Easing the traffic: The road-use effects of Indonesia's fuel subsidy reforms

Paul J. Burke[1*], Tsendsuren Batsuuri[1], Muhammad Halley Yudhistira[2]

[1] Australian National University, ACT 2601, Australia
[2] University of Indonesia, Indonesia
* Corresponding author. paul.j.burke@anu.edu.au, +61 2 6125 6566

10 March 2016

–Outline for ACE 2016–

Indonesia has serious traffic jams. This study uses data from 19 Indonesian toll roads over 2008–2015 to calculate the effects of Indonesia's historic recent fuel subsidy reforms on vehicle travel. The timing of the reforms was determined by budgetary and political factors, providing a suitable setting for estimating causal effects. Estimates using either monthly or quarterly data suggest an immediate gasoline price elasticity of motor vehicle trips on these roads of –0.07, increasing to around –0.15 when responses over the course of a year are considered. By the end of 2015, we estimate that Indonesia's fuel subsidy reforms of 2013 and 2014 had reduced traffic pressure on these roads by around 8% relative to the counterfactual without reform.

Keywords: Fuel subsidy, gasoline price, elasticity, traffic, Indonesia
JEL classifications: R41, R48, H20

Acknowledgements: We thank Jasa Marga for data. We are also grateful for comments received from audiences at the Australian National University, Padjadjaran University, Indonesian Institute of Sciences (LIPI), and the University of Indonesia.

1. Introduction

The budget of Indonesia, population 254 million (World Bank 2016), has for years been burdened by subsidies for oil consumption, principally for road transport. Total oil subsidies exceeded 15% of central government revenue in 2012 (Bank Indonesia 2016), with Indonesia ranked as the world's fourth-largest subsidizer of oil use in terms of total value (International Energy Agency 2016).[1] Indonesia's subsidized gasoline price was just 4,500 Indonesian rupiah per liter, or US 47 cents, which was below the world crude oil price. Subsidizing gasoline has been a regressive form of expenditure in Indonesia (World Bank 2012).

On 22 June 2013, President Susilo Bambang Yudhoyono implemented an overnight increase in Indonesia's subsidized gasoline price of 44%. On 18 November 2014 new President Joko Widodo increased this price by a further 31%. In the final days of 2014 President Widodo introduced a system of monthly price setting that aims to link the gasoline price to movements in the world oil price. A fixed subsidy of 1,000 rupiah per liter remains for diesel. These historic reforms, together with the falling world oil price in the second half of 2014 and through 2015, have seen a large reduction in Indonesia's expenditure on fuel subsidies.

In this study we investigate the effects of Indonesia's fuel subsidy reforms on road traffic. Indonesia has some of the world's most notorious traffic jams, bringing large costs to commuters and the economy more broadly. Many road trips are slowed, delayed, or forgone altogether as a result of traffic jams, and many commuters spend hours per day on the road. Traffic pressure is heaviest in the capital city of Jakarta, but is also serious in other cities.[2] By reducing the incentive to take trips of relatively low economic value, fuel subsidy reductions should be expected to provide a reasonably efficient means of reducing vehicle traffic.

Our analysis uses vehicle trip data for a panel of 19 Indonesian toll roads over 2008–2015. Aggregated monthly, the data represent a total of 9 billion trips by four-wheeled motor vehicles, buses, and trucks on roads in Java, Sumatra, and Bali.[3] Data for one road – the Bali Mandara Toll Road – also cover trips by motorcycles. The sample covers some of Indonesia's major urban and inter-urban roads, including the Jakarta-Cikampek Toll Road, Jakarta Inner Ring Road, Jagorawi Toll Road, and Jakarta Outer Ring Road (JORR). We use a distributed-lag specification to investigate both immediate and lagged effects of changes in the subsidized gasoline price. We also control for a host of other factors that are likely to affect vehicle trip flows. Vehicle trip numbers represent the most important structural determinant of whether a specific road will be subject to traffic jams during any given time period (Sugiyama et al. 2008).[4]

[1] Oil products are not only for transport use.

[2] Both Castrol (2015) and Waze (2015) rate Jakarta as having among the world's worst traffic jams. When data are available, other Indonesian cities – Bandung, Bogor, Denpasar, Surabaya, and Yogyakarta – also rank poorly.

[3] The data are based on the issuance of toll tariff tickets. The number of uninterrupted journeys is thus less than 9 billion, as some trips involve paying more than one toll.

[4] There are also many trigger-like determinants of traffic jams, such as weather events and accidents. Our focus is on the underlying pressure for traffic jams in the form of the number of vehicle trips.

To our knowledge this is the first study of the effects of major fuel subsidy reforms on vehicle travel. The study also provides the first estimates of the gasoline price elasticity of motor vehicle travel for Indonesia. The results are of potential use for the design of economic instruments to manage road traffic in Indonesia and elsewhere. They provide Ramsey (1927)-style support for the use of gasoline excise tax.

The paper proceeds as follows. Section 2 explains our method and a discussion of the expected effects of fuel subsidy reforms on road traffic. Our results are presented in Section 3. Section 4 relates our estimates to the existing literature. The final section concludes.

