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Auckland Road Pricing

Desktop research on Economic Impacts

Final Report to the Ministry of Transport

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Preface

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NZIER was established in 1958.

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Executive Summary

The problem of congestion

Region-wide and business firm costs

There is significant evidence from a range of studies of the current and growing importance of congestion within the Auckland conurbation. The annual cost of congestion has been previously estimated at over $700 million (1997 and 2002 $), suggesting that a 2008 figure well in excess of $1 billion per year (given growing traffic levels and cost inflation).

It is also evident that Auckland has been relatively badly served by passenger transport services, with poor levels of connectivity, regularity, reliability and speed in comparison say to Australian metropolitan areas.

Both residents and businesses in Auckland record high levels of dissatisfaction with the degree of congestion experienced. However, there is some evidence from the literature that businesses have been pursuing offsetting strategies such as night deliveries, flexible working hours for staff, and plant and depot relocations.

Looking overseas, estimates have been derived for the UK which suggest that because the average value of employer's business time is in the order of 4 times the average value of non-working time, roughly half of all travel time benefits are accounted for by employers' business time savings, even though this is only 1/6 of car traffic.

The extensive review of the international literature confirms the growing importance of congestion at the regional level, particularly in densely populated countries like the United Kingdom and within the metropolitan areas of 'world cities' such as London, Stockholm and Singapore.

The review also confirms that businesses are well aware of the costs that congestion imposes through increased trip times and lower trip reliability. In most instances, businesses are more than willing to pay for the improvements in raw material assembly and product delivery times that can result from congestion charging schemes such as those that are being considered in the case of Auckland.

Actions taken by firms in response to congestion

Looking at the international literature, there is a consensus that, in general, transport costs (and hence congestion costs and congestion charging) can exert very wide and pervasive economic effects on business firms, over both the short term and longer run. However, hard evidence of consistent generic relationships is sparse.

The effects can generally be placed in 2 categories:

- Distributive Effects involving the within sector and / or inter-sectoral and / or geographical redistribution of supply-demand relationships

- Generative Effects which increase net economic output at the firm, local, regional or national levels by using resources more effectively and / or using resources that were previously underutilized.

Transportation costs are typically found to be only a very small proportion of firms' total costs (usually less than five percent). As such, any improvements to the transport infrastructure is likely to yield small cost savings and gains to firms. There are likely to be relatively few cases where transport investment is both a necessary and a sufficient condition for the successful development and operation of a non-transport business.

As a general rule, studies suggest that transport is only an important factor, once the decision to set up in an area has been taken. In other words it is a necessary but not sufficient condition for decision-making on locating or relocating enterprises. A decision to relocate may be prompted by transport difficulties and inaccessibility. However, businesses are likely to change operations in discrete steps, and it is only when certain cost thresholds are reached that it becomes efficient to the firm to revise its number or location of outlets, plants or depots.

These findings are of direct relevance to the potential for congestion charging in Auckland. Businesses will react to the charging regime, in some case by making immediate and short-term changes (like route switching and night deliveries). Generally however, the adjustments will be longer term and will await the onset of other more direct business imperatives and incentives (like challenges by competitors or the pressure exerted by rising central city land values in favour of decentralization).

Benefits of travel time savings and trip reliability

Overseas studies suggest that there is a sound economic rationale for congestion charges that attempt to moderate the social costs that excessive numbers of private trips impose on the economy and society. For a road segment that is prone to congestion, the social optimum usage occurs where marginal social costs equate with average benefits – and this implies some form of rationing of road space by raising the cost of private trips.

There is European evidence that the value of road trip travel time for commuters in congested conditions is about 40 – 50% higher than in free-flow conditions. Again, trip reliability is highly valued for some types of trips – especially those involving business trips and the movements of some types of higher value freight (e.g. perishables).

The above evidence is consistent with the findings of the previous 2006 Auckland Road Pricing Evaluation Study (2006 ARPES) and the current round of exploratory studies on the merits of congestion charging in Auckland.

Impacts of road pricing

Sector-specific impacts

The forerunner to the current round of studies of congestion charging in Auckland, the Auckland Road Pricing Evaluation Study, has suggested (based on extensive modelling) that road pricing would be successful in reducing trip numbers and congestion but that any adverse overall effects on business activity would be small.

The positive externalities realised on high value trips may very well outweigh any dead-weight losses (even when the cost of the congestion charge is taken into account). Indeed, the availability of freed road space is likely to enable more productive activities to expand (i.e. pushing the demand curve for business trips outwards) – and eventually, the pattern of land use may also change and intensify as business prospers.

In the case of the London Congestion Charge (LCC) between 2002 and 2004, all vehicle-kilometres driven with the LCC zone fell from 1.64 millions to 1.38 millions (i.e. by around 16 percent). However, individual car trips (presumably many of these may be regarded as 'less essential' in economic terms) fell by 39 percent, whereas truck trips remained broadly constant and taxi trips rose by around 11 percent. The taxi and road transport sectors therefore appear to have been overall gainers.

The outcomes of the Stockholm and Singapore schemes are broadly in line with those of London, and consistent with past and current expectations of the impacts of congestion charging in Auckland.

Business location impacts

Congestion charging creates gainers and losers (indeed this is at the heart of the differential responses of different types of traffic). Over the longer term, this will influence the location of activity and there are likely to be boundary effects and shifts in land-use.

Evidence for the LCC suggests (not at all surprisingly) that the financial sector has been the biggest overall gainer, reflecting its positive impact on the convening of meetings and transfers of business documents etc. The hotels and leisure sector also appears to be a major gainer from improved access by relatively high income clients. Conversely, the effects on restaurants, cafes and retail establishments are more case-specific and problematic.

Insufficient time has elapsed in the cases of the existing congestion charging schemes overseas to make it possible to observe long-term business location impacts. However, (as will also probably be the case in Auckland), location shifts may well be precipitated or accentuated in the long-run for some forms of land-use (e.g. some types of inner city retailing). However, as long as there is continued demand for inner city land, the overall impacts may be small or possibly even positive (as suburban shoppers are better provided with local retail facilities).

Productivity and agglomeration impacts

With respect to the wider and longer term effects of road pricing, there is a small but growing international evidence base that increased journey speeds, can have a significant effect on regional productivity. It is not possible to fully quantify such effects at present from the monitoring work that has been done so far due to: measurement problems and costs; the technical problems that arise in calibrating impacts against a 'without intervention scenario'; and the short time periods that have so far elapsed.

Evidence on the presence and intensity of the linkage, matching, and catalytic effects that can arise from the collocation of businesses through 'agglomeration' is also limited in the case of Auckland. However, raising the potential to realise these forms of interconnectivity will very much condition Auckland's future ability to establish itself as a world city – and this in turn may hinge to some degree on its levels of physical connectivity and accessibility.

