulation and socialization of the transfer of private vehicles to public transportation. Then, the police continue to urge the people to be careful in driving and a pioneer in traffic safety.

Keywords: traffic accident; gasoline price; income per capita; elasticity

1. Introduction

Safety and accidents are two things that cannot be separated. Both are trade-offs by an individual when carrying out activities. Accident and safety issues are global issues and are still being investigated. But the policy consideration between the two things is to prevent accidents. According to World Health Organization (2013), traffic accidents are the ninth order of the ten causes of death globally, and an estimated 2030 traffic accidents ranked fifth after the heart and lungs. Aceh Province is part of the state of Indonesia, contributing to the number of traffic accidents. During observations of data from 2012 to 2017, the number of traffic accidents in 21 regencies/cities is 11,177. Traffic accidents will incur material costs or losses for both victims and perpetrators. The most serious accidents occurred in Bireuen and Lhokseumawe, 1393 and

1711. Material losses in Bireuen District were 1.94 billion rupiahs, while Lhokseumawe City was 2.7 billion rupiahs.

Meanwhile, the biggest material loss in Aceh Besar District was 6.81 billion rupiahs from 2012 to 2017 despite the slight accident rate compared to Bireuen and Lhokseumawe Districts. The lowest accident rate was 58 in Simeulue District. Meanwhile, the lowest material loss in Sabang City was IDR212.6 million. This condition gives an overview of accidents and material losses for each region. There are differences due to physical roads, vehicle densities, and systems (Chi et al., 2015). Indirectly the total loss of IDR 38 billion is money that must be paid, and the nature of the waste (does not provide economic benefits). Figure 1 shows the price of gasoline in 2015 was significantly lower than in other years.

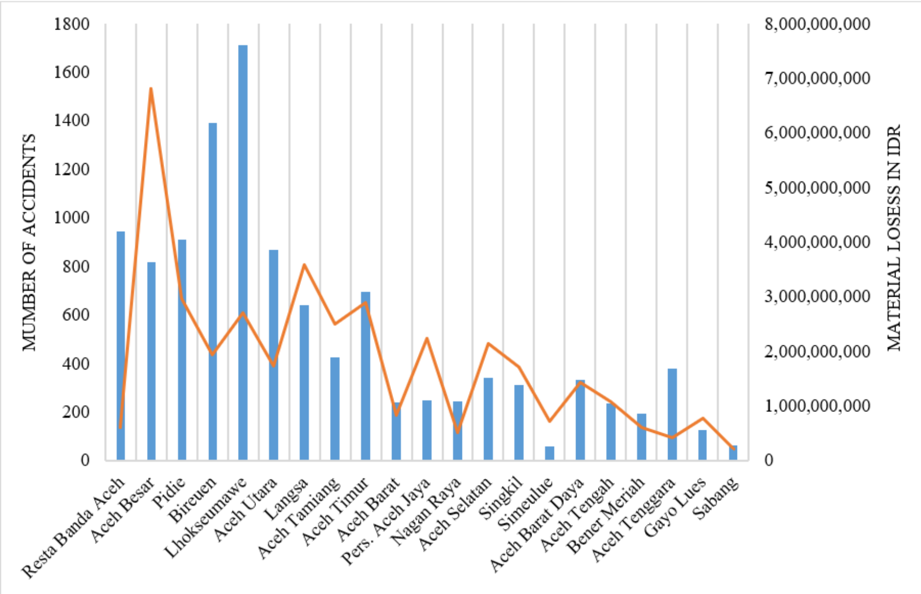

Figure 1. Number of traffic accidents and material losses during 2012-2017.
Source: Aceh Traffic Police Directorate, Pidie Jaya and Subulusalam (2017)

Traffic accidents by vehicles are not a natural occurrence. The emergence of traffic accidents is due to the indiscipline of drivers, such as drunkenness (Chi et al., 2011). However, various studies have been explaining the most significant source of traffic accidents is the price of gasoline (e.g., Ahangari et al., 2014; Chi et al., 2012, 2013, 2015; Grabowski & Morrisey, 2004; Nishitateno & Burke, 2014; Wilson et al., 2009; Zhu et al., 2015).

