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Some like it HOT: A comparison of Toll Roads and High Occupancy Toll Lanes

CM Naudé

ARRB Group Ltd, 500 Burwood Highway, Vermont South, VIC 3133, Australia.

Email for correspondence: cliff.naude@arrb.com.au

Abstract

Of the various forms of road pricing, conventional link/network tolls and High Occupancy Toll (HOT) lanes are two options that road authorities are increasingly having to consider, and both have been implemented in various countries for different reasons and with varying degrees of success. Conventional tolls (manual or electronically collected) involve charging for the use of a specified road link or network for a set length of road (or tunnel or bridge), while HOT lanes involve the use of a fast lane at no charge if there is a designated minimum number of occupants of the vehicle, toll if there are no passengers or a reduced charge if there are fewer than the designated number of occupants.

This paper first defines the two approaches and examines key projects where conventional tolls and HOT lanes have been implemented. It then compares and contrasts international experience of conventional tolls with HOT lanes in terms of their legal requirements, operational (e.g. traffic) impacts, social (equity & distributional) impacts and public acceptance. Finally, some lessons and policy implications are put forward for road authorities in Australia, taking into account recent initiatives such as the Henry Tax Review.

1. Introduction

Of the various forms of road pricing, conventional link/network tolls and High Occupancy Toll (HOT) lanes are two options that road authorities are increasingly having to consider, and both have been implemented in various countries for different reasons and with varying degrees of success. Conventional tolls (manual or electronically collected) involve charging for the use of a specified road link or network for a set length of road (or tunnel or bridge), while HOT lanes involve the use of a fast lane at no charge if there is a designated minimum number of occupants of the vehicle, toll if there are no passengers or a reduced charge if there are fewer than the designated number of occupants.

This paper first defines the two approaches and examines key projects where conventional tolls and HOT lanes have been implemented. It then compares and contrasts international experience of conventional tolls with HOT lanes in terms of their legal requirements, operational (e.g. traffic) impacts, social (equity & distributional) impacts and public acceptance. Finally, some lessons and policy implications are put forward for road authorities in Australia, taking into account recent initiatives such as the Henry Tax Review.

The paper is based on the author’s contribution to a review of the impacts of road pricing undertaken for Austroads (2010), as well as previous studies on road pricing to which the author also contributed, Austroads (2007a & 2007b). The latter study complemented Tsolakis and Naudé (2006) which set out an economic rationale for road pricing and Naudé et al. (2005) which went to some length to define transport congestion as a basis for road pricing. The emphasis of the paper is on the comparison of conventional tolls on road links, tunnels and bridges on the one hand and that on HOT lanes on the other. Finally, it does not include congestion pricing schemes such as the London cordon charging scheme, electronic tolling (Stockholm), Area Licensing Scheme (Singapore since 1975), and more recently the Singapore electronic road pricing (ERP) scheme.

2. Definitions and examples

Road pricing schemes are generally imposed for revenue generation and demand management purposes (Austroads, 2007b & IPA, 2009). They can also be imposed on a flat rate or variable, according to time of day, traffic volume, vehicle type and engine size (Austroads, Ibid & IPA, Ibid).

2.1 Tolling

In this study, tolling refers to the tolling of road links, bridges or tunnels. The Australian Transport Council (ATC) National Guidelines for Transport System Management (ATC, 2006) and Austroads Guide to Road Transport Planning (2008) define road links. Tolling is the oldest form of road pricing (see Austroads, 2007b) and is currently applied in many countries throughout the world, both in developed and developing, and in Australia date back to the 1800s (IPA, 2009). Tolls are mainly used to raise revenue for infrastructure construction and maintenance (IPA, Ibid).

Examples taken from the many toll projects around the world include the M6 Motorway Bypass Toll near Birmingham (UK), M1 Motorway Gormanston – Monasterboice in Ireland, N17 Urban Expressway in Johannesburg South Africa, and N1 Intercity Toll Road between Pretoria and Polokwane in South Africa, Mumbai – Pune Expressway in India, Pamplona-Logroño A-12 in Spain, A1 Intercity Lille-Paris in France. In Australia, tolling has mainly been applied to urban expressways, e.g. electronic tolling (e-tag) on the CityLink and EastLink Urban Freeways in Melbourne. Examples of tolled tunnels and bridges include: Sydney Harbour Bridge and Tunnel, Cross City Tunnel and Lane Cove Tunnel and the Severn River Crossing and Dartford Crossing in the UK. In some cases, as with cordon and area-wide pricing schemes such as London, Stockholm and Singapore, there has been a commitment by authorities to use at least some portion of revenues for public transport. Tolls can be conventional (on a flat rate throughout the day), or variable (varying with time of day or traffic volume) (Austroads, 2010 & IPA, 2009).