Resource re-allocation effects

With respect to congestion pricing, much transport investment (and this probably also applies in part to congestion pricing) influences business location and production decisions at the local and intra-regional levels but does not generate net national or regional growth.

Congestion is a major problem in many urban areas – it can lead to trip unreliability, and added business costs, and can be a tipping factor that drives businesses from Central Business Districts (CBDs). Congestion charging schemes (like capital investments in transport projects) may also reinforce prior locational differentiation (for example, high priority schemes by early adopters (e.g. the London Congestion Charge) may strengthen London's economic primacy at the partial expense of provincial centres).

In practice, there are many complexities surrounding the interactions between transport, logistics, production and distribution decisions, such that unambiguous answers are unlikely from even the best structured studies – everything depends ultimately on the energy of entrepreneurs and the interplay of a potential spectrum of intended and unintended effects.

Looking at London, Stockholm and Singapore, there is a common recognition across the three cities that congestion is an important problem and that congestion charging is an effective and appropriate means of addressing the problem. In all three cities, levels of public acceptance have risen following implementation.

There is also a consensus that, taken overall, the schemes have had a barely perceptible impact on overall economic growth. In the cases of all three cities, the effects were small and background economic growth appears to have 'washed out' any adverse effects on their overall urban economies.

The international literature therefore tends to confirm the results of the 2006 modelling for Auckland, which suggested that though there were likely to be some net losses in terms of business activity in the short-term, the overall effects would be very small in relation to the wider magnitude of business costs and the economy as a whole.

Impacts on business costs

With respect to Auckland, the conclusions of the previous 2006 ARPES Study were that the types of industries that are heavily represented in central Auckland (e.g. business services, travel and tourism) are likely to have average or less than average transport intensities, as they generate comparatively little heavy freight.

The 2006 ARPES Study noted that business trips made during the 6-10am period in Auckland (currently around 184,000 per day) represent less than 15 percent of all trips made in Auckland during that period, such that congestion impacts more heavily on commuter and private trips than it does on business trips per se.

The Study also concluded that the vehicle cost and time benefits from road pricing were only equivalent to 5-20 percent of the additional costs imposed by charging, so that the net effect on business would be negative. Overall, however, the expected increase in general business sector costs was expected to be very small – the net increase was modelled at as being equivalent to less than 0.01 percent of business costs (partly reflecting the reality that transport costs are not very significant to the majority of businesses).

The international literature confirms that congestion charging tends to create complex patterns of losers and gainers – between sectors, between industries and firms, and between geographical locations. However, the second and equally important inference is that – when all these distribution effects are taken into account – the net generative effects are relatively small but positive.

The review of the London, Stockholm and Singapore schemes suggest that while the wider growth or generative effects were small in aggregate, there were complex patterns of gainers and losers (i.e. distributive effects) in the short term. In all of the schemes, there is evidence of reductions in the levels of less-essential / low willingness-to-pay car trips.

On the other hand commercial vehicles like trucks and vans, and the users of taxis, were generally gainers (as were their drivers who experienced improved working conditions). It was noted in the case of Stockholm that established passenger transport users lost out from increased levels of usage and ‘congestion’ on buses and trains due to the addition of new patrons.

A similarly complex pattern of gainers and losers is to be expected if Auckland adopts a congestion charging scheme, with gains expected in such sectors as the courier, taxi and freight industries, and among central city businesses that are oriented to high value added / international market activities (e.g. business HQ offices, financial sector firms, etc.).

Boundary impacts

In both the London Congestion Charge and Stockholm cases, there were significant boundary issues. In the former, these concern the advantages and disadvantages of extending the scheme into the West End. In the case of Stockholm, they concern the perception by commuters from the outer suburbs to the CBD that they had been asked to bear the bulk of the charge, whereas inner city residents within the cordon zone had gained disproportionately from the improvement of the city centre environment.

It follows that boundary effects may be expected if Auckland implements a cordon charging scheme.

Economic externalities

The general economic background to the introduction of congestion charging is also important. In all three cases, the economies of the London, Stockholm and Singapore have experienced considerable economic growth during the introduction and implementation of congestion charging that emanates from their status as world cities. This growth is founded on drivers that have little relationship to either levels of congestion or measures to ameliorate congestion. Clearly, it is advantageous, in terms of public acceptability and impact on local businesses, to introduce congestion pricing against a background of economic buoyancy.

Looking longer term, the three cities appear to have confidence that congestion charging will have a positive impact on their international images (including their attraction of tourism and tourism expenditure) and that it is likely to stimulate and accentuate the attractiveness of the cities for new investment in higher value added activities. Such ‘agglomeration’ benefits are difficult to measure but there is increasing recognition worldwide that a city’s capacity to attract and retain internationally mobile highly skilled labour is a major key to continued growth.

Such positive effects could also develop in the case of Auckland, provided it continues to make progress in growing and diversifying its role as a world city.

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1. Introduction

1.1 Objectives

As stated in the Terms of Reference for the Study, the overall objective of the Economic Impact work is to assemble information on the economic impact of congestion at the local and wider national levels. It also seeks to identify the possible economic impacts of congestion pricing.

It is expected that the information will provide a picture of the types of expected economic costs and benefits that could result from direct road pricing in Auckland relative to the expected alternative.

The Terms of Reference specified that the associated Desktop Research would cover (with special reference of the applicability of the findings to Auckland):

1. the problem of congestion, including:
   - the economic cost of congestion at both a region-wide and firm specific level
   - actions taken by firms in response to congestion experienced (e.g. land use, business location, allocation of resources)
2. the benefit of travel time savings or increases in travel time reliability on productivity, particularly in conjunction with other economic factors such as agglomeration
3. the relative economic impact of road pricing as a means to address congestion in terms of:
   - specific impacts on sectors of the economy (e.g. retail, road transport)
   - business location impacts (other cities or offshore)
   - productivity gains including agglomeration impacts
   - reallocation of resources
   - out of pocket costs for businesses and compliance costs
   - boundary impacts (i.e. considering the impact of road pricing not just in the areas charged, but areas outside)
   - economic externalities (e.g. improved amenity for tourists)

It was expected that the desktop review would have a worldwide purview, but in particular focus on London/wider UK, Stockholm and Singapore and the associated economic evaluations and academic research of those schemes relative to other options.

1.2 Our approach

The international literature on the theory of congestion pricing for roads is truly vast in its aims and compass. Much of it is also highly technical which means that any extracts or summaries must, ideally, be carefully cross referenced on issues of theory, methodology, and modelling procedures. At the same time, each country, region and proposal has distinctive features which make it difficult to generalise on prospective outcomes or to utilise prior approaches as templates for schemes such as an Auckland Congestion Charge.