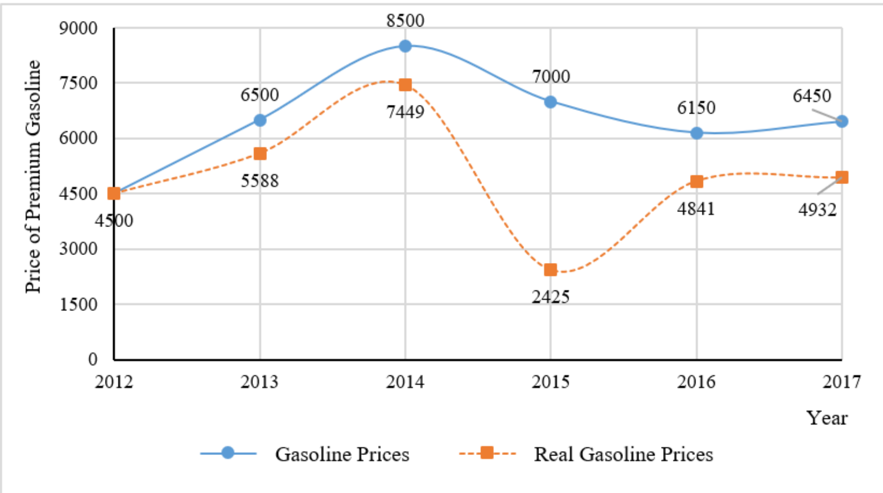

Figure 2. Price of premium gasoline and real premium gasoline prices in Aceh province 2012-2017.
Source: Oil and Gas Downstream Distribution Agency and BPS Aceh Province (2017)

Figure 2 describes the price of premium gasoline (government subsidies) and actual gasoline prices in Aceh Province from 201 to 2017. The pattern of the development of gasoline prices has decreased nominally. It differs in real terms from an increase in prices from 2425 rupiah in 2014 to 4932 rupiah in 2017. This actual figure is still far from the nominal figure, so gasoline is classified as cheap. In principle, a vehicle cannot run without fuel or gasoline. Vehicles and gasoline are complementary goods (Pindyck et al., 2013). If there is an increase in the price of gasoline, the number of vehicles decreases. As a developing country, the substitution of gasoline is complicated, so gasoline consumption is high even though income continues to grow (Dahl 2012). The effect of income per capita cannot be separated from traffic accidents due to the composition of the community. There is a difference between low, middle, and upper income (Musso et al., 2013). Middle- and middle-class per capita income has opportunities for vehicle changes based on the latest technology, such as vehicle speed. On the other hand, vehicles are valuable assets. Therefore, it is impossible to increase the number of vehicles and increase the potential for traffic accidents.

2. Literature Review

Grabowski & Morrisey (2004) examined the level of car accidents and gasoline prices. The analysis model uses Fixed Effect and exogenous semi-log variables on unemployment, age level, and car speed limit. The results show short-term estimates of real gasoline prices have a negative and significant effect on the level of car accidents. Exogenous variables such as unemployment explain rising unemployment. The accident rate would be reduced significantly. However, the 60-mph car speed limit has a significant negative effect. Still, when the speed limit becomes +75 mph, it significantly affects the level of car accidents. Different results by incorporating age elements are 18-24 times more likely to occur.

Hyatt et al. (2009) applied the gasoline price regulation approach to the level of accidents and deaths. Comparison of the price of steel with the average age of passengers (passengers) when USD 1-1.49 is 30.5 years. When gasoline prices rise from USD1.50 to 1.99, it is 31.3 years. The same results in the comparative testing of gasoline price regulation on the driver (driver) age, namely an increase in the price of gasoline, the driver's age have increased sharply by 37.7 years. Leigh & Geraghty (2008) suggested that gasoline price simulations can prevent death and accident rates. The increase in the base price of gasoline (base) from 10 percent to 50 percent prevented the death toll from accidents by 4984 people or affected negatively.