2. Method

2.1 Model and data

The monthly motor vehicle flow data cover 19 toll roads operated by Jasa Marga and its subsidiaries. 70% government owned, Jasa Marga is the largest toll road operator in Indonesia. 17 of the 19 roads are on Java, Indonesia's most populated island. The sample also includes one road in North Sumatra (Belmera Toll Road) and one in Bali (Bali Mandara Toll Road). The data cover 2008–2015. Six of the 19 roads opened during this period, meaning that the panel has an unbalanced structure. A list of the 19 roads, in descending order of motor vehicle flows for the month of December 2015, is presented in Table 1.

-Table 1-

Our focus on toll roads is data-driven, as suitable data are not available for non-toll roads. Nevertheless, these roads are not obscure; the sample covers some of Indonesia's most heavily-used roads, including some of the major commuter roads in Greater Jakarta. Toll roads are also policy-relevant in that their ticketing infrastructure might potentially in the future be able to be used for time-of-day congestion pricing, as we will discuss. The data are for ticketed trips. While they are believed to be of relatively high quality, it is important to note that they are affected by some changes to ticketing arrangements. Our modeling will control for the effects of such changes.

We use the following log-log model:

$$\ln T_{r,m} = \sum_{j=1}^{T} \alpha_j \ln P_{m-j} + \beta_{m:y} + \beta_r + \gamma_r t + \mathbf{X}'_{r,m}\boldsymbol{\delta} + \varepsilon_{r,m} \quad (1)$$

where T is the number of vehicle trips on road r in month m. P is the subsidized price for premium gasoline (RON 88), which constituted 97% of Indonesia's gasoline fuel sales in 2012.[5] The gasoline price is measured at the end of the month, and does not vary by road. We use the first lag of the gasoline price to ensure it is measured prior to vehicle flows in month m. We also add additional lags back to T=12, as it may take time to respond to fuel price changes.

[5] Calculated as share of RON 88 in (RON88 + RON92 + RON 95) using data from the Ministry of Energy and Mineral Resources (2014). RON = Research Octane Number.

Transport demand is seasonal. To capture this, Eq. (1) controls for the month of the year ($\beta_{m:y}$). We also include road fixed effects (β_r) to capture the different sizes and underlying demand conditions faced by each road. The use of road fixed effects means that our results are "within estimates" that utilize the time-series variation in the data. We also control for a linear time trend (t) for each road. Doing so assumes that each road's vehicle flow is subject to an underlying exponential growth or decline process, provided $\gamma_r \neq 0$. We allow this underlying growth rate to vary by road. Population growth, income growth, and a growing taste for private four-wheeled motor vehicle travel are factors likely to be generating underlying growth pressure.

Eq. (1)'s **X** vector includes an extensive list of additional variables. The list includes dummies for Idul Fitri (end of Ramadan) – an event that does not occur in the same month in each year, meaning that it is not captured by the month dummies. We interact the Idul Fitri dummies with the road fixed effects, as some roads are likely to experience higher demand during Idul Fitri, while others may face reduced demand. The control set also includes the number of lanes of each road, as some roads had new lanes open during our study period. We also control for the log toll tariff; a dummy to capture improvements in the Jabodetabek Commuterline from 2013; local precipitation; flood dummies for the Prof Dr Sedyatmo Toll Road in February 2008 and for Jakarta roads in January 2013; and ticketing changes affecting the Prof Dr Sedyatmo Toll Road, Jagorawi Toll Road, Jakarta-Cikampek Toll Road, Cipularang Toll Road, and Padalarang-Cileunyi Toll Road. We also control for first-month dummies for roads opened during the course of a month; the opening of important connecting roads; and extensions to existing roads. A full list of controls and their definitions is provided in Appendix 1. Additional discussion of the controls and the results for these controls is provided in section 3.

17 of the 19 roads in our panel are part of an interconnected road system on Java, Indonesia's most populated island. Some of the roads directly connect to one another, and single journeys often involve travelling on more than one of the roads. Due to interconnections and also potentially unobserved time-specific shocks, our data are likely to exhibit cross-sectional dependence. Tests indeed reject the null of cross-sectional independence.[6] We consequently use the panel estimator of Driscoll and Kraay (1998) to account for general forms of spatial and temporal dependence. This estimator produces standard errors that are non-parametrically adjusted for heteroskedasticity, autocorrelation, and potential correlation in error terms across the roads. The method is suited to panels with relatively long time dimensions; our sample has up to 96 observations per road.

In addition to a monthly panel we also present estimates using a quarterly panel. Doing so allows us to explore the robustness of our results and to control for the growth rate of gross domestic product (GDP), which is not available monthly. We also present estimates using

[6] A Breusch and Pagan (1980) Lagrange multiplier test rejects cross-sectional independence at the 1% significance level for the balanced sub-set of the panel.

monthly data for (a) an aggregate of the 19 toll roads, and (b) an aggregate of the 13 toll roads that were open throughout our full study period.

The analysis has been conducted and we are currently writing up the results.