If the situation is challenging from a deductive viewpoint, it is even more challenging from an empirical stance. While there is already a large range of impending or ongoing schemes, the practice of congestion charging is still young. There are no schemes for which full post-evaluation economic analyses have been prepared. Many are still being fine-tuned. In every case, promoters are finding their way in developing evaluation frameworks and still putting in place monitoring indicators. And as with pre-design assessment, most schemes are unique in terms of their objectives, policy frameworks, geographical and economic milieus, etc.

It is also readily obvious that there are wide potential ramifications for national, regional and local economies in adjustments to transport costs, congestion charges and transport investment over the short, medium and longer terms. All demand for transport is derived demand. Ultimately, changes in the transport sector play out wide and long across other sectors of the economy. Too often, the problems associated with pinning down such varies and pervasive effects elude full solution by researchers – and the scale of effort required is beyond the resources available or is simply not cost-effective.

This Desktop Study therefore takes a pragmatic approach. It does not attempt to provide an independent academic review of all the issues or all of the literature – this would be beyond the resources allocated to the project. Rather, it attempts to focus clearly on the best available prior review information, and to highlight results that appear to be relevant to the design of a congestion pricing scheme for a city such as Auckland.

The study has the following structure:

- Section 2 starts by setting the geographic and economic context for the evaluation of congestion and congestion charging measures in Auckland. It then provides a review of the existing evidence relating to the problem of congestion in Auckland;
- Section 3 focuses on the overseas evidence on the problem of congestion. It first provides a brief background to the description and measurement of congestion. It then looks at the economic costs of congestion and reviews the literature on assessing the marginal value of time in congested conditions and the marginal value of trip reliability. It draws heavily on the literature that is available for the United Kingdom;
- Section 4 examines the overseas evidence on the impact of transport costs and congestion on firms. It looks in particular at United Kingdom and United States evidence on the interaction between transport costs and business viability and the relationships that may exist between transport costs and firm scale. The

section then goes on to consider the changing interdependencies that are evident between levels of movement (i.e. transport intensity) and economic growth (and the degree to which the two forces may be 'decoupled');

- Section 5 considers the general overseas evidence on the potential impacts of road pricing. It starts by reviewing and developing the theoretical framework for evaluating the impact of congestion charging. This provides a context for the evaluation of some of the monitoring results from the London Congestion Charge relating to business losses and boundary effects. The section then goes on to discuss the potential longer term impacts of congestion charging on urban form, the agglomeration of economic activity, and the general economic relationships at the regional level;
- Section 6 provides holistic reviews of three important overseas congestion charging schemes: the London Congestion Charge; the Stockholm Congestion Charge; and the Singapore Area Licensing Scheme.

The Executive Summary draws together the conclusions and recommendations of the study with respect to the design and development of a congestion charging scheme for Auckland.

2. The Auckland context

2.1 Auckland geography and history

As noted in the previous Auckland Road Pricing Study (2006 ARPES) Auckland's geography places pressure on transport nodes, creates bottlenecks and constrains the development of the transport system. In particular:

- North-south trips must traverse the Auckland isthmus which acts as a natural funnel / filter
- The isthmus itself is narrow and bounded by extensive tracts of water to west and east which severely limits development options
- The motorway network has relied heavily on a single north-south corridor (State Highway 1)
- Plans to provide a parallel 'Western Ring Route' and a lattice linking this to State Highway 1 are hindered by residential developments, land shortages and a general paucity of project options.

Auckland's history has also contributed to current transport problems. As noted by Mees and Dodson (2002), development has tended to favour road construction over investment in passenger transport. This has perpetuated and encouraged low-density housing, decentralisation and the growth of second order cities within the conurbation. In turn, this has resulted in a Central Business District (CBD) with a relatively low share of regional employment (currently 12 percent).

Consistent with the above trends, Auckland exhibits very high levels of car ownership, comparable with the USA, Australia and Canada (although per capita incomes in New Zealand are well below those in the comparator countries). Correspondingly, Auckland also has very low levels of public transport utilisation. Currently, only 7 percent of trips during the peak period are on public transport, compared with around 17 percent in Wellington.

2.2 The Auckland economy

2.2.1 Background

Auckland City generally outperforms the rest of New Zealand in economic terms, consistent with its role as the hub of the nation's largest metropolitan area and its increasing linkages with global trade and investment activities. It employs around 310,000 people, (approximately 51 per cent of regional and 17 per cent of national employment). Key statistics for the City and the Auckland Region are presented below in Table 1.

Table 1 Key economic statistics for Auckland City and Auckland Region

Indicator	Period	Geographic Level			Annual % change		
		Auckland City	Auckland Region	NZ	Auckland City	Auckland Region	NZ
Real GDP[1]	year ended Mar 06	$19,814m	$40,105m	$125,928m	4.8%	3.1%	2.0%
Population (usually resident)	as at Jun 06	430,500	1,358,100	4,139,500	1.2%	1.6%	1.0%
Employment (employed count)	as at Feb 06	306,840	602,180	1,763,160	3.5%	3.0%	2.1%
Un-employment rate (annual average)	as at Mar 07	3.8%	3.9%	3.8%	-	-	-
New dwelling consents	year ended Mar 07	1,725	6,769	25,740	-9.0%	-6.0%	-1.3%
New non-residential construction (value)	year ended Mar 07	$357.1m	$995.6m	$4059.0m	-12.9%	3.6%	2.4%
House prices	year ended Feb 07	$507,500	$443,000	$343,500	7.4%	9.2%	10.6%
House sales	year ended Feb 07	11,546	35,575	105,664	7.0%	-28.4%	4.3%
Retail sales	year ended Mar 07	$8,715m	$20,952m	$62,305m	4.0%	3.4%	4.7%

Source: Statistics NZ / Auckland City Council / NZIER

The City's economy grew by 4.8 per cent in the year ended March 2006, (significantly above the national growth rate of 2 per cent). Almost half of Auckland City's Gross Domestic Product (GDP) growth came from the finance and insurance, property and business services sectors in the year ending March 2006. A further quarter of the growth resulted from transport, storage and communications business activities. The most notable fall in activity occurred in other (non-food) manufacturing.

Property and business services remain the dominant sector, accounting for 23 per cent of total city employment. Seventy-five per cent of the region's finance and insurance jobs, 71 per cent of communication services jobs, and 68 per cent of regional employment in property and business services are located within Auckland City. The City is estimated to host 41 per cent of the nation's ICT jobs, and 39 per cent of national employment in the creative sector.

More recently, strong growth in real GDP and job creation has moderated somewhat as a result of high interest rates and the strength of the New Zealand dollar, skill shortages and rising labour costs, and the impact of slowing migration on housing demand and house construction. Forecasts for the medium term suggest that the City's economy will enjoy a modest resurgence on the back of lower interest rates, a depreciating exchange rate and increasing exports.

