



SOCIO-ECONOMIC FACTORS AFFECTING THE CHOICE OF TRANSPORTATION MODE IN JAKARTA METROPOLITAN AREA

Rizky Maulana^a, Muhammad Halley Yudhistira^{b,c}

^aDepartment of Economics, Universitas Indonesia, rizky.maulana82@ui.ac.id

^bInstitute for Economic and Social Research, Faculty of Economics and Business, Universitas Indonesia

^cResearch Cluster of Urban and Transportation Economics, Department of Economics, Universitas Indonesia

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ABSTRACT

This study aims to analyze the effect of socio-economic factors on the choice of transportation mode. The socio-economic variables used in this study are income, education, sex, employment sector, motorcycle ownership, car ownership, city of origin, commuting distance, and a number of commuters in a household. The object of this study is a commuter worker in Jakarta Metropolitan Area. One of the main problems in JMA is traffic congestion. Recent studies stated that public transportation able to decrease the problem of congestion. However, for some reason, the commuters of JMA are reluctant to use it. With the 2014 Jabodetabek commuter survey, we obtain a result that eight of nine socio-economic variables used in this study are statistically significant. We use a multinomial logit method to estimate the model.

Keyword: *Commuter, Transportation mode choice, Public transportation*

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1. INTRODUCTION

Population growth in a city causes several problems. Jakarta Metropolitan Area (JMA) is growing into a megapolitan city, the increasing volume of vehicles and the gathering of people from various parts of Indonesia who come to JMA have caused congestion problems. The congestion problem causes several losses for a city in the form of negative externalities, such as increased travel time from a place to a destination, traffic accidents, pollution and excess fuel consumption (Harmadi et al., 2015; Luo et al., 2007; Nadi & Murad, 2019). Even congestion can interfere with mental health, such as triggering stress and anxiety disorders (Nadrian et al., 2019).

The costs incurred due to congestion are estimated to be 50.2 trillion Rupiah annually. If the congestion problem is not taken as soon as possible, this figure will increase to sixty-five trillion Rupiah per year in 2020, of which 28.1 trillion are vehicle operating costs such as fuel wasted in traffic congestion and the other 36.9 trillion is due to the costs of wasted time (Harmadi et al., 2015). In general, congestion occurs when there are too many vehicles in one place at the same time. According to commuter statistics by Statistics Indonesia, millions of vehicles passing through JMA each day, of which 63.2% are motorcycles, and 8.83% are passenger cars. In contrast, mass public transportation such as KRL and TransJakarta only amounts to 9.16% and 3.37% of the total vehicles in JMA (Badan Pusat Statistik, 2019). It implies that the motorcycles and passenger cars, which are privately owned vehicles, responsible for the severe traffic congestion in JMA. Public transportations are effective in reducing traffic congestion. However, commuters in JMA are reluctant to use one.

We aim to analyze the behavior of commuter workers who live in JMA in choosing the mode of transportation for work. We divide the modes of transportation into three categories; TransJakarta, Commuterline, and other modes. A commuter is a worker who goes to another city to work and returns to their residence on the same day (Badan Pusat Statistik, 2019). Various factors influence the commuter's

decision to choose a transportation mode. However, we focus on income, education, sex, employment sector, motorcycle ownership, car ownership, commuting distance, city of origin, and the number of commuters in a household.

Chotib (2019), in a study, covered ten metropolitan areas in Indonesia, including JMA, as well as Setyodhono (2017). This study also uses JMA as an object of study. Chotib (2019) divided the transportation modes into two categories; public and private transportation, while this study divides into three categories by separating public transportation into TransJakarta and Commuterline because these two modes are the major public transportation networks in JMA. Therefore, the method is also different. The mass transportation network that has just been established in JMA is the LRT. However, this study cannot estimate it because of limitations on the dataset.

2. DATA AND METHODS

This study analyzes the effect of socio-economic variables on the commuter's choice of transportation mode. The socio-economic variables used in this study are income, education, sex, employment sector, motorcycle ownership, car ownership, commuting distance, city of origin, and the number of commuters in a household. The data in this study obtained from the 2014 Jabodetabek commuter survey by Statistics Indonesia. Transportation mode choice is a dependent variable, while socio-economic indicators are independent variables. The variable definition is as follows:

Table 1. Variable Definition

Variable	Definition
Transportation Mode Choice	The main transportation mode used by commuter in JMA to work. The variable divided into three categories; TransJakarta, Commuterline, and other modes such as private vehicles and personalized public transportation.
Income	A Commuter's monthly income obtained from employment. The data is in Rupiah.
Education	A dummy variable of commuter's highest education. The variable takes one if a commuter possessed a higher education (college), and zero otherwise.
Sex	A dummy variable of commuter's gender. The variable takes one if a commuter is a male, and zero otherwise.
Employment Sector	A dummy variable of commuter's employment sector. The variable takes one if a commuter works in a formal sector, and zero otherwise.
Motorcycle Ownership	A dummy variable of commuter's vehicle ownership. The variable takes one if a commuter owning a motorcycle, and zero otherwise.
Car Ownership	A dummy variable of commuter's vehicle ownership. The variable takes one if a commuter owning a car, and zero otherwise.
Commuting Distance	Traveled distance from a commuter's residence to a workplace. The data is in kilometer.
City of Origin	A dummy variable of commuter's residence. The variable takes one if a commuter lives in Jakarta SCR, and zero otherwise.
# of Commuters in a Household	The number of household member who commute to work everyday.

The transportation mode variable consists of three choices. It means that the variable was estimated by the multinomial logit model (MNL). This model is suitable for estimating the variable with more than two choices: TransJakarta, Commuterline, and other modes. The logit model is a non-linear regression model, neither the parameter nor the variable. Therefore, the MNL was estimated using a maximum likelihood estimator rather than ordinary least square (Gujarati, 2003).

We observe the probability of the event of $Y=i$ occur. $i=1$ if a commuter chooses TransJakarta as the main transportation mode or $i=2$ if a commuter chooses Commuterline as the main transportation mode. Meanwhile, $i=3$, where a commuter chooses other modes as the main transportation mode, remains as a comparison. Therefore, the model uses two logit functions. The equations are as follows:

$$g_1(x) = \ln \left[\frac{P(Y = 1|x)}{P(Y = 3|x)} \right] = \ln \left[\frac{P_1}{P_3} \right]$$

$$= \beta_{10} + \beta_{11}Income + \beta_{12}Education + \beta_{13}Sex + \beta_{14}Employment + \beta_{15}Motorcycle + \beta_{16}Car + \beta_{17}Distance + \beta_{18}City + \beta_{19}Comm$$

$$g_2(x) = \ln \left[\frac{P(Y = 2|x)}{P(Y = 3|x)} \right] = \ln \left[\frac{P_2}{P_3} \right]$$

$$= \beta_{20} + \beta_{21}Income + \beta_{22}Education + \beta_{23}Sex + \beta_{24}Employment + \beta_{25}Motorcycle + \beta_{26}Car + \beta_{27}Distance + \beta_{28}City + \beta_{29}Comm$$

$g_1(x)$ is a logit function of using TransJakarta compared with using other modes as the main transportation mode; $g_2(x)$ is a logit function of using Commuterline compared with using other modes as the main transportation mode; *Income* is commuter's monthly income obtained from employment; *Sex* is a dummy variable of commuter's gender; *Employment* is a dummy variable of commuter's employment sector; *Motorcycle* is a dummy variable of commuter's motorcycle ownership; *Car* is a dummy variable of commuter's car ownership; *Distance* is a kilometer measured of commuter's traveled distance from residence to the workplace; *City* is a dummy variable of commuter's residence; *Comm* is a number of commuters that live in a household. The models then estimated with the following equation:

$$P(Y = j|x) = \frac{e^{g_j(x)}}{\sum_{j=1}^2 e^{g_j(x)}}$$

Where $P(Y = j|x)$ is the odds of using transportation mode j compared to a transportation mode choice that became a base.

The sample in this study is a commuter worker in JMA. A worker is someone who is making an effort to obtain or help to obtain an income or a profit of at least an hour continuously over the past week. Therefore, a commuter worker is a worker who works outside their city of residence and returns to their residence on the same day regularly (Badan Pusat Statistik, 2019).

The choice of transportation mode is a dependent variable. Since the dependent variable consists of three categories, we use a multinomial logistic regression method to analyze the socio-economic factors and transportation mode. The data was collected from the 2014 Jabodetabek commuter survey by Statistics Indonesia. We use JMA because it is the largest metropolitan area in Indonesia in terms of population. TransJakarta and Commuterline is the major public transportation network service in JMA, while other modes consist of motorcycles, cars, and personalized public transport such as online transportation.

