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Peak-Load Pricing in Portland: Theory, Application, and Recommendations for Central Business District Pricing Policy

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Theory, Application, and Recommendations for Central Business District Pricing Policy

In order to make good microeconomic policy in the public sector, non-rivalrous goods and joint costs need to be addressed. One field where ***non-rivalrous goods*** *and joint costs are important to consider is in the economics of* ***peak-load pricing*** *and transportation policy. This concept is often applied to electrical utilities, but not often applied as a way to relieve the burden of downtown traffic congestion during peak traffic times or to increase city revenues. This paper discusses the theory of peak-load pricing as it applies to* ***"central business districts"*** *(CBDs). It demonstrates successful and unsuccessful examples of peak-flow pricing in CBDs in other cities, including how the* ***private costs*** *of driving interact with potentially implementing a policy, and how politics play a role in implementing peak-load pricing policies. Finally, it discusses current transportation policies in Portland, Oregon, and recommends the city implement a congestion pricing policy.*

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INTRODUCTION: NON-RIVALROUS GOODS AND JOINT COSTS

City officials need to have a plan to reduce the negative effects of traffic congestion and the environmental externalities of an entire population commuting throughout a city. Because urban centers have grown astronomically in the land-wealthy United States, traffic congestion and its impact on the environment and even equity have become an increasing issue in the U.S. Public policy is necessary to mitigate these issues.

When working within the realm of public policy, it is important that the study of economics addresses the issue of non-rivalrous goods. Roads provide a place for cars to drive all the time, but they are utilized differently depending on the time of day. Peak traffic times see higher congestion, while off-peak times see

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lower congestion.[1] If we continue to use this division of traffic times, we can consider them to be non-rivalrous goods because "an increase or decrease in the amount of [road] used to provide one … does not change the amount of [road] available to supply the other."[2] In other words, it does not matter how much road is used, but simply that roads exist during both peak and off-peak traffic times.

Another important concept to understand with the idea of peak traffic times and off-peak traffic times is the idea of joint costs. Essentially, joint costs occur "when two or more discrete outputs are made from some of the same inputs."[3] For example, traffic happens during peak times and off-peak times, but roads are nevertheless used for cars (and other vehicles) during both times. Furthermore, "the problem is deducing whether the marginal cost of an output is greater or less than its marginal benefit."[4] How do you decide if the roads have a greater benefit during peak times or off-peak times? They clearly benefit cars all the time. One way to address the issue of joint costs is simply to add up the marginal benefits and then compare them to the marginal costs.[5]

When utilizing roads, drivers in much of the United States are shielded from the full marginal social costs of driving. They also often underestimate the private costs of driving. Economists have advocated for a long time for drivers to pay the marginal costs of using highways, though it has been politically unpopular until relatively recently.[6] In this paper, I will walk through the theoretical model of peak-load pricing and how it might apply to a central business district (CBD). A peak-load pricing model would require drivers to share the marginal costs of driving during peak traffic times. Then I will describe how such a policy might work, give examples, and explain the private costs of driving in more detail. Finally, I offer my recommendations for how and when to implement a peak-load pricing policy in Portland, Oregon. For the purposes of this report, we will assume that all non-public motorized vehicles would count equally, and that roads would be priced depending on location and typical congestion patterns.

1. Anastasios Charisis, Stephen Spana, Evangelos Kaisar, and Lili Du. "Logistics Hub Location-scheduling Model for Inner-city Last Mile Deliveries." International *Journal for Traffic and Transport Engineering* 10, no. 2 (2020): 170, doi: 10.7708/ijtte.2020.10(2).04.

2. Friedman, Lee S. *The Microeconomics of Public Policy Analysis*. (Princeton, N.J.: Princeton University Press, 2002), 355.

3. Friedman, *Microeconomics*, 357.

4. Friedman, *Microeconomics*, 357.

5. Friedman, *Microeconomics*, 357.

6. B. Starr McMullen. "Congestion Pricing and Demand Management: A Discussion of the Issues." *Policy Studies Journal* 21, no. 2 (1993): 285-86, 89, doi:10.1111/j.1541-0072.1993.tb01822.x.

PEAK-LOAD PRICING THEORY

There are several kinds of costs associated with peak-load pricing: private costs, average costs, and marginal costs. Private costs include any short- or long-term real cost or opportunity cost paid by the driver for their personal belongings. This could be fuel, car repair costs, time spent sitting in traffic that could have been spent doing other things, etc. Average costs in this case include the normal costs to public agencies of building, maintaining, and policing the road. The marginal cost in this case is the additional driving time of one more vehicle driving on the road.