Over the longer term, Auckland City expects to enjoy higher future growth than the New Zealand economy as a whole. This is largely because the nation's higher value added business services - including financial services, information communication technology (ICT) and the creative sectors - are focussed on the city.

Retail spending in Auckland City has grown moderately in the last year - retail sales across New Zealand grew by 4.7 per cent in the year to March 2007 whereas the City's sales grew by 4 per cent. This is substantially lower than the annual average rate of 6.5 per cent for the period March 2000 to March 2007.

The increased fuel prices contributed to the lower levels of retail spending in the first half of 2006 as more of the household budget went on buying petrol. The decline in fuel prices late in 2006 reversed this shift in spending. This points up the importance of transport issues and transport costs in constraining economic growth.

2.2.2 Relative economic performance

Looking at Auckland in an international context, the Auckland economy is not performing especially well. This seems linked in particular to poor productivity performance which in turn is reflected in a relatively low GDP per capita. As shown in Table 2, Auckland has the lowest per capita income among the comparator cities and, on average, has a per capita income that is 36 per cent lower than its Australian counterparts.

Table 2 Auckland's relative international performance

City – Region	Average growth per annum (1995-2006)[2]			Real GDP per capita 2006[3]
	Real GDP	Real GDP/Cap	Population	(2006 $US)
Auckland region	4.0%	2.0%	2.0%	$20,973
Sydney	2.8%	1.9%	0.9%	$32,800
Perth	4.1%	2.5%	1.5%	$36,546
Brisbane	4.9%	2.9%	2.0%	$29,365
Melbourne	3.7%	2.5%	1.1%	$32,904
Madrid	5.8%	3.9%	1.4%	$34,343
Singapore	5.1%	3.0%	2.0%	$29,311
Portland	4.6%	3.3%	1.3%	$38,021
Seattle	3.8%	2.4%	1.4%	$38,600

Source: Auckland City Council (2007) / NZIER

2.3 Auckland as a potential 'World City'

2.3.1 The World City concept

Auckland's potential to grow and thrive (and its future access to opportunities to take up international roles) are relevant to assessing the impact of congestion and part that congestion pricing can play in making the city more competitive. There are clearly potential positive feed-backs between, on the one hand, improving accessibility and environmental quality in a large city by managing transport demand effectively and, on the other hand, encouraging domestic and overseas investors to locate there to take advantage of shared linkages and synergies (i.e. 'agglomeration economies').

The question then arises as to 'How far Auckland can be regarded as an emerging internationally competitive or world city?'

A global, internationally competitive or 'world city' can be defined broadly as 'an important node point in the global economic system' (see Globalization and World Cities Study Group and Network (GaWC)[1]). Among the characteristics that define first rank world cities are:

[1] See Global and World Cities Network at http://www.lboro.ac.uk/gawc/

- international first-name familiarity (e.g. The Big Apple)
- active influence on and participation in international events and world affairs (e.g. New York has the United Nations HQ)
- a relatively large population (the centre of a metropolitan area with a population of at least one million, typically several million)
- a major international airport that serves as an established hub for several international airlines
- an advanced internal transportation system that includes motorways and/or a large mass transit network
- strong immigrant / expatriate communities
- strong representation by international financial institutions, law firms, corporate headquarters, international conglomerates, and stock exchanges (for example the World Bank, or the London Stock Exchange)
- an advanced communications infrastructure system (e.g. including fiberoptics, Wi-Fi networks, cellular phone services, and other high-speed lines of communications)
- world-renowned cultural institutions, such as museums and universities
- a lively cultural scene, including film festivals, premieres, a thriving music or theatre scene (for example, West End theatre and Broadway); an orchestra, an opera company, art galleries, and street performers
- several powerful and influential media outlets with an international reach, such as the BBC, Reuters, *The New York Times*, or *Agence France-Presse*
- strong sporting community, including major sports facilities, home teams in major league sports, and the ability and historical experience to host international sporting events such as the Olympic Games, Football World Cup, or Grand Slam tennis events.

The GaWC has attempted to rank world cities, as shown in the Table below.

Table 3 Estimated current rankings of World Cities

World City score / rankings	Cities in class
ALPHA CITIES	
11-12 First Rank	London, New York City, Paris, Tokyo
10 Second Rank	Chicago, Frankfurt, Hong Kong, Los Angeles, Milan, Singapore
BETA CITIES	
9 Third Rank	San Francisco, Sydney, Toronto, Zürich
8 Fourth Rank	Brussels, Madrid, Mexico City, São Paulo
7 Fifth Rank	Moscow, Seoul
GAMMA CITIES	
6 Sixth Rank	Amsterdam, Boston, Caracas, Dallas, Düsseldorf, Geneva, Houston, Jakarta, Johannesburg, Melbourne, Osaka, Prague, Santiago, Taipei, Washington, D.C.
5 Seventh Rank	Bangkok, Beijing, Montreal, Rome, Stockholm, Warsaw
4 Eighth Rank	Atlanta, Barcelona, Berlin, Budapest, Buenos Aires, Copenhagen, Hamburg, Istanbul, Kuala Lumpur, Manila, Miami, Minneapolis, Munich, Shanghai
INCIPIENT WORLD CITIES	
3 Strongly energing	Athens, Auckland, Dublin, Helsinki, Luxembourg, Lyon, Mumbai, New Delhi, Philadelphia, Rio de Janeiro, Tel Aviv, Vienna
2 Moderately emerging	Abu Dhabi, Almaty, Birmingham (UK), Bogotá, Bratislava, Brisbane, Bucharest, Cairo, Cleveland, Cologne, Detroit, Dubai, Ho Chi Minh City, Kiev, Lima, Lisbon, Manchester, Montevideo, Oslo, Riyadh, Rotterdam, Seattle, Stuttgart, The Hague, Vancouver
1 Weakly emerging	Adelaide, Antwerp, Aarhus, Baltimore, Bangalore, Bologna, Brasília, Calgary, Cape Town, Colombo, Columbus, Dresden, Edinburgh, Genoa, Glasgow, Gothenburg, Guangzhou, Hanoi, Kansas City, Leeds, Lille, Marseille, Richmond, St. Petersburg, Tashkent, Tehran, Tijuana, Turin, Utrecht, Wellington

Source: GaWC / NZIER

The schema shows that no New Zealand city is currently classed as a world city, though Auckland is viewed as ‘strongly emerging’ and Wellington as ‘weakly emerging’ incipient world cities.

This suggests that, in the case of Auckland, the feed-back mechanism may be emergent and developing between improving accessibility and environmental quality through congestion control and pricing, and encouraging domestic and overseas investors to locate there to take advantage of agglomeration economies.

In this regard, it is interesting to note that the principal comparators to Auckland for road pricing schemes are much more advanced in the rankings. London is classed as a first rank Alpha City, Singapore as a second rank Alpha City and Stockholm as a seventh rank Gamma City.