Recent studies related to the transportation mode choice have been done, and the results were mixed. Public transportation is an inferior service. It means the relationship between income and demand for public transportation is negative. An increase in income decreases the odds of the commuters to use public transportation (Amoh-Gyimah & Aidoo, 2013; Ashalatha et al., 2013; Chotib, 2019; Liu, 2007; Loo et al., 2015; Masoumi, 2019; Mayo & Taboada, 2019; Meena et al., 2019; Sekhar, 2016; Setyodhono, 2017; Thrane, 2015). The income is diverted to use private vehicles that can increase their utility, since private transportation such as motorcycle, car, and online transportation are more convenient than public transportation.

Recent studies showed that education has a negative effect on public transportation use. It means that when an individual possessed a higher education, the odds of using public transportation decreases (Amoh-Gyimah & Aidoo, 2013; Chotib, 2019; Sekhar, 2016; Setyodhono, 2017). We use a dummy on the education variable. The variable takes one if a commuter possessed a higher education and takes zero otherwise.

Based on sex, men are preferred to use private vehicles such as motorcycles and cars compared to public transportation (Amoh-Gyimah & Aidoo, 2013; Ashalatha et al., 2013; Ko et al., 2019; Loo et al., 2015; Meena et al., 2019; Sekhar, 2016). However, in other studies, it is stated otherwise. Men are more likely to use public transportation and active mode than private ones (Mayo & Taboada, 2019; Nordfjaern et al., 2019; Pike & Lubell, 2016).

According to Setyodhono (2017), the employment sector affects the commuter's decision to choose the transportation mode. According to the study, workers with employee or labor status have higher odds of using public transportation than private vehicles. The employee or labor is classified as a formal employment sector. On the other hand, Chotib (2019) stated that workers in the formal employment sector have higher odds of using private vehicles than public transportation. Similar to recent studies, we use a dummy variable to represent the employment sector. The variable takes one if a commuter works in a formal sector, and takes zero otherwise.

A commuter who possessed a private vehicle such as a motorcycle or car tends to use their private vehicles to work. It is proven by recent studies (Ashalatha et al., 2013; Masoumi, 2019; Sekhar, 2016). We divide the vehicle ownership into two variables; motorcycle ownership and car ownership. Road in Indonesia, especially JMA, was dominated by a motorcycle. The data have shown that the number of motorcycles in JMA has reached 63% of the total vehicle, while cars are only 8.3% (Badan Pusat Statistik, 2019). Owning a motorcycle could be a different implication than owning a car. With a high level of traffic congestion, owning a car does not always end up using it. However, owning a motorcycle that only requires a small amount of space in the road will ease the commuter to get through the congested road in JMA. Therefore, it is important to differentiate the vehicle ownership into two different types of vehicles. We use a dummy to represent the motorcycle and car ownership. The variables take one if a commuter owned a motorcycle or a car, and takes zero otherwise.

The commuters with a further commuting distance are more likely to use public transportation (Chotib, 2019; Setyodhono, 2017; Thrane, 2015). Different results were obtained by Amoh-Gyimah & Aidoo (2013), while commuters with a further commuting distance are less likely to use public transportation and prefer private vehicles.

The city of origin variable is important for explaining the choice of transportation mode. The city of origin variable reflects the public transportation facilities in that city. We use a dummy variable to represent the city of origin variable. The variable takes one if a commuter lives in Jakarta Special Capital Region (SCR), and takes zero otherwise. Cities with good road facilities tend to have good public transportation networks as well, thus encouraging commuters to use them (Mayo & Taboada, 2019). The closer the city of origin and city of destination also affects the choice of mode of transportation (Loo et al., 2015).

We also estimate the effect of the number of commuters in a household. Based on recent studies, a household that has more commuter are more likely to possessed and use a car to work (Cumming et al., 2019; Meena et al., 2019; Yang et al., 2017). It does not always mean that all household members share the same workplace, but they have the possibility to go through the same road.

3. RESULT AND DISCUSSION

The commuter workers that became the sample of this study is 4,740 observations. Of those 4,740, 122 or 2.57% of them are using TransJakarta, 365 or 7.70 commuters using Commuterline, and the highest amount of them use other transportation modes such as motorcycles, car, and personalized public transportation. The complete statistic descriptive statistics of all variable is as follows:

Table 2. Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Transportation Mode Choice	4,740	2.871	0.404	1	3
Income	4,740	4398267	5325277	0	1.20e+08
Education	4,740	0.370	0.482	0	1