2.2 High Occupancy Toll (HOT) lanes

High Occupancy Toll (HOT) lanes have hitherto been applied in the U.S. and usually involve the use of a designated lane by either high occupancy vehicles (HOV) with either 2 or more occupants (i.e. HOV2+, HOV3+) for free or at a discounted rate or by single occupant vehicles (SOVs) that pay a toll for the use of the lane. In several cases, the HOT lane has been constructed as a barrier-separated lane (or segment of road) through the median of an existing highway (FHWA, 2003). It therefore offers road users the choice of using the possibly more congested ‘free’ or general purpose lanes which have no restriction on access or the HOT lanes depending on vehicle occupancy or willingness to pay. It has also taken the form of a flat rate toll as well as a variable toll depending on time of day, vehicle occupancy or level of congestion on the ‘free’ lanes (FHWA, 2008a). It was originally preceded by HOV lanes which were not successful and resulted in underutilised lanes but grew out of a demand by drivers of SOVs that were willing to pay for a faster trip but did not have the required number of occupants. Indeed, the benefits of HOT lanes would be measured against the impacts of the HOV only facility (see Kim, 2002).

However, HOT Lanes have also been implemented in the case of a congested HOV facility which required improvement, e.g. by increasing vehicle occupancy requirements (e.g. to HOV3+ from HOV2+), thereby reducing the number of vehicles using the facility, as well as by tolling SOVs and, to a lesser extent, vehicles with lower vehicle occupancy. Various combinations therefore exist in terms of vehicle occupancy, toll levels and variations by time of day on the HOT Lane. A definition of a HOT Lane is also contained in FHWA (2008b).

HOT lanes have been implemented on US highways, for example, San Diego Interstate 15 (I-15), Orange County State Route 91 (SR-91), Minneapolis Interstate 394 (I-394), Houston Interstate 10 (I-10) Katy Freeway, Denver Interstate 25 (I-25), I-95 Miami-Dade County and SR-167 Puget sound (Mahendra et al., 2010). HOT lanes are primarily used for demand management, the second objective of road pricing schemes laid out in Austroads (2007b), Austroads (2010) and IPA (2009).

3. Points of comparison and contrast

Link / network tolls and HOT lanes are compared and contrasted in this paper in terms of the following criteria:

- Scheme scope and objectives
- Legal /regulatory framework
- Institutional arrangements and public / private involvement
- Technology
- Traffic impacts
- Demand elasticities
- Impact on adjacent / local road networks
- Traffic diversion and alternative routes
- Distributional impacts / Equity
- Public consultation and acceptance.

The criteria identified above will now be used to compare and contrast toll roads with HOT lanes.

4. Comparison of toll roads and HOT lanes

4.1 Scheme scope and objectives

In link / network tolling, the entire scheme is tolled and there is no distinction between lanes, while in the case of HOT lanes there is a general purpose lane and an HOV / HOT lane (e.g. HOV2+) that is tolled. In the case of the former, there is no option but to pay the toll, except if another route altogether is used, which may be longer and therefore involve increased time and vehicle operating cost (VOCs). In the case of the latter, the choice is between a potentially congested general purpose lane and the HOT lane along the same route so the issue is measured in terms of paying for time savings. This is an important distinction because it impacts on a lot of the discussion that follows.

Link / network tolls are implemented for revenue generation purposes, i.e. recouping the costs of provision of infrastructure in question, i.e. expressway standard routes, bridges or tunnels that might otherwise not be constructed. HOT lanes have historically been developed from underperforming HOV lanes and have been used to recoup the costs of infrastructure provision. There would also be a congestion pricing argument, i.e. rationing scarce road space.

4.2 Legal / regulatory framework

A strong legal and regulatory framework is a prerequisite for both tolls and HOT lanes Mahendra et al. (2010) and becomes even more important in the case of toll roads in negotiating concessions with the private sector, e.g. Build Operate Transfer (BOT) and Build Own Operate transfer (BOOT) arrangements.

The regulatory framework also varies across countries, but generally legislation is required, especially if an agreement with the private sector is involved. Specific enabling legislation is often required in terms of establishing a tolling authority, the distribution of revenues, and the ownership of the infrastructure (e.g. legislation describing the nature of responsibilities between the government and the private sector in the case of a PPP agreement). Key elements of a regulatory framework vary widely across countries and jurisdictions but broadly include:

- authority to toll
- tolling of certain vehicle types
- authority to toll specific roads on the network
- enforcement
- distribution of revenues
- intergovernmental jurisdiction and institutional issues
- consultation requirements
- operational procedures
- signage to the toll road from the network
- land acquisition
- degree of involvement by the private sector.