There is therefore likely to be some risk in the case of Auckland that its bid to become a world city is not fulfilled – and that the wider agglomeration benefits associated in part with congestion pricing are not fully realised – in spite of the policy measures noted below.

2.3.2 National policy

The Ministry of Economic Development (MED) has stated that:

> *New Zealand needs a vibrant, dynamic city where highly talented people want to live. As a gateway between New Zealand and the world Auckland needs to be more internationally connected in terms of business, people and knowledge. International evidence highlights the importance of having at least one outward-facing, global city to lead a nation's economic development.*

MED is therefore actively seeking to advance Auckland as a world city[2]. This theme is promoted by the Government Urban and Economic Development Office (GUEDO). In this regard, GUEDO comments that:

> *Auckland has been cast by many commentators as being on the cusp of becoming a world-class city. To achieve this, the Auckland economy must also be transformed. Transformed, Auckland will become the home of globally competitive firms (and uncompetitive industries will vanish) supported by a first-class pool of skilled labour. It is likely that a transformed economy will find strength in its diversity, but depth in key sectors/industries. Through these key industries, Auckland's international reputation will grow and its products and expertise will be sought throughout the world. Accordingly, Auckland will be seen as one of the best places in the world to live, do business, and visit.*

Among the pre-conditions for success, the following issues are noted:

- the need to grow globally competitive firms in Auckland e.g. opportunity to build on Auckland's strengths and points of difference, improve collaboration between firms and research organisations in Auckland and deepen key innovation clusters;

[2] http://www.med.govt.nz/templates/ContentTopicSummary____23001.aspx

- having world class infrastructure in Auckland e.g. security and reliability of Auckland's energy supply, a world class public transport system and affordable, high-quality, ubiquitous broadband;
- having innovative and productive workplaces in Auckland e.g. skill shortages in some sectors, need to lift education attainment especially in deprived areas, capitalising on the opportunities presented by Auckland's large migrant community and large youth population (including international students); and
- leveraging off environmental sustainability in Auckland (e.g. the opportunity to improve urban form and connectivity).

Interestingly, two of the four issues relate to improvements in transport, urban form and urban connectivity – consistent with the need to satisfactorily address congestion problems.

2.3.3 Regional policy

At the regional level, Auckland Regional Council commissioned the 2006 'Metro Project'[3] which aimed to ensure that:

> *Auckland is an internationally competitive, inclusive and dynamic economy; a great place to live and conduct business; and a place buzzing with innovation, where skilled people work in world-class enterprises*
>
> as
>
> *It is only Auckland that will lead in the competition amongst global cities for new investment, international events and for the most talented people. We have to take a united view about Auckland's value to New Zealand - this country is just too small to be thinking any other way.*

Among its major recommendations were that:

– Transport, energy and broadband and wireless connectivity must be advanced in a committed and systematic manner.

2.3.4 Auckland City policy

Auckland City Council's 'Into the Future Strategy' states its vision in the following terms[4]:

> *In the next 10 years Auckland's CBD will grow and consolidate its international reputation as one of the world's most vibrant and dynamic business and cultural centres.*

To realise the vision, Auckland's CBD in the future will be:

[3] http://www.arc.govt.nz/economy/the-metro-project/the-metro-project_home.cfm

[4] http://www.aucklandcity.govt.nz/council/documents/cbdstrategy/default.asp

- recognised as one of the world's premier business locations
- Auckland's CBD will be a place where innovation and entrepreneurship are nurtured, access is easy and new business is actively encouraged.

To do this, Auckland City expects to work with other stakeholders to market the competitive advantages of the CBD as a business location in order to attract and retain business. As part of this initiative, Auckland City expects to develop a high-quality urban environment, with the CBD containing ‘a lively mix of business, education, residential, recreation and cultural activity’, and new developments embracing high quality urban design that is sympathetic to the city's history and natural environment.

Auckland CBD’s key users were consulted by the ACC on the formulation of the Into the Future strategy. The main challenges identified by the CBD's key users were:

- difficulty in accessing the CBD
- traffic congestion and domination by vehicles
- addressing safety concerns
- quality of developments, particularly apartment buildings
- ability of existing regulatory control to deliver quality outcomes
- the existing Queen St environment
- links through the CBD
- protecting heritage
- achieving good urban design
- access to the waterfront
- making the CBD pedestrian friendly
- developing an identity for the CBD
- managing growth – both residential and economic
- improving the 'look and feel'
- the increasing influence of education, and its associated risks
- improving the CBD as a tourist destination.

These responses are consistent with improving accessibility and trip reliability for CBD movements, and the quality of the urban environment, in the context of congestion charging.

2.4 Auckland’s congestion problems

There is accumulating evidence of the magnitude and adverse impact of congestion affecting Auckland City and the Auckland region. A 1997 study by Ernst and Young, ‘Alternative Transport Infrastructure Investments and Economic

Development for the Auckland Region' estimated the economic cost of congestion in the Auckland Region at $755 million (1997 dollars), of which around 25 percent is borne by the manufacturing and distribution sectors.

This estimate was reached by aggregating:

- the costs of individual trip delays (including time and vehicle operating costs) based on the Auckland Regional Transport (ART) Model (estimated at $570m per year or 73.5% of the total)
- the economic costs of delays (both direct and indirect) to the manufacturing and distribution sectors (estimated at $185m per year or 24.5% of the total).

Assuming annual traffic growth averaging 5 percent, the Allen Group Report (2004) updated the figure to $1.0 billion per year (in 2004 dollars). However, the Allen Report also quotes a 2004 study by the Auckland Regional Council which suggests an overall figure of around $4 billion per year. Some of the problems that arise in making these kinds of estimates are discussed in much more detail in Section 3 of this Report, drawing on examples from the United Kingdom.

Grimes (2007) quotes Transit NZ (2005) figures for Auckland suggesting that the median all day travel speed on major roads in the Auckland Region decreased from 43.3 km/hr in March 2002 to 36.3 km/hr in March 2003. In consequence, average travel speeds declined by 7km per hour such that a 20 km journey would take an extra 5 minutes travel time.

The Allen Report (2004) also cites AUSROADS / Transit NZ 2003 data comparing nominal and actual travel speeds in Australian metropolitan areas with those of Auckland. The results suggest that:

- Un-congested travel speeds in Auckland averaged 65km/hr (towards bottom of Australian range of 63-72 km/hr)
- Auckland's congested travel speed (40 km/hr) was lower than any in Australian metropolitan area (with the latter ranging between 41-53 km/hr)
- Auckland had the greatest gap between actual and un-congested travel speeds of all of the metropolitan areas.

Despite substantial capital investment in transport systems in recent years, there is evidence that Auckland still lags comparable Australian cities in the travel times achieved by its transportation systems.