Wiebe et al. (2016) illustrated that mortality in Africa is one of the biggest sources of accidents. The research uses Granger Cause estimates to see the effects of past, present, and future accidents on GDP. The results show the accident level affects GDP, but on the contrary, it does not. The effects of accidents only affect the present. Chi et al. (2010) examined the impact of gasoline prices on-road accidents with several control variables. The regression model of this study is Poisson regression because accidents are random and unpredictable. The estimation results explain the effect of rising gasoline prices in both short and medium-term reducing (negative) traffic accidents. However, the short-term influence is stronger than the medium-term. Both terms affect young and old drivers and reducing traffic accidents can increase social benefits. The review by Chi et al. (2011) explains that accidents occur due to the driver's negligence in driving under alcohol. Increasing gasoline prices can reduce accidents by drunk drivers, but if the driver consumes alcohol that has a large impact, a traffic accident occurs. The price of gasoline and alcohol consumption negatively and strongly influences traffic accidents.

Furthermore, Chi et al. (2012) used different locations in Alabama. Accident effects are used at different age levels, gender, and ethnicity. The research method uses binomial regression variables from monthly data from 1999 to 2009. Results show that gasoline prices reduce traffic accidents both short and long term. Short-term and long-term results are not much different in demographic categories. Gasoline prices strongly negatively affect the 16 to 20 years age group compared to 31-34 and 65+ in the short term.

Chi et al. (2013) documented that accidents were not always the same in each region, and there was a previous time factor even though the variables used were the same. The estimation method uses negative Poisson regression and lag. The results explain how gasoline prices have decreased for nine months ago and peaked in the previous 12 months. Meanwhile, the previous 18 months explained that accidents had diminished gradually. Next, Chi et al. (2013) demonstrated that accidents in villages and cities were not significantly different. However, accidents in the village can be reduced more if the price of gasoline increases compared to the city. Chi et al. (2015) added that if the price of gasoline rises, it increases traffic safety, especially for those aged 75 years and over. Nonetheless, the gasoline price has increased with no effect on safety levels at the age of 20-34, and the reverse has occurred in accidents.

Wilson et al. (2009) examined the relationship between gasoline prices and driving accidents in 1990-2007 in the United States using the ARIMA estimation method. The results show that the number of vehicles will be high if gasoline prices become cheaper. The number of accidents and real gasoline prices are significantly positive. It is because real gasoline prices are much cheaper than nominal gasoline prices. Even so, vehicle substitution occurred when the price of gasoline rose. According to (Lin & Prince 2013), the gasoline demand depends on the price elasticity of gasoline itself. The research model is a dynamic log model. The results show that gasoline demand is significantly reduced when the medium and high gasoline prices are volatile. When the volatility of gasoline prices is low, there will still be a reduction but not as big as the medium and high impacts. The same study by (Musso et al., 2013) found that gasoline consumption depends on one's income. As the price of gasoline increases, the number of vehicles in the toll is reduced but not significant to the upper class. Different low-income communities will reduce vehicle use, but in the medium term, the time factor is an important consideration even though gasoline prices fluctuate.

Zhu et al. (2015) examined the relationship between gasoline prices and vehicle accidents, and the number of injuries. This research model is ARIMA. The results of this study show that vehicle and cireda accidents have a strong relationship with an increase in gasoline price, which is 76 percent to 85 percent. Generally, accidents are dominated by 92.5 percent of men. The ARIMA model displayed a rise in gasoline prices, resulting in an increase in accidents by 800 cases and 10,290 injuries from 2002 to 2011 in California. Zhu et al. (2015) recently reviewed that gasoline prices and motorcycle sales positively correlated. ARIMA results show that when gasoline prices rise by USD1, motorcycle accidents increase to 233.

Further research by Burger & Kaffine (2009) examined gasoline prices and vehicle speeds. This study's results show that gasoline prices' effect on vehicle speed at 02.00 - 04.00 am negative and insignificant. During rush hour, the result indicated a positive and significant effect. The increase in the price of gasoline and income by USD 1 will increase by 7 percent. The rain has significant negative effects, and post-holidays and summer increase significant vehicle speeds. This study supported by Wolff (2014) stated that income has a significant negative impact on driving speed, but gasoline prices have a positive and significant effect. Weather conditions show a negative and significant effect. The average driver's speed is 52 mph - 102 mph.