In Figure 1, the space between O and A represents the private costs to drivers, while the space between A and B represents the average costs (and marginal costs) to public agencies. At line D_1, the demand curve for non-peak traffic times, the marginal cost and average costs are the same. We know that traffic is not congested because the marginal cost during non-peak times makes each vehicle trip cost equal to the next one, up to line C.[7]

At line C, where congestion increases, so does the marginal cost. Each new vehicle added to the road increases congestion. People are spending more time sitting in traffic, which increases the marginal cost. The place in the model where the marginal cost increases above the average cost is an important opportunity for revenue. According to McMullen, "the optimal user fee for a public agency to charge is one that makes the total price paid for the vehicle trip equal to its marginal cost."[8] Looking back at Figure 1, line D_2 represents the vehicle trip demand during a peak traffic time. If only the average cost is charged as a user fee, then traffic expands to line Q_2, which would mean more congestion. However, if the average cost plus the marginal cost (GD+DE) is charged as a user fee, then traffic contracts to line Q*. Congestion is reduced and the city receives a higher revenue. In this scenario, GD is charged as a road tax, but DE is the price of the congestion fee.[9]

7. McMullen, "Congestion Pricing," 285-86, 89.
8. McMullen, "Congestion Pricing," 285-86, 89.
9. McMullen, "Congestion Pricing," 285-86, 89.

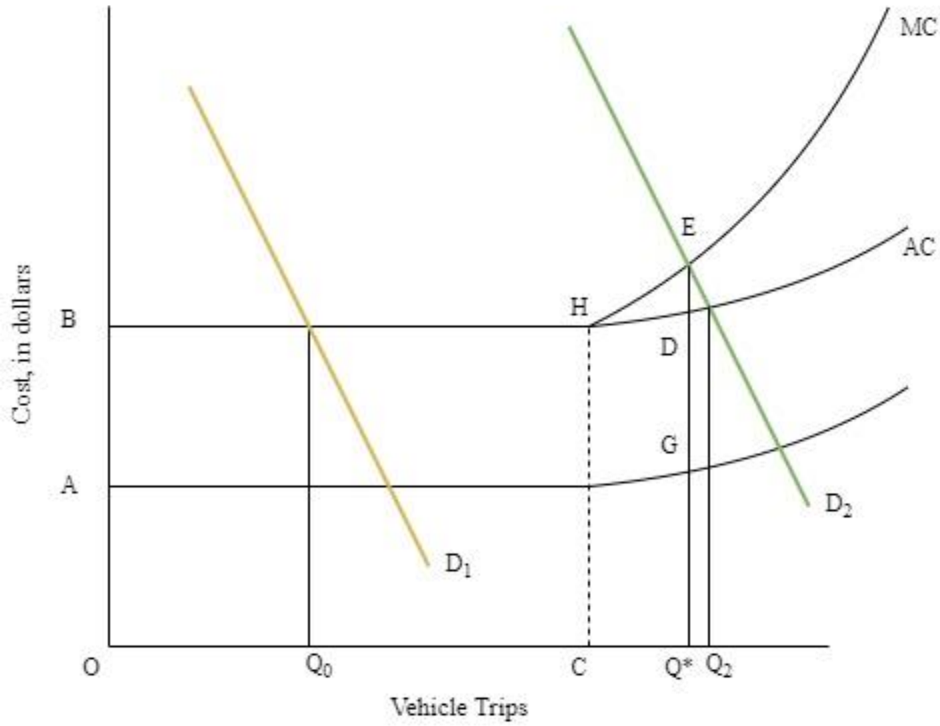

Figure 1: Theoretical peak-load pricing scheme[10]

It is important to note that peak-load pricing will not reduce traffic congestion at high-peak times drastically enough to equal congestion at low-peak times.[11] However, congestion can be contained while also creating revenue for the city. Additionally, utilizing taxes to reduce vehicle traffic congestion can be a transparent way to encourage commuters to use public transit, thus increasing confidence in government.[12]

One reason why drivers might make more trips into a CBD even during congestion is an underestimation of their own private costs. Many drivers only consider the cost of fuel when calculating their private costs, forgetting to include long-term maintenance costs and even the value of their time that could be spent elsewhere. Because of this, drivers are more likely to make more trips into and out

10. McMullen, "Congestion Pricing," 286.

11. McMullen, "Congestion Pricing," 286.

12. Shwu-Ping Guo, and Chaug-Ing Hsu. "Impacts of Transportation External Cost Pricing Fare Reductions on Household Mode/Route and Environmental Improvements." *Journal of Urban Planning and Development* 136, no. 4 (2010): 339-40, doi:10.1061/(ASCE)UP.1943-5444.0000036.

of the CBD, increasing traffic congestion and marginal costs for everyone.[13] By creating a policy with a visible cost, drivers are more likely to become aware of driving costs in addition to fuel costs.