FHWA (2003) presents a more detailed examination of the need for and components of a regulatory framework.

In the case of Australian toll projects, legislation for specific projects has been passed at a state (provincial) level and includes the Melbourne City Link Act 1995, the EastLink Project Act 2004 in Melbourne, and the Sydney Harbour Tunnel (Private Joint Venture) Act 1987. Apart from the provisions of such acts relating to definition of the project and land acquisition, key provisions are those relating to the authority to toll.

Numerous examples of legislation exist for individual toll projects in other countries, relating to specific projects (road links, bridges & tunnels) and concession types, e.g. the M6 Motorway in the UK governed by a Statutory Instrument, the M6 Motorway Scheme 1998. Specific provisions relating to traffic management aspects such as definition of the toll project, road access to the toll projects, works that may be done to increase capacity of adjacent and alternative roads, are stipulated in concession agreements relating to individual projects and supplementary to the legislation.

For example, motorways in the United Kingdom require a Statutory Instrument prior to construction. The Statutory Instruments relating to the M6 Toll Motorway near Birmingham are numerous and include the Birmingham Northern Relief Road and Connecting Roads Scheme 1998, Statutory Instrument 1998 No. 121.

In the case of HOT lanes, the Transportation Equity Act for the Twenty First Century (TEA-21) then permitted tolling on a trial basis in terms of two pilot programs (FHWA, 2003; Replogle and Funderburg, 2006):

- FHWA Value Pricing Pilot Program (VPPP) that permitted real time variable pricing
- Interstate Toll Pilot Program that permitted flat rate tolls for revenue purposes, but not for congestion reduction.

HOT lanes were implemented as part of the VPPP until the Transportation Authorisation Act 2003 (FHWA, 2003). Any HOT lanes implemented under the VPPP maintained their legal authority to toll, unless/until this was removed by specific legislation. HOT lanes also had to comply with state and local laws in terms of toll collection. In California, 2006 state legislation provided that, until 2012, Regional Transportation Authorities (RTAs), in co-operation with the State DOT, could apply to the California Transportation Commission (CTC) to develop and operate HOT projects.

4.3 Institutional arrangements and public / private involvement

Link / network tolls involve central, regional (state/provincial) and to a lesser extent local government as infrastructure owners, initiators or champions, e.g. France. Road agencies have also been involved at a national level, e.g. the Highways Agency in the UK and South African National Road Agency Limited (SANRAL), due to the tolling of primary road networks (i.e. highways). State/regional/provincial road government will also play a role in terms of some primary road networks falling under that level of government, e.g. the South Africa urban toll road network in Gauteng Province. Hitherto, local government has played a secondary role in tolling of primary roads worldwide due to the nature of the networks involved, although they may be involved in urban expressways or tunnels and bridges. HOT lanes have involved state government primarily in the U.S., albeit under the umbrella of federal legislation, e.g. Caltrans in the case of the SR-91 Orange County California.

Much has been made of the case for private sector involvement of the private sector in the provision of toll roads and this is the case across a number of examples where the private sector is a concessionaire often under some public private partnership (PPP) arrangement, e.g. UK and South Africa. In an analysis of the tolling experience in Norway, Lauridsen (2011) finds no evidence of savings in construction costs where the private sector has been involved through loan financing versus the traditional route of budget allocations, although there were reductions in construction time and innovations in implementation strategy, project management and financing arrangements. In some cases, e.g. Sydney's Cross City Tunnel and Lane Cove Tunnel, private sector involvement has continued but changed as the original operators found their original business models inadequate because anticipated traffic growth did not materialise and the projects had to be refinanced (www.tollroadsnews.com/node/193).

In contrast, HOT lanes have not involved sustained long term private sector involvement and where the latter was initially involved, e.g. the SR-91 in Orange County, California, the scheme reverted to state road authority responsibility.

4.4 Technology

A key feature of HOT lanes are electronic toll collection (ETC) systems (FHWA, 2003). Most ETC systems involve dedicated short range communications (DSRC) with a vehicle positioning system (VPS) technology, with Automatic Number Plate Recognition (ANPR) as a backup on the enforcement/billing side (FHWA, 2008a, FHWA, 2008c & 2008d). [1]

There are two main technology options for options for charging on toll roads. These are the manual system mostly applied to older toll road schemes and the modern electronic toll collection (ETC) system. A combination of these two systems is also sometimes used (World Bank 2002).