Research in developed countries was carried out by Ahangari et al. (2014). The study uses a fixed effect panel model. Based on the results of these studies, gasoline prices and traffic accidents are elastic, where the decline in gasoline prices is 10 percent, and accidents increase by 2.19 percent. Nishitateno & Burke (2014) found that the effect of world oil prices has an impact on the price of gasoline in the country, so there is a potential for endogeneity. Accident reduction can be made if there is an increase in gasoline prices by 10 percent. If global oil subsidies are released, around 35,000 deaths can be avoided annually. While research in Indonesia by Kusdarwati & Hartono (2016) explained the price of gasoline has a negative but insignificant effect. Subsequent results, real GDP has a negative and significant effect on traffic accidents.

3. Materials and Methods

The scope of this research is 21 districts/cities in Aceh Province. Data in the absence of 2 districts/cities because Pidie Jaya District is still in Pidie District and Subulussalam Municipality in Singkil District. The year of observation starts from 2012 to 2017. The type of data used in this study is secondary data. Secondary data for the variable number of traffic accidents (KCL) collected from the Directorate of Traffic of the Aceh Regional Police, and the price of gasoline (HB), the Octan 88 type premium gasoline subsidized by the government, comes from BPH MIGAS. Real Gasoline prices (e.g., Grabowski & Morrisey, 2004) are divided by nominal prices with Aceh Customer Price Index. Still, this study divides Aceh inflation into percent and nominal gasoline prices minus previous results. Finally, income (Y) is Per Capita's GRDP based on constant 2010 prices derived from the Central Bureau of Statistics of Aceh (BPS).

3.1 Technique Estimation Panel

3.1.1 Pooled Least Square (PLS)

This technique is for panel data. Before making a regression, we combine cross-section data with time-series data (data pool). Then this combined data is treated as a single unit of observation used to estimate the model with the OLS method. As a result of combining data, it cannot see the difference between individuals or between time. It is certainly not suitable for using panel data. Both intercept and slope do not change between individuals and between times. It means that everyone has a different intercept. Two techniques are usually used to create a model from the panel data to overcome this problem: the fixed-effect method and the random effect method (Gujarati & Porter 2003).

3.1.2 Fixed Effect Model (FEM)

The fixed-effect model, which is the rationale, is the existence of variables that are not all included in the equation model, allowing an intercept that is not constant (in other words, this intercept may change for each individual). This method allows changes in α (intercept) at each i and t (region and time). To find out whether α (intercept) is constant on each i and t, or change, can be tested by using the equation 1 below:

$$F \{(RSSols - RSSMET) / RSSMET\}. \{(i\,t - i - t) / (i + t - 2)\}, \tag{1}$$

The F stat value is compared with the F table; if the calculation result is greater than the F table, we can reject the hypothesis, meaning that α (intercept) is not constant at each i and t. In other words, MET (Fixed Effect Method) is better (Gujarati & Porter, 2003).

3.1.3 Random Effect Model (REM)

Using Fixed Effect Model, the difference between individuals (regions) and or time is reflected through an intercept (intercept changes between individuals and between times). In the Random Effect Model, these differences are accommodated through errors from the model. This technique also considers that errors may correlate throughout the time series and cross-section. Given that two components contribute to the formation of errors, namely individuals and time, random errors in the Random Effect Model also need to be broken down into errors for individual components, time component errors, and combined errors. Thus, the Random Effect Model (REM) equation is generally formulated (Gujarati & Porter, 2003).

$$Y_{it} = \alpha + \beta X_{it} + \varepsilon_{it};\ \varepsilon_{it} = u_i + v_t + w_{it}, \tag{2}$$

Where, u_i = Component error cross-section, v_t = Time-series error component, w_{it} = Component error combined. The assumptions used for the error component are; $u_i \sim N(0, \sigma u^2)$; $v_t \sim N(0, \sigma v^2)$; $w_{it} \sim N(0, \sigma w^2)$.

In equation 2, we can identify that the Random Effect Model considers the average effect of cross-section and time-series data represented in the intercept. Whereas random effect deviation for time series data is represented in vt, the deviation for cross-section data is stated in ut. It is known that: $\varepsilon it = u_i + v_t + w_{it}$. Thus, the variance of the error can be written; Var $(\varepsilon it) = \sigma u^2 + \sigma v^2 + \sigma w^2$. It is certainly different from the OLS model applied to the data panel (pooled data), as described above, which has an error variant of; Var $(\varepsilon it) = \sigma w2$. Thus, the Random Effect Method can be estimated by OLS if $\sigma u^2 = \sigma v^2 = 0$ Gujarati & Porter (2003).