INTERNATIONAL AND DOMESTIC POLICY APPLICATIONS

The first successfully implemented peak-load pricing policy took effect in Singapore in 1975. The Singaporean government began by utilizing a flat-rate sticker system to allow entry into the CBD, hoping to reduce traffic congestion during peak times by 25-30%. They discovered that traffic congestion was reduced by 40% and that public transit users increased. Because the fee was waived for carpools of four or more people, a significant increase was seen in these carpools as well. On the other hand, travel time increased by 44% during peak times, largely because of the increased use of the public transit system. Off-peak traffic also increased. Low-income individuals were inconvenienced, indicating that public transit fares should be reduced, and the public transit system should be expanded to make transportation into CBDs more equitable during peak times.[14] Guo and Hsu (2010) demonstrated similar findings in their recent comparison of peak-load pricing policies and transit fare-reduction policies.[15]

Technology advances since 1975 have allowed for more cost-effective and convenient ways to charge user fees during peak times. In 1983 Hong Kong began testing an automatic vehicle identification system (AVI) which allows public agencies to identify when vehicles enter CBDs. Then public agencies can mail a bill to the driver at the end of the month, rather than requiring an in-person purchase or the infrastructure of a toll booth on every street. This system was incredibly accurate, even in 1983; however, due to political obstacles, the policy was never fully implemented.[16] Politics have also kept road-pricing schemes from being implemented in the United States over the years. In most cases, the areas that were considering peak-pricing schemes in CBDs or highways received a significant amount of negative press, which ultimately caused the projects to fail. For example, press coverage of the campaign to implement peak-load pricing policy in the CBD of San Francisco in the 1970s focused on some of the controversial aspects of the policy and did not discuss the benefits of the policy.[17] By working with the press

13. McMullen, “Congestion Pricing,” 289-90.
14. McMullen, “Congestion Pricing,” 290-91.
15. Guo and Hsu, “Impacts,” 344-47.
16. McMullen, “Congestion Pricing,” 291.
17. McMullen, “Congestion Pricing,” 291.

and possibly local businesses to attract positive press that discusses the benefits of peak-load pricing policy, Portland may overcome this obstacle.

PORTLAND TRAFFIC AND TRANSIT POLICIES

According to a policy report by Rubin and Mansour (2013) for the Reason Foundation, Portland has some unique policies related to transit and traffic. Through its unique set of policies, the Portland urbanized area saw a 29% increase in unlinked transit passenger trips per capita. The same region saw a 25% increase in transit passenger-miles per capita in the same time period.[18] However, transit usage increases in Portland align with congestion increases. While transit usage increase of course does not cause traffic congestion increase, these increases are likely caused by the same set of policies.[19]

One such policy reappropriates funding originally intended to be used for highway construction and road improvement to public transport projects. Another policy sets specific, explicit city goals to establish high-capacity ratios for city roads which ultimately increases traffic congestion.[20] A third policy involves prioritizing transit system development and preventing construction of new high-capacity roads.[21] A fourth policy specifically assigns more than half of combined transportation funding to transit (rather than road projects) for the next 15 years despite the majority of commuters driving in on roads. These combined policies lead to increases in both congestion and transit usage.[22] While it appears that Portland was hoping to drive traffic commuters to use public transit instead, this set of policies does not seem to have enticed a significant number of drivers to switch to transit. Furthermore, these land use policies alone are not as effective as they might be if combined with congestion pricing policies, such as peak-load pricing.

POLICY RECOMMENDATIONS FOR PORTLAND

A study using data from Portland, Oregon, sought to empirically test if land use planning and congestion pricing support each other in reducing "road congestion and other environmental and social externalities associated with driving."[23] The

18. Thomas A. Rubin and Fatma Mansour, "Transit Utilization and Traffic Congestion: Is There a Connection?" December 2013, "Case Study: Portland," http://trid.trb.org/view/1285621.

19. Rubin and Mansour, "Transit Utilization and Traffic Congestion."

20. Rubin and Mansour, "Transit Utilization and Traffic Congestion."

21. Rubin and Mansour, "Transit Utilization and Traffic Congestion."

22. Rubin and Mansour, "Transit Utilization and Traffic Congestion."

23. Zhan Guo, Asha Weinstein Agrawal, and Jennifer Dill, "Are Land Use Planning and Congestion Pricing Mutually Supportive?" *Journal of the American Planning Association* 77, no. 3 (July 1, 2011): 243, https://doi.org/10.1080/01944363.2011.592129.

results of this study demonstrated that congestion pricing affects congestion more effectively in more densely populated areas, such as urban areas, than in less densely populated areas, such as suburban areas. Additionally, land use planning factors were more heavily influenced by variable-rate fee structures than flat-rate fee structures. This means that with land use planning, congestion pricing was more helpful for planning land use areas that encouraged people to use transit instead of traffic.[24]

One important factor to consider when preparing for a peak-load pricing policy is determining how you will set pricing policies to accurately reflect time-dependent traffic patterns and heterogeneous user preferences. Lu, Mahmassani, and Zhou (2008) developed a bi-criterion dynamic user equilibrium traffic assignment model (BDUE) that captures "traffic dynamics and users' responses to toll charges for the design and evaluation of time-dependent pricing schemes."[25] Portland should engage in research using this or a similar dynamic user equilibrium model in preparing for utilizing a peak-load pricing scheme.