Toll projects meanwhile, have moved from manual toll collection (still in use in several cases) to ETC schemes such as Melbourne's EastLink. Both DSRC and ANPR are a feature of these schemes. Road pricing technology in general and specifically its application in an urban setting and use of DSRC and ANPR are discussed in detail in Tsolakis et al. (2005) and Austroads (2006). Australia has a significant experience with e-tag systems that conform to a national protocol for tolling system (IPA, 2009) and have the advantage of potential uses across a number of applications, e.g. parking charges (IPA, Ibid). Privacy concerns identified in PRoGRESS Project (2004) are not regarded as insurmountable in Australia (IPA, 2009).

4.5 Traffic impacts

The case of the M6 Motorway Bypass (an intercity road) in the UK shows that average weekday traffic volumes increased on the toll road and decreased by 12-15% on the M6 Motorway itself (effectively the alternative route) as traffic shifted to the tolled bypass (Highways Agency, 2004). Weekend traffic volumes on the M6 Motorway itself fell by 15-20%. Most of the traffic shifting to the M6 Motorway consisted of light vehicles but no major shift of heavy commercial vehicles (Highways Agency, 2004). Travel times can therefore be expected to fall substantially on the alternative road, e.g. on the M6 Motorway after the opening of the M6 Motorway Bypass, with travel times almost halving on the M6 Motorway after the opening of the toll road (Highways Agency, Ibid). As an example of variable tolling, increasing the toll from $2.50 to $4 (i.e. by 60%) during AM peak times on the Sydney Harbour Bridge in 2008 and 2009 resulted in a reduction of traffic volumes of between 9-11% (IPA, 2009).

Traffic volumes have also increased on HOT lanes and fallen on the GP lanes after implementation, e.g. increasing by 17% in the case of the SR-91 (Sullivan, 2000) and by 13% in the case of the I-394 MnPASS (Cambridge Systematics, 2006). In the latter case, the AM peak volume of SOV traffic increased by 1,034% on the MnPASS while HOV traffic on the MNPASS fell by 21%, resulting in a 22% increase for AM peak hour traffic. This pattern was reversed on the GP lane where HOV traffic increased by 12% and SOV traffic fell by 4%, resulting in a 4% reduction of AM peak traffic on the GP lane. Speeds on the I-394 MnPASS HOT lanes have been 5-6% higher than those on the GP lanes (Cambridge Systematics, 2006), closer to the 65mph (104km/h) 'optimum' which is the objective of these lanes. Travel time savings on the I-10 Katy Freeway and Northwest IH-10 QuickRide HOT lanes project in 2001 were attained (see Burris and Sullivan, 2006), with average speeds on the HOT lane being about double that on the general purpose lanes, i.e. very close to the stated objective of variable tolled facilities being 65mph (104km/h).

According to Poole (2002), facility operators have used variable pricing on both the I-15 and the SR-91 to attempt to maintain operating speeds of 60-65mph (96-104km/h) on the HOT lane, despite pressure to increase the number of vehicles using the HOT lane by reducing the toll (thereby involving speeds of 30-35mph or 48-84km/h). In the case of the SR-91, demand has increased following the economic downturn of 2008, with an increase to 12.7m trips on the express lanes in 2010 (i.e. an increase of 5.2% over 2009 levels), as well as on the HOV3+ facility (an increase of 6.3% over 2009 levels) (OCTA, 2010).

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[1] See also Tsolakis et al. (2005) for an overview of road pricing technologies.

According to FHWA (2003), a single HOT lane will have a lower managed capacity than multiple HOT lanes due to traffic interaction. For example, flows on the Houston I-10 Katy Freeway QuickRide, a one lane, reversible-flow facility, are kept to 1,500 vehicles per lane per hour (note passenger car equivalents or PCE). However, the SR 91 Express Lanes, which provide two travel lanes in each direction, have been able to operate at acceptable conditions with flow rates of 1,800 vehicles/ hour/lane. The FHWA HOT Lane Development Guide (FHWA, 2003) recommends 1,700 vehicles per lane per hour as an average capacity level for lane management in the case of HOT lane traffic planning, although this might be increased / decreased depending on traffic and road alignment and topography.