3.2 Model concepts and specifications

The best and most efficient approach to research is to follow the model that has been done in previous research. Researchers used the approach taken by (e.g., Chi et al., 2010, 2013, 2015; Grabowski & Morrisey, 2004; Kusdarwati & Hartono, 2016; Nishitateno & Burke, 2014; Wilson et al., 2009). Using the price of real gasoline as the value of actual gasoline prices and the influence of inflation factors. However, data availability causes this research to be limited in studies and analysis. Then, the model is used in this study can be written as in equation 3 below:

$$KCL_{it} = f(HB_{it}, Y_{it}) + \varepsilon_{it} \tag{3}$$

Where, KCL, t = traffic accident for each region/ time. HBi, t = Real Gasoline Prices for each region/ time. Yi, t, = Revenue based on the 2010 constant price of each region/ time. εi, t = error term. Next, the equation (3) is transformed into the function in the form of the natural logarithm equation as seen in equation 4:

$$Ln\ KCL_{it} = \alpha_0 + \alpha_1\ LnHB_{it} + \alpha_2\ LnY_{it} + \theta_i + \varepsilon_{it} \tag{4}$$

Equation (4) displays the elasticity of the explanatory variables to measure the substantial influence on the variables seen. The sensitivity of the independent variable means that a bit of change will significantly impact the dependent variable.

4. Results and Discussion

4.1. Descriptive statistics

Descriptive statistics have an explanation of the description of the observed data. Measurement of this picture is seen from the mean, maximum, minimum, standard deviation, and normal distribution with Jarque-Bera. The variables in this study have been transformed into natural logarithms. The results of descriptive statistics are as follows:

Table 1. The results of descriptive statistics.

Variable	LKCL	LHB	LY
Mean	4.09	8.44	15.18
Max.	6.34	8.91	16.71
Min.	1.60	7.79	13.6
Std. Dev	0.93	0.37	0.77
Jarque-Bera	1.12	2.08	2.95
	[0.571]	[0.216]	[0.228]

Note: [] is the probability value.

Table 1 displays the result of descriptive statistics. This study found that the mean value of LKCL is 4.06, LHB is 8.44, and LY is 15.18. The maximum value of LKCL is 6.34, LHB is 8.91, and LY is 16.71. LKCL minimum value is 1.60, LHB is 7.79, and LY is 13.6. Also, this study indicated that the data of this study is normally distributed (see Jarque-Bera significant value is higher than 0.05).

4.2 Traffic Accident Panel Regression

This study uses a panel model to analyze the effect of premium gasoline prices and per capita income on traffic accidents in 21 districts/cities. There are three types of estimation of the panel model, namely Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). Fixed and Random Estimates provide an overview of each region there are differences. In contrast to the common estimation, it is done by estimating OLS where all data is done the same (Gujarati & Porter, 2003). Selection of the best model estimates is needed to get the best results (see Table 3). These estimates are selected by Chow / Redundant Test, Hausman Test, and LM Test. The results of the three estimates and the estimation of the corresponding model estimates in Table 2 are as follows.

Table 2. The result of traffic accident panel regression results in 21 districts/cities in Aceh province.

Variable		CEM	FEM	REM
Constant	(α_0)	-8.83 (-4.98)**	-14.59 (-1.55)	-9.11 (-2.34)*
LHB	(α_1)	-0.13 (-0.85)	-0.13 (-1.29)	-0.13 (-2.46)*
LY	(α_2)	0.926 (12.2)**	1.30 (2.13)**	0.94 (3.85)**
District	(i)	21	21	21
Time	(t)	5	5	5
Observation		105	105	105
R2		0.595	0.87	0.31
Adj. R2		0.58	0.83	0.30
F-statistics		74.9 [0.000]**	25.27 [0.000]**	23.54 [0.000]**
Jarque-Bera		0.84 [0.654]	2.09 [0.351]	0.88 [0.643]
Heteros LR	(i)	37.48 [0.014]**	-	-
	(t)	9.93 [0.979]	-	-

Durbin-Watson		0.46	1.43	1.17
CSD Test	BP LM	392.16 [0.000]**	393.37 [0.000]**	390.82 [0.000]**

Note: () is t-statistics, [] is Probability, **,* is significant at the level 1% and 5%.

