Abstract

In this dissertation, I investigate the effects of introducing electronic road pricing (ERP) in the Jakarta Metropolitan Area (JMA) by using the spatial general equilibrium (SGE) model. The ERP charges all car and motorcycle users who pass the boundary of the central business district (CBD). In transport economics, this type of road pricing is commonly referred to as the cordon pricing. The plan itself has entered the legislative process since the central government enacted Government Regulation (PP) No. 32/2011 on Traffic Management and Engineering. The regulation provides a legal framework within which the Jakarta local government may execute the ERP plan. At the same time, there is a continuous debate at the national level on whether the gasoline subsidy in Indonesia should be reduced to create more funds for social and development spending. Reducing the gasoline subsidy implies an increase in the gasoline price, which is similar to the gasoline tax practices that are found in developed countries. It is also interesting to compare the performance of the cordon toll to that of the gas tax policy in reducing congestion and generating welfare gain.

Based on the work of Anas and his co-authors, I analyze the effects of road tolls by using the SGE model to accommodate the assumption of the polycentric city of the JMA. The SGE model includes a multicentric city feature as well as the interactions among workers, producers, and the government. The JMA is divided into ten zones and three subregions, i.e. the CBD, the sub-central business district (SBD), and the suburbs, which serve as both working and residential zones. Production takes place in all zones, where the final goods are heterogeneous across zones. Workers are divided into three groups exogenously and cannot upgrade into the higher group, and vice versa. They consume final goods, land, and leisure to maximize their utility subject to the annual income.

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Given the possible consumption bundles, workers choose the best home-to-work choice that would maximize their utility. Given their home-to-work choice, workers must commute and shop by using the available transport modes (the car, the motorcycle, and the public bus) and route choices. The residents minimize the generalized travel cost, which consists of the monetary travel cost and the travel time cost, by choosing a mode-route arrangement. The model incorporates the endogenous per car equivalent unit (PCU) due to the heterogeneous traffic flow. The crowding cost of the public bus is introduced as a positive function of bus ridership and a time multiplier parameter. The latter variable is defined as the marginal rate of substitution of the travel time between the congested and the base levels. Interactions among producers, workers, and the government are reflected in three different markets, i.e. the labor, the land, and the final goods markets. The equilibrium endogenously determines the land, the employment, and the final goods allocations between the producers and the workers, as well as among all prices.

Using the aforementioned SGE model, I investigate the welfare effects of the CBD cordon toll of the JMA. Initially, the CBD cordon toll as proposed by the Japan External Trade Organization (JETRO) is simulated: 15 thousand rupiah (1.5 USD) for the private car users and 5 thousand rupiah (0.5 USD) for the motorcycle users. Other simulated cases are developed by widening the cordon ring or charging the private car users only. Two scenarios for a wider cordon are the SBD cordon and the step-tolling CBD+SBD cordon. The results show that the welfare gain is 225.7 thousand rupiah or approximately 0.48 percent of the gross annual income, while the gain for wider cases is 60-75 percent higher. The welfare gain, however, is lower if the time multiplier parameter is higher, which prevents road users from switching to the public bus, and in turn, reduces the congestion level less. Doubling the base parameter of the time

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multiplier results in a 0.3-0.4-percent decrease in congestion reduction and a 4.5-6.1-percent decrease in welfare gain.

A simpler cordon toll scheme that focuses on charging private car users may attain a higher gain than the tolling of both private modes. The car tolling yields a wider generalized cost between the car and the other modes than tolling both the car and the motorcycle. As a result, it drives more car users to switch to the use of motorcycles, which is faster than the use of public buses, and thus generates higher daily travel time saving than the tolling of both cars and motorcycles. Yet, the higher the toll, the less the gap is between the tolling of all private modes and that of the car only. For each additional toll, the private-based cordon toll drives out more private mode users than those driven out by the car-based cordon toll. Beyond 60 thousand rupiah of the cordon toll, the gain under the private-based toll becomes higher.

I evaluate the welfare effects of the gasoline tax as an alternative anti-congestion policy and compare the results to those of the CBD cordon toll. Two scenarios are considered. First, the gas tax affects all transport modes, including the bus fare. I refer to this scenario as the general gas tax policy. Second, the gas tax is assumed to have no direct effect on the bus fare to the extent that the fare remains constant. This scenario is then referred to as the policy mix. Because the gas tax policy captures more road users and serves as a distance-based road tax regardless of the private modes, an increase of 25 percent in the gas price ensures that the general gas tax policy obtains a similar level of welfare gain as the private CBD cordon toll. The policy mix provides better results than the general tax policy since it reduces more congestion and provides higher travel time saving. An increase of 22 percent in the gas price under the policy is sufficient for obtaining the welfare gain under the private CBD cordon toll. The policy mix creates a wider gap of the generalized travel

cost between the private modes and the public bus, and hence allows more car and motorcycle users to switch to the public bus than those allowed by the general tax policy.

In the long run, the road pricing changes not only the workers' transportation behaviors, but also their commuting arrangements. I investigate how the road tolls influence the residents' choices of residential and/or working locations. Three road toll scenarios are then considered, i.e. the cordon toll, the area toll, and the gasoline tax. In general, the area toll is similar to the cordon toll, except that the area toll also levies the interzonal trips of the designated area. Two equilibrium regimes related to the workers' behavior are considered: the flexible home-to-work choice and the fixed residential choice.

Under the flexible regime, the results of the cordon toll confirm the findings of previous studies, which have asserted that the cordon tolls may lead to a more dispersed city if the cordoned area is small enough. Nevertheless, the dispersion effects can be minimized as long as a sufficient discount is offered to the CBD residents, as seen in the cases of the area toll. The gas tax policy rather creates a more compact urban form, as a direct toll-avoidance response of the workers is a reduction of the commuting distance. Interestingly, the car-based cordon scenarios lessen the effects, or even contradict the results, of the private-based cordon scenarios. Under the car CBD cordon toll, the concentration effect is present. The reason is that, although the private- and the car-based CBD cordon cases allow relatively similar travel time saving in the CBD zone, the latter yields significantly less expected annual monetary travel cost, and in turn, achieves a positive net gain and invites more residents to live in the CBD.

Meanwhile, the fixed residential choice regime allows workers to exploit fully the flexible job location choice by anticipating the increase of the generalized travel cost. The results, however, show that, in general, the curvature of em-

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ployment changes does not differ significantly from the results under the flexible residential location choice, except for those concerning the general gas tax policy. Employment in the CBD decreases while the opposite occurs under the flexible home-to-work choice regime. Since 53 percent of the total residents live in the suburban zones, the dispersion result occurs as some suburban workers alternate their working places from the CBD and the SBD zones to the suburban zones.

This research contributes to better understanding of the effects of road toll policies when the traffic flow is heterogeneous and the public transport uses the same road networks as the other private modes. The simulation results suggest some policy choices from which the JMA authority may select an appropriate road toll scheme for the road congestion reduction of Jakarta.