4.6 Demand elasticities

For tolling schemes, these elasticities can vary for different tolling situations, but they are generally small, mostly ranging from -0.2 to -0.5 (Lake & Ferreira, 2002) and from -0.03 to -0.3 for pre-AM peak and post-PM peak respectively (Burris & Pendyala, 2002) and -0.03 to -0.36 for toll projects in Lee County, Florida (Mahendra et al. 2010), indicating some degree of ‘inflexibility’ in travel response. This is consistent with the nature of most tolling schemes. They are normally ‘special’ high demand roads with poor alternatives for most trips, and often represent ‘special’ infrastructure assets like bridges and tunnels, which provide improved access for land-use constrained parts of a network. Elasticities for toll roads are generally smaller than those for HOT lanes and dependent upon the level of the toll but can also be affected by the presence of alternative routes and modes. The Cross City Tunnel in Sydney apparently did not attract traffic from parallel routes either side of the street it was intended to replace, Williams Street (www.tollroadsnews.com/node/193), which was supposed to be turned into a boulevard with limited capacity for through traffic and transit and cycling facilities, bus lanes of which did not materialise (NSW Auditor General, 2006). The route attracted about 50,000 vehicles per day (vpd) toll free, falling to 25,000vpd on full toll and 34,000vpd when tolls were halved (NSW Auditor General, Ibid); this compared to the projected 88,000vpd anticipated originally. Similarly, forecasts for the Lane Cove Tunnel in Sydney were 90-110,000vpd, with an initial toll free period resulting in 75,000vpd but this fell to 50,000vpd once a toll of $2.55 was introduced (Phillips, 2007). The associated schemes designed to augment the toll road, namely reducing capacity on Epping Road (alternative route) and bus lanes, were not implemented fully once public discontent surfaced.

Demand elasticities of HOT projects are generally higher and complex because of the level of the toll and the vehicle occupancy requirements of the facility, not to mention the availability of alternative routes (general purpose lanes) and modes (public transport). Price elasticity of demand for use of the HOT lanes in peak period traffic was estimated at -0.7 to -0.8, similar but smaller to those estimated for targeted price increases, which yielded price elasticities between -0.9 and -1 (Sullivan, 2000). These elasticity estimates demonstrate the close position of the HOT lanes to the neighbouring general purpose lanes – a situation very much suited to using pricing as an efficient and effective mechanism for congestion.

When HOV requirements were increased on the SR-14 in Los Angeles County California, from HOV2+ to HOV3+, there was minimal change in usage of the tolled component of the HOT facility, but a significant reduction in usage (drop of 65%) of the free (HOV) component of the HOT facility. This implies that HOV2+ users largely dropped into the general purpose lanes rather than pay a toll for the use of the HOT lane. However, when HOV requirements were kept constant and tolls on the HOT lane were doubled, usage of the tolled component of the HOT facility fell by 56% and that of the free (HOV) component increased by 14%. These results imply that as the toll was doubled, the number of users prepared to pay for the use of the HOT lane more than halved, while some users were prepared to take on at least one passenger to keep using the HOT lane through the HOV2+ option (FHWA, 2003). In the case of the I-10 Katy Freeway, congestion led to an increase in vehicle occupancy from HOV2+ to HOV3+, which resulted in a significant reduction of traffic such that HOV2+

vehicles were allowed back onto the HOT facility if they paid a $2 toll, i.e. lower than the SOVs using the facility (Burris & Figueroa, 2006).

4.7 Impact on adjacent local road networks

Overall, the implementation of HOT lanes and tolls seems to have an impact on local road networks, e.g. arterials. In the case of HOT lanes, a majority (80%) of business respondents in BBC Research & Felsburg, Holt and Ullevig (2006) on the I-394 thought that the HOT lane had a negative impact on traffic on local arterials because traffic on local roads seemed to have increased as vehicles seemed to be pushed away from the I-394. This also seems to be the case with the I-15 San Diego. The CDOT (2006) study also made the point that it was unclear whether local roads would not have been congested anyway without the HOT facility. Also, it was thought that capacity had not been increased on local arterials feeding the HOT facility to meet demand and entry/exit demands, or whether additional traffic had been generated on local roads due to increased economic activity brought to the area by HOT lanes.

4.8 Traffic diversion and alternative routes

Alternative routes are an important issue for toll roads, with this requirement being legislated (e.g. in the case of South African toll roads in the 1980s). The shift of traffic away from the toll road to the untolled alternative road or road network can affect the viability of the toll project and is an issue when estimating demand elasticities (see discussion on toll road demand elasticities elsewhere in this paper) and toll road risk. Traffic diversion from a toll route to the alternative road is quite likely in the case of an existing road being tolled, e.g. the M1 Motorway (Gormanston to Monasterboice) in Ireland (see Hegarty, 2002), where the expected traffic diversion to the alternative route was estimated to be 28% immediately after tolling. Most diverting traffic was estimated to be local and medium distance traffic, while the bulk of traffic remaining on the route after tolling was long distance traffic.