Table 2 shows three types of model estimates with panel data. The first estimate is common, explaining that HB has a negative and insignificant effect on traffic accidents, while Y has a positive and significant effect on 1 percent. Next, the second estimate is Fixed. The results show HB has a negative but insignificant effect and Y has a positive and significant effect of 1 percent on traffic accidents. Then the final estimation result is that Random explained HB has a negative sign and a significant 5 percent of traffic accidents. Similarly, Y obtained a positive and significant effect of 1 percent on traffic accidents. The theoretical approach of the three models is very appropriate and the same as the correlation test results. But the selection of the model estimation is needed for testing. Redundant Test between Common and Fixed and Hausman are aiming to choose between Random and Fixed and LM Test (Lagrange Multiplier) to choose Common with Random.

Table 3. The result of the model selection criteria.

Model Selection		**Chi-Statistics**	**Conclusion**
Redundant Test	FE	120.49 [0.000]**	Fixed (H1)
Hausman Test	RE	0.364 [0.83]	Random (H0)
LM Test		75.95 [0.000]**	Random (H0)

Note: [] is the probability, **,* is significant at the level of 1% and 5%.

Table 3 shows the Redundant Test with Chi-Stat approach obtained a value of 120.49 and significant at the level of 1 percent then concluded rejecting H0 so that the appropriate estimation model is Fixed. The next stage is the Hausman test. The Chi-stat results obtained were 0.364 but insignificant at the 5 percent level. Therefore, H0 is accepted, or the Random model is more appropriate. The third stage test, namely the LM test, shows Random is more suitable than the common because the Chi-stat is 75.95 and is significant 1 percent.

The estimation results using the Random model show that the price of premium gasoline has a negative and significant effect. As complementary goods for vehicles, the effect of rising prices of premium gasoline proves that it can reduce the number of traffic accidents. The aesthetic results explained that if there was an increase in the price of premium gasoline by 1 percent, traffic accidents would decrease by 0.13 percent, assuming ceteris paribus. These results are consistent with those studied by Grabowski & Morrisey (2004), Chi et al. (2015), and Zhu et al. (2015). Previous research explains that gasoline is the main ingredient of a vehicle, but price considerations are an important benchmark (Wilson et al., 2009), but there must be an appropriate price measure. Low and cheap gasoline prices will change the public's view and will not always consider the consumption of other goods.

While the influence of per capita income on traffic accidents is positive and statistically significant, it explains that the increase in per capita income has a strong impact. If there is an increase of 1 percent, the number of traffic accidents increases by 0.94 percent, assuming ceteris paribus. These results also explain the elasticity of the LY variable is close to elastic, so per capita income is a sensitive variable if there is a change or increase. In line with Musso et al. (2013), who found that the amount of income will affect a person in vehicle changes, and low gasoline prices encourage higher technology and potentially increase the number of private vehicles.

5. Conclusions

In conclusion, this study has successfully investigated the effect of premium gasoline prices on traffic accidents. This study found premium gasoline price has a negative impact on traffic accidents. The elasticity of this variable is close to elastic. Based on the results of the previous conclusions and analysis, the suggestion is that, for the government, the prevention of traffic accidents is very necessary. From the results of this study, the effect of premium gasoline prices and per capita income is an important point. With prices at the current IDR 6,450.00 can reduce the number of traffic accidents and prices. The government needs to limit the number of private vehicles due to the increase in per capita income and the socialization of the transfer of private vehicles to public transportation. Furthermore, it is necessary to socialize the traffic police with the public so that they drive carefully on the road and pay more attention to security. The police continue to urge people always to be pioneers of traffic safety.

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References

Ahangari, H., Outlaw, J., Atkinson-Palombo, C., & Garrick, N. W. (2014). Investigation into impact of fluctuations in gasoline prices and macroeconomic conditions on road safety in developed countries. *Transportation Research Record*, *2465*(1), 48–56. https://doi.org/https://doi.org/10.3141/2465-07

Burger, N. E., & Kaffine, D. T. (2009). Gas prices, traffic, and freeway speeds in Los Angeles. *The Review of Economics and Statistics*, *91*(3), 652–657.