Other factors to consider when developing a peak-load pricing policy relate to land use planning and congestion pricing working together. The first factor to consider when structuring the policy is that coordinating congestion pricing with current and future land use planning has a sizeable impact on the economic and political success of a policy. Another factor is that economic effects include short-term spillover effects and long-term decisions to relocate based on pricing policies. A third factor to consider is that political effects include revenue and spending of collected moneys. This might be an issue more often in dense neighborhoods that rely more on transit than traffic, thus reducing revenue from congestion pricing and increasing transit spending pressures.[26]

A well-coordinated land use planning and congestion pricing effort is more likely to be successful politically than one aggressive initiative of either planning or pricing, though the outcomes in terms of revenue and spending may be similar. This means that urban planners can either use pricing to best utilize current land use patterns or they can plan land use to take best advantage of congestion pricing zones. However, "uncoordinated pricing schemes are likely to work against their policy objectives by encouraging spillover to areas with lower travel costs, perhaps

24. Guo, Weinstein Agrawal, and Dill, "Land Use Planning and Congestion Pricing," 243.

25. Chung-Cheng Lu, Hani S. Mahmassani, and Xuesong Zhou, "A Bi-Criterion Dynamic User Equilibrium Traffic Assignment Model and Solution Algorithm for Evaluating Dynamic Road Pricing Strategies," Transportation Research Part C: Emerging Technologies 16, no. 4 (August 1, 2008): 387, https://doi.org/10.1016/j.trc.2007.08.002.

26. Guo, Weinstein Agrawal, and Dill, "Land Use Planning and Congestion Pricing," 244.

facilitating sprawl."[27] In Portland, this might mean that CBD congestion pricing policies need to extend east across the Willamette River to account for traffic hubs in East Portland, such as the Moda Center and Lloyd Center areas.

The implication of the study by Guo, Weinstein Agrawal, and Dill (2011) is that a well-coordinated pricing and planning scheme is more likely to create beneficial behavioral changes than congestion pricing and land use planning independent of each other. Since Portland currently utilizes a land use planning scheme (intentionally creating traffic congestion in an attempt to reduce the number of drivers) and not a coordinated congestion pricing scheme in addition to land use planning, the author recommends implementing a coordinated plan involving both peak-load pricing and land use planning.

LIMITATIONS

This study relies on secondary data and analysis, which means that it is subject to selection bias and the biases of the authors providing the analysis. This has been accounted for by the author as much as possible in applying previous analyses but is likely not perfectly accounted for.

CONCLUSION

There are many reasons why peak-load pricing in CBDs is a good policy, including reducing single-driver vehicles that increase congestion, helping the environment, and increasing environmental and transportation equity throughout the city. Single-driver trucks completing last mile deliveries in particular add to negative environmental impacts and increases in traffic congestion.[28] On the other hand, a reduction in traffic congestion would lead to lower urban temperatures, thus reducing the effect of the urban heat island and creating more equitable environmental impacts in urban areas like Downtown Portland.[29] Additionally, if there is sufficient public transit infrastructure available, transportation equity will increase under a peak-load pricing policy in the CBD, especially if combined with

27. Guo, Weinstein Agrawal, and Dill, "Land Use Planning and Congestion Pricing," 244.

28. Charisis et al., "Logistics Hub," 169.

29. Haddad Louiza, Aouachria Zéroual and Haddad Djamel. "Impact of the Transport on the Urban Heat Island." *International Journal for Traffic and Transport Engineering* 5, 3(2015): 252-53, doi:10.7708/ijtte.2015.5(3).03.

current land use planning policies.[30] Most importantly, it will relieve traffic congestion in Downtown Portland and provide the city with additional revenue for road and transit projects.

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30. McMullen, "Congestion Pricing," 290-91; Guo, Weinstein Agrawal, and Dill, "Land Use Planning and Congestion Pricing," 244.

Rubin, Thomas A. and Fatma Mansour, "Transit Utilization and Traffic Congestion: Is There a Connection?" December 2013, "Case Study: Portland," http://trid.trb.org/view/1285621.