Traffic diversion on toll roads in South Africa assumes that toll fees should not exceed 75% of savings (implying negative price elasticity of >1) (Kekana, 2006). Traffic diversion of 30-40% of existing volumes occurred on the N1 North Toll Road in South Africa came into operation, while 40-50% of heavy vehicles were estimated to have diverted from the road since the introduction of the toll (Kekana, 2006). Traffic diversion was to major arterial and local streets as traffic sought to avoid toll plazas on the road, especially closer to built up urban areas. A higher percentage (45%) of users of the N1 toll road used the road every day than those on the alternative (35%), implying that these frequent users sought to make savings through use of the toll road. The provision of a free alternative route has led to traffic diversion away from the (new) toll road in countries such as Mexico and Hungary (World Bank, 2002). Kalmanje and Kockelmans (2006) work on toll roads in Texas showed that roads within 1 mile of the toll roads generally indicated greater volume/capacity ratio (VCR) reductions and increased travel speeds after the introduction of the tolls than those within a 5 mile vicinity. Traffic diversion from a toll road varies significantly and has numerous consequences. Swan and Belzer (2008) show that traffic diversion away from toll roads in the U.S. varies substantially across toll projects. Using data on toll roads in Ohio, estimated diversion of truck traffic was estimated to be from 2-14% of predicted volumes (Swan & Belzer, 2008).

In the case of HOT lanes, traffic diversion has not occurred due to the insistence of operators on ‘non-compete’ provisions restricting investment in other transport modes, corridors and even general purpose lanes that might attract traffic away from the HOT scheme, e.g. the case of the SR-91 in Orange County, California, although no such provisions appeared where the scheme reverted to the state road authority, Caltrans (see below). In the case of others, e.g. the I-15 San Diego, an alternative freeway route as such did not exist (FHWA, 2003), outside of the general purpose lanes on the I-15 itself. A majority (80%) of business respondents in BBC Research & Felsburg, Holt and Ullevig (2006) on the I-394 thought that the HOT lane had a negative impact on traffic on local arterials because traffic on local roads seemed to have increased as vehicles seemed to be pushed away from the I-394. This was also found to be the case with the I-15 San Diego (Ibid).

4.9 Distributional impacts / equity

It has been estimated by Plotnick et al (2009) that tolls can impact on low-income households because their impact as a proportion of household income is significantly higher than in the case of high income households, e.g. while ‘poor’ (or low-income) households would pay as much as 15% of their income to travel on toll roads in the Puget Sound area of the U.S. versus 4% of ‘non-poor’ households income. The availability of alternative modes as well as alternative routes and infrastructure will also spread the impact of tolls, e.g. the existence of HOT lanes provides an alternative because the impact on low-income households will be different to that of tolls alone because of the option of HOV travel as well as general purpose lanes. Similarly, the availability of public transport options will also affect the impact of tolls on low-income households.

Plotnick et al (2009) points to the fact that equity issues arising from tolling have been examined for some time since Vickrey’s 1968 paper entitled ‘Congestion charges and welfare’. According to Weinstein and Sciara (2004) in Plotnick et al. (2009), ‘equity’ encompasses income equity as well as geographical, modal and gender equity. Of these, various authors emphasise different types of equity which will serve to predict how they may react to tolls and increases in them, e.g. Giuliano (1994) argue that gender and occupation are most important while Ungemah (2007) emphasises income and geographic equity (see Plotnick et al, 2009).

Income equity involves income saved through use of the tolled facility, as well as travel time savings through use of the tolled facilities (Plotnick, 2009) – therefore the issue in this regard becomes the financial and time impacts of using the toll road for low-income versus for middle and high income households. Moreover, the distribution of toll expenditures across income groups is also important, especially on a project level. For specific projects, the equity impacts involve income, employment and demographic characteristics of the study area. This would include household car ownership levels across income groups, level of employment across income groups and post toll use of transportation facilities, e.g. use of the toll road, alternative routes and public transport modes.

Plotnick et al (Ibid) goes further to point out the differences in equity impacts of tolls and HOT lanes.

- Tolls may generally be regressive in terms of their impacts on low-income households (i.e. comprise a greater proportion of household income / expenditure), especially because low income groups generally have fewer alternatives available in the form of flexible working conditions, access to alternative modes of transport in some countries (e.g. U.S. versus Europe, partly urban land use options and residential locations of different income groups, where low-income groups can be located further from job opportunities in some countries).