Relatively recent estimates have also been compiled for the Booz Allen Hamilton (2005) 'Surface Transportation Costs and Charges study'. This estimated the cost of congestion in Auckland at $701 million per year (in 2002 $), broken down into $320 million for peak congestion and $381 million for off-peak congestion. At the same time, the national costs of congestion were estimated at $961 million, such that Auckland accounted for 73 percent of the total.

Grimes (2007) also quotes Transit NZ (2005) comparisons that focus on train and bus travel times. The study compares Auckland, Brisbane, Adelaide, and Perth.

As shown in Table 3, Auckland public transport speeds are slow compared with Australian cities and are especially slow in comparison to Perth which has invested heavily in Public Transport.

Table 4 Relative passenger transport performance

City Average	Fastest travel speeds (km/hr) – Off-peak	Fastest travel speeds (km/hr) – Peak
Auckland	24.5	27.6
Adelaide	30.8	30.8
Brisbane	28.0	27.5
Perth	41.7	42.3

Source: Grimes (2007) / NZIER

This partly explains why public transport boardings in Auckland have fallen from about 130 per capita per year in 1960 to around 40 per capita per year in 2006 (Abusah and de Bruyn, 2007).

In summary then, there is strong evidence that Auckland is experiencing heavy and intensifying congestion – and that Public Transport is currently making a very limited contribution to alleviating that congestion.

2.5 Impact of transport costs and congestion on Auckland firms

2.5.1 Impact of transport costs on business

The ARPES study makes the following generalisations on transport costs and economic performance with respect to Auckland:

- Transportation costs are not trivial
- Travel time costs are significant but it is difficult to determine actual impacts (particularly those relating to private car trips)
- Even allowing for travel time costs and both freight and associated car travel costs, transport costs as a whole are a small component of total business expenditures for most sectors of the economy (in the order of 1-2%).

The 2006 ARPES study also quotes the Infometrics Report (2003), 'Generating Growth: Infrastructure' which surveyed 50 major businesses and business organizations in New Zealand. The sample covered larger businesses which are more heavily oriented to exports. The results suggested that:

- Transport accounted for an average of around 9 percent of business costs for the sample (compared to an estimated 4.4 percent economy-wide average, using the same mode of calculation)

- Key transport concerns raised by respondents were:
  - availability of the right type of transport services
  - reliability, speed and frequency of service concerns
  - costs of freight and business travel
  - social and business costs of traffic congestion
- Many businesses were pursuing counteracting / offsetting measures to mitigate transport difficulties, including, for example:
  - night deliveries
  - flexible working hours for staff
  - developing location strategies (including the use of inland ports).

More recent interview surveys within the 2006 ARPES study highlight growing concerns with congestion. They report that 74 percent of residents identified the reduction of traffic congestion as 'very important' and a further 20 percent identified is as 'important'. Similarly, 80 percent of all businesses identified the reduction of traffic congestion as 'very important' and the balance regarded it as 'important' – with the comment that 'something must be done!'

The 2006 ARPES study also notes that the types of industries that are heavily represented in central Auckland (e.g. business services, travel and tourism) are likely to have average or less than average transport intensities, as they generate comparatively little heavy freight). It also observed that business trips made during the 6-10am period in Auckland (currently around 184,000 per day) represent less than 15 percent of all trips made in Auckland during that period), such that congestion impacts more heavily on commuter and private trips than it does on business trips per se.

2.5.2 Transport costs, congestion and agglomeration

Grimes (2007) draws attention to the role that accessibility plays in fostering inter-industry linkages, catalytic growth and development synergy within a regional economy. Together these impacts have been termed the 'economies of agglomeration'. According to Grimes, agglomeration engenders benefits such as:

- thicker labour markets (i.e. better matching of workers to jobs)
- better links between producers and suppliers
- knowledge spillovers from local contacts.

Such benefits are reflected in the steep rise in land values and building rentals as one moves towards the centre of a city like Auckland.

Grimes notes the international evidence that agglomeration benefits are highest within 40 minute travel time zone from a CBD, and that populations of areas that are 60 minutes drive time from a CBD have average levels of productivity that are typically only ¼ of those of populations that are 30 minutes drive time from the

CBD. This suggests that congestion stifles agglomeration and the improvement of productivity but that congestion charging and investments in transport systems can counteract these tendencies.

Although evidence on the presence and intensity of agglomeration effects in Auckland is limited, Grimes (2007) notes several recent studies that appear to confirm that such effects are indeed powerful:

- Lewis and Stillman (2007) find Auckland has higher absolute levels and higher levels of growth of labour income than other areas of New Zealand
- Mare and Timmins (2006) find evidence that the geographic concentration of industries and industrially-diversified markets (as found in Auckland) are both associated with raised productivity
- Grimes & Liang (2007) find that central Auckland has markedly higher land rents, with the gradients from the periphery to the CBD becoming steeper in the period 1992 -2004.

In addition, the recent ASCARI (2007) study 'Assessing Agglomeration Impacts in Auckland: Linkages with Regional Strategies' has concluded that there are strong links between transport accessibility, employment density and productivity and that a compact urban form (whether the metropolitan area is polycentric or monocentric) is probably most appropriate in supporting the growth of major cities through agglomeration. The study also concludes with respect to Auckland that policies to promote compact development and reduce urban sprawl and the dispersion of employment need to be supported by transport network interventions that increase accessibility to the CBD. This is turn is held to imply an increasing role for public transport.

2.6 Assessments of the impact of road pricing in Auckland

2.6.1 General insights

Any assessment of opportunities for introducing congestion pricing in central Auckland, must take account of the observation by Mees and Dodson (2002) that:

> *Historically, Auckland's transport planning has followed the most extreme pro-car American models, far more closely than has been the case in Australian or Canadian cities, or even many cities in the U.S.A. The Auckland transport system has been centred around freeways for much longer than other comparable cities, and this is one of the major reasons for the extremely low usage of public transport.*

This points to the possibility to the need to assess how far congestion pricing in central Auckland could:

– spur the growth of secondary centres (e.g. Waitakere, Manukau) through decentralisation

- intensify road usage on some road segments, and by some types of users, and
- affect the growth of some types of economic activity in downtown Auckland.

2.6.2 Results of the ARPES Study

In assessing the impacts of potential road pricing schemes in Auckland, the 2006 ARPES study notes that effects arise from:

- changes in the numbers, timing and mode of trips
- shifts in business costs including: out-of-pocket costs from fares, charges and operating costs; time and convenience effects; downstream effects on associated businesses.

It is notable that the 2006 ARPES study does not consider longer term effects such as those related to business location / relocation and the potential benefits of agglomeration.

The study assesses 5 types of schemes and the expected impacts of road charging (based on runs of the 'RART' strategic traffic model developed for the ARPES study) are summarised overleaf.