Chi, G., Brown, W., Zhang, X., & Zheng, Y. (2015). Safer roads owing to higher gasoline prices: How long it takes. *American Journal of Public Health*, *105*(8), e119–e125. https://doi.org/10.2105/AJPH.2015.302579

Chi, G., Cosby, A. G., Quddus, M. A., Gilbert, P. A., & Levinson, D. (2010). Gasoline prices and traffic safety in Mississippi. *Journal of Safety Research*, *41*(6), 493–500.

Chi, G., McClure, T. E., & Brown, D. B. (2012). Gasoline prices and traffic crashes in Alabama, 1999–2009. *Traffic Injury Prevention*, *13*(5), 476–484.

Chi, G., Porter, J. R., Cosby, A. G., & Levinson, D. (2013). The impact of gasoline price changes on traffic safety: a time geography explanation. *Journal of Transport Geography*, *28*, 1–11.

Chi, G., Zhou, X., McClure, T. E., Gilbert, P. A., Cosby, A. G., Zhang, L., Robertson, A. A., & Levinson, D. (2011). Gasoline prices and their relationship to drunk-driving crashes. *Accident Analysis & Prevention*, *43*(1), 194–203.

Dahl, C. A. (2012). Measuring global gasoline and diesel price and income elasticities. *Energy Policy*, *41*, 2–13.

Grabowski, D. C., & Morrisey, M. A. (2004). Gasoline prices and motor vehicle fatalities. *Journal of Policy Analysis and Management*, *23*(3), 575–593.

Gujarati, D. N., & Porter, D. C. (2003). Basic econometrics (ed.). *Singapore: McGrew Hill Book Co*.

Hyatt, E., Griffin, R., Rue III, L. W., & McGwin Jr, G. (2009). The association between price of regular-grade gasoline and injury and mortality rates among occupants involved in motorcycle-and automobile-related motor vehicle collisions. *Accident Analysis & Prevention*, *41*(5), 1075–1079.

Kusdarwati, E., & Hartono, D. (2016). Pengaruh Harga Bensin terhadap Kecelakaan Lalu Lintas di Indonesia. *Jurnal Ekonomi Dan Pembangunan Indonesia*, *16*(2), 173–186.

Leigh, J. P., & Geraghty, E. M. (2008). High gasoline prices and mortality from motor vehicle crashes and air pollution. *Journal of Occupational and Environmental Medicine*, *5*(30), 249–254. https://doi.org/10.1097/JOM.0b013e318162f5c4

Lin, C.-Y. C., & Prince, L. (2013). Gasoline price volatility and the elasticity of demand for gasoline. *Energy Economics*, *38*, 111–117. https://doi.org/10.1016/j.eneco.2013.03.001

Musso, A., Piccioni, C., Tozzi, M., Godard, G., Lapeyre, A., & Papandreou, K. (2013). Road transport elasticity: how fuel price changes can affect traffic demand on a toll motorway. *Procedia-Social and Behavioral Sciences*, *87*, 85–102.

Nishitateno, S., & Burke, P. J. (2014). The motorcycle Kuznets curve. *Journal of Transport Geography*, *36*, 116–123.

Pindyck, R. S., Rubinfeld, D. L., & Rabasco, E. (2013). *Microeconomia*. Pearson Education Limited.

Wiebe, D. J., Ray, S., Maswabi, T., Kgathi, C., & Branas, C. C. (2016). Economic development and road traffic fatalities in two neighbouring African nations. *African Journal of Emergency Medicine*, *6*(2), 80–86.

Wilson, F. A., Stimpson, J. P., & Hilsenrath, P. E. (2009). Gasoline prices and their relationship to rising motorcycle fatalities, 1990–2007. *American Journal of Public Health*, *99*(10), 1753–1758.

Wolff, H. (2014). Value of time: Speeding behavior and gasoline prices. *Journal of Environmental Economics and Management*, *67*(1), 71–88.

World Health Organization. (2013). Global status report on road safety 2013: supporting a decade of action. *Geneva, Switzerland*.

Zhu, H., Wilson, F. A., & Stimpson, J. P. (2015). The relationship between gasoline price and patterns of motorcycle fatalities and injuries. *Injury Prevention*, *21*(3), 153–158.