- High income households benefit from tolls due to their higher value of time, while low-income households lose from the imposition of a toll due to their lower value of time (taking toll costs and value of travel time savings into account for all income groups and whether, in the case of low-and middle-income users, they are able to switch to alternative modes or routes to avoid the toll)[2]. High income users have a higher value of time (in the case of savings) and so would be more inclined to pay the toll. Low-income users may have less flexible work hours and there is an argument for them having a higher value of time than allowed for in some cases. Sullivan (2000) found that work hour flexibility had no impact on usage of HOT facilities, due to inflexible working hours and alternative transport options (e.g. HOV travel and general purpose lanes).

In terms of the impacts of HOT lanes on low-income communities, research examined in Plotnick et al. (2009), e.g. the SR-91 (see Sullivan, 2000) and the Katy Freeway QuickRide HOT, suggests that income and work flexibility had little or no influence on use of the HOT lanes. Mahendra et al. (2010) likewise identified equity as not an issue with regard to HOT lanes or at least a manageable one.

4.10 Public consultation and acceptance

The importance of consultation and public acceptance of pricing schemes is emphasised in the PRoGRESS Project (2004) and the UK Department for Transport (DfT, 2004) has identified it as the single biggest challenge in implementing road pricing and directly linked to equity (Mahendra et al. (2010). Public support for toll lanes is as strong as that for HOT lanes, with levels of public support 73% for HOT lanes and 71% for traditional toll roads Mahendra et al. 2010). However, Mahendra et al. (Ibid) also state that there is more public support for new toll roads than tolling of existing roads.

Public consultation has been shown to be a critical factor in the development of HOT lanes (Mahendra et al., Ibid). As HOT lane ‘champions’, state road authorities have sponsored numerous HOT schemes in the U.S., e.g. Orange County Transportation Authority (OCTA) in the case of the SR-91, SANDAG in the case of the I-15. Private sector involvement invariably implies potentially complex contractual issues in the development of HOT facilities. In the case of the SR-91, the contractual arrangements meant that the state road authority, Caltrans, was unable through so-called ‘non-compete’ provisions in the agreement to make certain changes or improvements to transportation infrastructure in the corridor that could be deemed to add capacity, e.g. develop additional (competing) infrastructure. The sale of the SR-91 to the OCTA involved no such provisions (FHWA, 2003). The Orange County Transportation Authority (OCTA) was obliged to purchase the SR-91 Express Lanes facility from the CPTC in 2003 (OCTA, 2008) due to the non-compete clauses in the agreement which were hampering its broader traffic management plans in the region (Swan & Belzer, 2008).

HOT lanes have generally been well accepted by road users and the public, with approval as high as 60-80% of users (FHWA, 2008a). A survey of Minneapolis consumers in 2006 (FHWA, 2008b) found approval of HOT lanes to be by 71% of high income users, 61% of middle income users and 64% of low income users. A survey of 800 I-15 users conducted in 2001 generated the following findings (FHWA, 2003):

- 91% of I-15 users thought that travel time savings through the I-15 Express Lanes were a good idea
- 66% of those who do not use them supported the I-15 Express Lanes

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[2] In studies in the U.S. (see Giuliano, 1994 in Plotnick et al. 2009) net benefits were held to accrue for low- and middle-income users where they were able to avoid paying the toll. Results are, however, specific to particular projects and categories of users in these projects.

- 73% of I-15 non-users thought that HOT lanes reduced congestion in the corridor
- 89% of I-15 users supported the extension of the Express Lanes, while the extension of the Express Lanes was the first choice amongst both users and non-users for congestion reduction in the corridor
- 80% of the lowest income users of the I-15 users agreed that SOVs should be able to use the HOT lanes for a fee.

There has been extensive stakeholder consultation involving affected local government, stakeholder groups and the general public evident from HOT lane projects and this certainly the finding of research undertaken for this paper and this may play a large part in the public acceptance of HOT projects. The point is made further in Mahendra et al. (2010) that each state involved in and having control of HOT lane projects has “well-established community outreach and consultation strategies” that include such channels of communication and interaction as community meetings, internet websites developed as a communication channel for the project (e.g. SR-91 Express Lanes project, see www.91expresslanes.com). The high level of public and stakeholder consultation was necessary as these projects were not only publicly owned and operated but also involved the conversion of HOV projects to HOT projects, a potentially controversial development.

5. Summarised comparison of toll roads and HOT lanes

Table 1 provides a summarised comparison of tolls and HOT lanes based on the preceding discussion.