Table 5 Estimated potential impacts of alternative 2006 ARPES schemes (2016 traffic estimates- AM Peak)

CASE	**No pricing Case**	Single Cordon scheme	Double Cordon	Area	**Strategic Network**	**Parking Levy**
Total Traffic Demand – vehicle trips	446,299	436,646	440,508	409,462	437,287	432,414
Average Vehicle Travel Time - minutes	15.4	13.3	14.7	14.1	14.7	14.7
Difference	Baseline	-5.97	-7.86	-5.43	-5.07	-1.92
% Difference	Baseline	-30%	-40%	-27%	-26%	-10%
Mean Journey to Work Travel Times – minutes - Vehicles	18.0	15.0	14.8	16.0	17.0	16.9
Difference	Baseline	-3.0	-3.2	-2.0	-1.0	-1.1
% Difference	Baseline	-17%	-18%	-11%	-6%	-6%
Journey to Work Travel Times – minutes – Passenger Transport	51.1	44.9	43.4	42.7	48.6	43.3
Difference	Baseline	-6.2	-7.7	-8.4	-2.5	-7.8
% Difference	Baseline	-12%	-15%	-16%	-5%	-15%
Business trips made per day	171,000	171,000	170,000	158,000	169,000	172,000
Change in Total Trip Cost - excluding Road Pricing)	Baseline	-0.6%	-0.9%	1.5%	0.2%	0.2%
Change in Total Trip Cost – including Road Pricing	Baseline	+5.9%	+7.2%	+11.2%	+7.1%	+0.2%

Source: ARPES / NZIER

The most important conclusions regarding general economic impacts are that:

- the schemes would result in relatively small falls in the number of vehicles using the road system (with falls generally in the 2-3% range but rising as high as around 9 percent for the Area scheme)
- by way of contrast, the schemes would generally lead to significant improvements in average trip travel times (with the highest gains of 17-18 percent being for the Cordon scheme)

- Similarly, if the assessment of beneficial effects is restricted to journeys to work, average travel trip times would fall between 12 to 15 percent for the cordon schemes. In this case, significant gains would also be realised in the Area scheme (from reductions in less essential trips like school drop-offs and pick-ups) and the Parking scheme (from reductions in less essential shopping and recreational trips that coincide with peak flows).

The results for business trips suggest that:

- single and double cordon tolling schemes would have little impact on business trip levels and that a parking levy could increase business trip levels slightly. However, an Area scheme, as it would affect all movements within the charging zone, would be expected to significantly reduce business trip levels
- Average trip costs decline for the single and double cordon schemes (when the calculation excludes the cost of the road charges)
- Average trip costs, when the road charges are included, vary quite widely. They are lowest for the parking levy scheme because businesses generally use dedicated parking / loading bays that would remain outside the scheme

With respect to the specific impacts on different business sectors, the findings were that:

- in the Single Cordon scheme, all sectors experience cost increases, ranging from 0.4% in mining to 5.6% in manufacturing but trip numbers increase overall
- in the Double Cordon scheme, overall there is no change in trip activity. The manufacturing, construction, and education sectors experience small reductions
- the Area scheme shows significant reductions in trips across a range of industries (in the range 10-30%)
- the Strategic Network Charging scheme shows a 0.5-1.1 percent reduction in trips across all sectors
- For the Parking Levy scheme modest trip reductions and cost increases are seen in all sectors of the economy (under 1.5%).

Overall the 2006 ARPES study concluded that:

- implementing any of the 5 charging schemes would result in relatively small negative effects on the business sector
- the vehicle cost and time benefits from road pricing are only equivalent to 5-20 percent of the additional costs imposed by charging, so that the net effect on business will be negative
- Overall, however, the increase in business sector costs is very small – the net increase is equivalent to less than 0.01 percent of business costs (partly reflecting the reality that transport costs are not very significant to the majority of businesses).

2.7 Conclusions on the Auckland context

Auckland's geography and history condition its current ability to absorb traffic growth. It is located in a narrow isthmus that draws movements across the conurbation into a constructed north-south corridor. The marked tendency in the past for transport initiatives to favour roads and car movements over passenger transport (including suburban rail services) has further encouraged low density development and decentralization. These factors have in turn boosted vehicle trip numbers.

Auckland is New Zealand's premier city and it has enjoyed relatively strong growth in recent years. It hosts large clusters of high value added businesses – including such sectors as financial services, information technology and the creative sectors. However, average per capita incomes lag those of comparable overseas centres and recent economic performance has been similarly modest in comparison to many overseas 'world cities'.

There is significant evidence from a range of studies of the current and growing importance of congestion within the Auckland conurbation. The annual cost of congestion has been previously estimated at well over $700 million (1997 and 2002 $), suggesting that a 2008 figure well in excess of $1 million per year (given growing traffic levels and cost inflation).

It is also evident that Auckland has been relatively badly served by passenger transport services, with poor levels of connectivity, regularity, reliability and speed in comparison say to Australian metropolitan areas.

Both residents and businesses record high levels of dissatisfaction with the degree of congestion experienced. However, there is some evidence that businesses have been pursuing offsetting strategies such as night deliveries, flexible working hours for staff, and plant and depot relocations.

Evidence on the presence and intensity of the linkage, matching, and catalytic effects that can arise from the collocation of businesses through 'agglomeration' is limited in the case of Auckland. However, raising the potential to realise these forms of interconnectivity will very much condition Auckland's future ability to establish itself as a world city – and this in turn may hinge to some degree on its levels of physical connectivity and accessibility.

The forerunner to the current round of studies of congestion charging in Auckland, the 2006 Auckland Road Pricing Evaluation Study, has suggested (based on extensive modelling) that road pricing would be successful in reducing trip numbers and congestion and that any adverse overall effects on business activity would be small.

Finally, it should be noted that there will inevitably be an element of conjecture in cross-referencing Auckland's problems, needs and solutions to those of overseas cities, as has been undertaken in the remainder of this Report. In this regard, readers must heed the caution that is also given the 2006 ARPES Study that:

> *Road charging aimed at addressing congestion has not yet been implemented in a city like Auckland. The London and Singapore schemes are most similar to that which would be needed for Auckland. However, both were implemented in cities with dense population, a much more congested central business district, and much higher public transport mode shares.*

The purpose of the work that follows is therefore to search for lessons from the international experience, bearing in mind the special problems that arise in validating comparisons.

3. Overseas evidence on the economic costs of congestion

3.1 Introductory comment

Although this Report has the specific objective of exploring the economics of congestion and congestion charging, it is worth noting at the outset that structured economic deductions and measurements provide only one approach to characterising and treating congestion.

One potentially promising alternative line of inquiry combines physics and assessments of the probability of different types of human behaviour. This approach is discussed in some detail in P. Ball's book (2005) 'Critical Mass and how one thing leads to another'[5]. Ball provides a chapter entitled 'On the Road – the inexorable dynamics of traffic' that discusses the insights that can be gained from wave and particle physics and risk and contingency models.