Variable	Obs.	Mean	Std. Dev.	Min	Max
Sex	4,740	0.714	0.451	0	1
Employment Sector	4,740	0.928	0.258	0	1
Motorcycle Ownership	4,740	0.904	0.294	0	1
Car Ownership	4,740	0.305	0.460	0	1
City of Origin	4,740	0.410	0.491	0	1
Commuting Distance	4,740	21.269	15.122	0	104
# of Commuter in a Household	4,740	1.640	0.844	1	5

Note: Transportation mode choice is a dependent variable, while the other variables are the independent variable. Transportation mode choice divided into three categories; using TransJakarta, using Commuterline, and using other modes. The total observation in this study is 4,740 commuter workers. Income is in Rupiah, commuting distance is in Kilometer, and the number of commuters in a household is in a number of people. Meanwhile, other variables are in the form of a dummy. All data obtained from the 2014 Jabodetabek commuter survey by Statistics Indonesia.

The education variable is a dummy variable. The commuters who possessed a higher education are 1,755 or 37.03% of a total sample, while other commuters do not possess higher education. Male commuters are 3,386 of a total sample. In the dataset, very few commuters work in an informal sector. There are only 340 or 7.17% of them, while other commuters work in a formal sector. Motorcycle owners are more than car owners. As much as 4,286 commuters owning a motorcycle, while only 1,446 of commuters owning a car. There are 1,944 or 41% commuters live in Jakarta SCR, while other commuters live in other cities in JMA.

The income variable has a negative relationship with a transportation mode choice variable. The income variable is significant at a 95% confidence level. An increase in income decreases the commuter's odds of using TransJakarta and Commuterline relative to the other modes. Therefore, the TransJakarta and Commuterline considered inferior goods compared to the other modes such as motorcycle, car, and personalized public transport (Pindyck & Rubinfeld, 2013). Based on the marginal effect, an increase in income by a million Rupiah decreases the odds of using TransJakarta by 0.19%, while the odds of using Commuterline decreases by 0.5%. The result of the estimation was matched with recent studies (Amoh-Gyimah & Aidoo, 2013; Ashalatha et al., 2013; Chotib, 2019; Liu, 2007; Loo et al., 2015; Masoumi, 2019; Mayo & Taboada, 2019; Meena et al., 2019; Sekhar, 2016; Setyodhono, 2017; Thrane, 2015). TransJakarta and Commuterline considered an inferior good in JMA because when the commuter's income increases, they will choose other modes that they expect to be better than TransJakarta and Commuterline. Multiple factors affect one's decision to choose a transportation mode. One of the factors is comfort, and a private vehicle considered to be more comfortable than mass public transportation (Anik et al., 2018; Borhan et al., 2019; Burian et al., 2018).

Sex has a negative relationship with a transportation mode choice. Sex variable significant at a 99% confidence level. Since the dummy variable takes one if the commuter is a male, therefore, male commuters are less likely to use TransJakarta compared to the other modes by 0.25 times and are less likely to use Commuterline compared to the other modes by 0.4 times. The results are similar to recent studies (Amoh-Gyimah & Aidoo, 2013; Ashalatha et al., 2013; Ko et al., 2019; Loo et al., 2015; Meena et al., 2019; Sekhar, 2016). It means that men are more likely to drive or ride by themselves while females, on the other hand, are more preferred public transportation.

Motorcycle ownership negatively significant on transportation mode choice at a 99% confidence level. Commuters who own a motorcycle are more likely to not using TransJakarta by 0.26 times and are more likely to not using Commuterline by 0.46 times compared to the other modes. This result is similar to recent studies (Ashalatha et al., 2013; Masoumi, 2019; Sekhar, 2016). However, on the other hand, the car ownership variable is not significant. Owning a car does not always mean a commuter will use them daily. In a congested road of JMA, using a motorcycle is a better option to decrease travel time.

Commuters who live in Jakarta SCR are more likely to use TransJakarta by 8.3 times and are more likely to use Commuterline by 0.36 times relative to the other modes. The odds of using TransJakarta are bigger than the odds of using Commuterline. It means that the TransJakarta facility in Jakarta SCR is more satisfying

than Commuterline. We do not estimate the effect of accessibility. However, from the data, it could be reflected that commuters in Jakarta SCR are easier to find TransJakarta bus stop rather than Commuterline station because TransJakarta has a 217 bus stop while Commuterline only has 79 stations. Besides, the TransJakarta fare is cheaper than Commuterline.