Table 1: Comparison of tolls and HOT lanes

Criteria	Tolling	HOT lanes
Objective	Revenue generation for the scheme, road infrastructure provision	Demand management, infrastructure provision
Infrastructure type	Road links, tunnels & bridges	Roads only so far (U.S. experience)
International application	Numerous countries, incl. Mexico, South Africa, UK, France, Spain, Australia	USA only
Legal framework	Legal authority required	Legal authority required
Traffic impacts	Traffic reductions on tolling of existing road, as traffic moves to alternative route, local roads	Increased travel speeds, reduced travel times on implementation of HOT lane, limitations on alternative routes & modes through ‘non-compete’ provisions
Demand elasticities	-0.03 to 0.36	-0.7 to -0.8 Demand more elastic than toll roads due to availability of GP lanes, HOV
Private sector involvement	Private sector involved as toll concessionaires, some public sector involvement	Public sector involvement (state & local government)
Public consultation / acceptance	Public acceptance	High level of public acceptance

Criteria	Tolling	HOT lanes
Distributional / equity impacts	Impact on household income & expenditure greater for low income people, Value of travel time savings, availability of alternative route, vehicle occupancy spread impact of tolls	Availability of GP lane, HOV option

Source: ARRB

6. Implications for Australia

The Henry Tax Review (Treasury, 2010) advocates “location-specific congestion charges” that vary by time of day, resulting in higher travel speeds and shorter travel times with reduced vehicle operating costs for road users and therefore reduced environmental impacts. Revenues from these charges would be allocated to funding public transport. The approach advocated in Infrastructure Partnerships Australia (IPA, 2009) is of a national road pricing scheme, including all forms of road pricing for road network purposes at all levels (federal, state and local) and public transport.

IPA (Ibid) argued that because Australia has well-established electronic tolling projects across several capital cities, e.g. EastLink in Melbourne, there is an opportunity to harmonise across these projects in terms of technologies and charges, and these would form a key component of an Australian Road Pricing Scheme recommended in that study. An issue in this regard would be the basis for tolls applied to cars and heavy vehicles and the need to differentiate between them. Another aspect of the proposed scheme would be time of day pricing and this is also an area in which tolls could play a part. However, as IPA (Ibid) points out, this would require re-negotiation of existing commercial agreements with toll road concessionaires and a broader consideration of integrated transport management encompassing road networks and public transport systems (IPA, Ibid).

In that context, attention must be paid to whether traffic levels on Australian urban toll road networks are sufficient for more variation of tolls in terms of time of day, traffic levels and vehicle types. The experience of tolling tunnels in Sydney for example has shown that users are indeed price sensitive, especially when there are alternative routes. This also requires a thorough understanding of the sensitivity of road users to toll levels (i.e. elasticities). There is therefore some scope for the consideration of HOT lanes in Australia as a flexible alternative to conventional tolls where traffic volumes are sufficiently high on the routes concerned to support both general purpose lane(s) and an HOT lane, with possibilities of variation in vehicle occupancy and time of day tolling. However, the role of alternative routes need to be properly understood for the HOT facility to be successful, not to mention the value of travel time of road users, e.g. those using GP lanes and those prepared to ride share or pay a toll.

7. Conclusion

This comparison of conventional tolling and HOT lanes has identified key differences and similarities between the two in terms of such areas as scheme objectives, legal and regulatory framework, and public acceptance, as shown in Table 1 of this paper.

Conventional tolling has been primarily applied across a range of countries with the objective of revenue generation to finance major items of road infrastructure, e.g. Sydney’s Cross City Tunnel and Melbourne’s EastLink, while HOT lanes have been implemented in the U.S. with the primary objective of demand management in busy urban road corridors. Demand for HOT lanes has also been found to be more elastic than for conventional tolls, due to the availability of options of GP lanes, ride sharing and tolls. HOT lanes have also been found to perform well in terms of distributional / equity impacts. This in turn could explain the apparent high level of public acceptance of these schemes, although a key element of that might also be the careful implementation of individual projects, usually with much public consultation. An underlying legal framework has been shown to be a necessity for both instruments, highlighting the need for an important role for government especially in the early stages of implementation of the concept.

The application of HOT lanes in certain corridors under certain traffic conditions in Australia can be undertaken by carefully selected ‘pilot’ studies where appropriate and incorporating this learning into future projects, e.g. regarding behavioural responses such as demand elasticities. These ‘pilot’ studies will be sources of local data to facilitate the estimation of key local parameters. They would also be useful for testing public acceptance of the concept in Australia and developing an appropriate implementation strategy at state and local level if the concept shows promise.

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