Table 3. Regression Results

Variable	Coefficient	RRR	Marginal Effect
TransJakarta			
Income	-8.92e-08** (4.43e-08)	-	-1.90e-09
Education	0.468** (0.234)	1.597	-
Sex	-1.395*** (0.204)	0.247	-
Employment	2.391** (1.023)	10.924	-
Motorcycle Ownership	-1.330*** (0.225)	0.264	-
Car Ownership	-0.047 (0.263)	0.953	-
City of Origin	2.117*** (0.257)	8.314	-
Commuting Distance	0.334*** (0.006)	-	0.0006
# of Commuter in a Household	0.246** (0.114)	-	0.005
Commuterline			
Income	-8.21e-08*** (2.38e-08)	-	-4.86e-09
Education	0.450*** (0.140)	1.568	-
Sex	-0.909*** (0.129)	0.402	-
Employment	0.797*** (0.307)	2.219	-
Motorcycle Ownership	-0.756*** (0.181)	0.469	-
Car Ownership	-0.101 (0.155)	0.903	-
City of Origin	-1.013*** (0.158)	0.362	-
Commuting Distance	0.053*** (0.003)	-	0.003
# of Commuter in a Household	0.136** (0.069)	-	0.007
Other Modes		(Base Outcome)	
Obs.		4,740	
Pseudo R ²		0.184	

Note: The numbers in parentheses are standard errors. Variable coefficients are presented above the standard errors. The dummy variables interpreted in a relative risk ratio, while the continuous variable interpreted in a marginal effect. * p<0,1, ** p<0,05, ***p<0,01.

The commuting distance variable positively significant on transportation mode choice at a 95% confidence level. An increase in commuting distance increases the likelihood of using TransJakarta and

Commuterline. Suppose the commuting distance increases by 1 kilometer, the likelihood of using TransJakarta and Commuterline increases by 0.06% and 0.3%. The result is similar to recent studies (Chotib, 2019; Setyodhono, 2017; Thrane, 2015). Commuters will choose the fastest transportation mode when they travel further (Mattisson et al., 2018). In JMA, TransJakarta and Commuterline operate in a dedicated track separated from private vehicles such as motorcycles and cars. TransJakarta operates on a special track located on the side of the road while Commuterline, as rail-based transportation, operates in a rail. Therefore, TransJakarta and Commuterline could travel faster than the other modes that do not operate in a dedicated track.

4. CONCLUSION

We analyze the effect of socio-economic factors on the choice of transportation mode. The socio-economic variables used in this study are income, education, sex, employment sector, motorcycle ownership, car ownership, city of origin, commuting distance, and a number of commuters in a household. The object of this study is a commuter worker in JMA. We use a different transportation mode choice and dataset with a recent study that also used commuter workers in JMA as an object (Chotib, 2019).

Of the nine socio-economic variables, one of them, the car ownership variable, is not statistically significant. TransJakarta and Commuterline in JMA considered an inferior transportation mode. It is proved by the negative coefficient. Female commuters are more likely to use TransJakarta and Commuterline relative to the other modes compared to a male commuter. Several recent studies stated that, for male, a motorcycle or a car is not merely a mode of transportation to get them from point A to point B, but rather to give them satisfaction to ride or drive it (Jia et al., 2018; Loo et al., 2015; Van et al., 2014). Motorcycle owners are not likely to use TransJakarta or Commuterline as motorcycle could get them to the workplace more practical. Jakarta SCR has good TransJakarta and Commuterline facilities. Therefore, commuters in Jakarta SCR are preferred to use TransJakarta or Commuterline as the main transportation mode. Since a commuter will choose the fastest mode to travel far, they are more likely to use TransJakarta and Commuterline, which operates on a dedicated special track separated from the other modes. Besides, using public transportation means the commuter could avoid fatigue from the far travel distance.

Since the motorcycle ownership affects the choice of transportation mode, to divert the commuters from the private vehicle to mass public transportation mode the local government of Jakarta Metropolitan Area should control the private vehicle growth in JMA such as making the requirements to have a vehicle more difficult or to set vehicle tax higher. Commuters in Jakarta SCR are more likely to choose TransJakarta and Commuterline because of the good facilities. Local government also encouraged to improve the mass public transportation facilities in cities outside Jakarta SCR to promote more ridership of TransJakarta and Commuterline. The local government should also improve the TransJakarta and Commuterline facilities to be more suitable for female commuter's characteristics since female commuters are more likely to use them compared to the other modes.

However, this study has a limitation. We only analyze the socio-economic variables while there are still many other factors that affect the choice of transportation mode. Therefore, future studies are encouraged to explore other variables that affect the choice of transportation mode.

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