In particular, Ball draws attention to the need to consider differentiating:

- Free flow traffic (characterised in particular by the ability to overtake more or less at liberty)
- Synchronised flow (characterised by the natural regimentation of drivers in crowded conditions and the virtual absence of overtaking)
- Fluctuations (caused by careless, stressed or risk averse drivers getting too close to preceding vehicles or slowing too abruptly)
- Jams (generally traceable to network anomalies like bottlenecks, on-ramps, hills and corners but also related to accidents dependent on driver failure).

In conclusion, Ball suggests that one approach to congestion is to institutionalise synchronised flow, through improved driver information, auto-piloting (20 percent adoption may be all that is required in some instances to restore synchronicity), and traffic demand management techniques (including road pricing).

However, Ball also notes the strong adverse reaction that is likely to be engendered among some member of the public to proposals for the introduction of innovations such as Global Positioning Satellite trip monitoring and charging, and auto-piloting by remote systems.

[5] Ball, P. , (2004), 'Critical Mass – How one thing leads to another', Arrow Books, UK

3.2 Measuring the economic costs of congestion

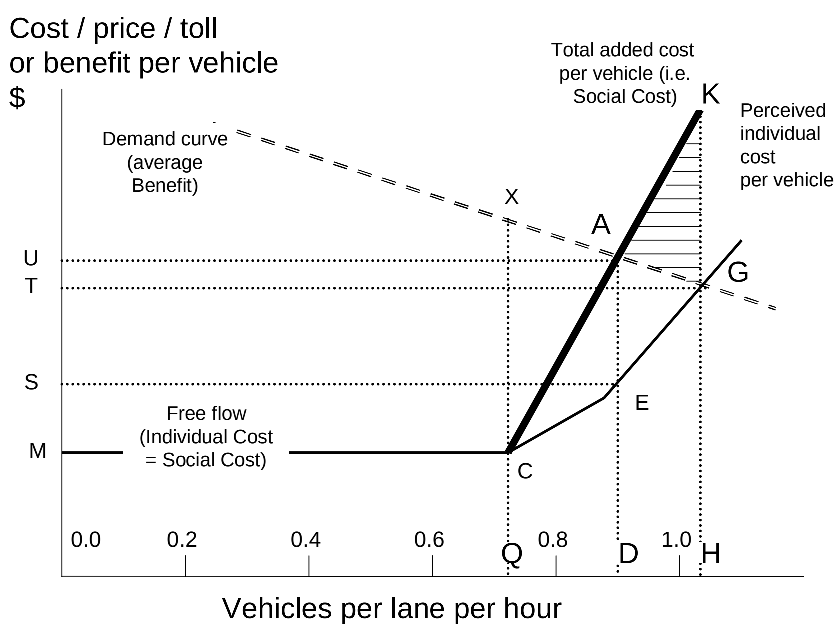
3.2.1 Theoretical background

a) Graphical analysis

The basic economics of peak hour traffic and peak-hour pricing is illustrated in Figure 1 below, drawing on Downs (2004)[6].

The demand curve shown in Figure 1 illustrates the average amount that motorists would be willing to pay for the use of a highway. As the number of vehicles per lane per hour rises (horizontal axis), the average benefit declines because of increased congestion (i.e. the demand curve is downward sloping with respect to the costs imposed by congestion).

Figure 1 Economics of peak hour traffic and pricing



Source: Downs (2004) / NZIER

The solid line MC shows the marginal private costs incurred by motorists in using the highway. In free-flow conditions, the cost remains constant. However, beyond Q, congestion reduces average speeds and the costs incurred by individual drivers rise along the trajectory CEG. However, the costs contributed by each additional driver are greater than the costs born by the individual, such that total costs per vehicle (i.e. social costs) rise on the trajectory CAK – that is private and social costs diverge.

[6] Downs, A., (2004), 'Still Stuck in Traffic – Coping with peak-hour Traffic Congestion', The Brookings Institution

The social optimum occurs therefore where marginal social costs meet average benefits (i.e. point A on the demand curve). On the other hand, the private optimum occurs at much higher traffic densities (i.e. the point G on the demand curve).

To stop traffic rising beyond the social optimum (i.e. D), it is necessary to impose a toll equivalent to AE (or SU).

The social costs (net welfare loss) associated with not imposing a peak hour toll, are given by the area of the shaded triangle GAK. This is defined by the intersections of the marginal social (point A) and marginal private costs (point G) with the average benefit curve, and the slope of the marginal social cost curve. The maximum loss on the last entrants into the road (i.e. the maximum difference between social and private social costs before further additions to traffic are deterred by excessive congestion) is defined by KG.

b) Definitions and measurement complexities

In practice, there are a number of different theoretical approaches to estimating the economic costs of congestion and it is useful to start by defining these.

Marginal cost of road travel typically increases with each additional unit of travel, as roads become more congested. *Short run marginal costs* are those associated with fixed capacity (i.e. excluding traffic demand management and /or investment in increased capacity). On the other hand, *long run marginal costs* are calculated on the assumption that capacity can be freed or expanded (i.e. the cost of the expanding capacity itself forms a component of the long run marginal cost).

> *Basic marginal costs* are those directly by the user (e.g. fuel usage, the value of their own time etc.).
>
> *Marginal external costs* (or 'externalities') are incremental costs that are not borne by the trip maker. With respect to trips made by road they include road wear and tear, delays to other users, increased accident risk[7] and environmental costs.

Marginal social costs are the sum of marginal external costs and basic marginal costs (excluding at this point any consideration of spillovers from trip costs to questions of business viability and adjustment).

One important and immediately tangible item of marginal external costs is delays to other users and this in fact is often referred to as the *marginal external cost of congestion* (MECC). It is important to note that the MECC is defined as the external costs that are borne by the users of the transport system (e.g. delay and reliability costs).

[7] Reducing congestion will lower the number of vehicles on roads and this could contribute to reducing the accident rate. On the other hand, uncongested traffic may move at higher speeds and this may increase the average severity of accidents. Such effects can contribute substantially to changes in marginal costs.

The sections that follow focus on the components of MECC – namely, time costs and potential savings and reliability effects.

3.3 Marginal value of time spent in congested conditions

3.3.1 The basic marginal value of time in travel

The international literature on the value of travel time savings is vast[8]. There has also been both controversy and evolution in the specification and assessment of travel time values. The work of Mackie et al (2003) for the UK Department of Transport provides a very useful summary of the issues.

As a starting point, Mackie et al (p5) note that:

> *Because the average value of employer's business time is in the order of 4 times the average value of non-working time, roughly half of all travel time benefits are accounted for by employers' business time savings, even though this is only 1/6 of car traffic.*

While it is relatively easy to assess business time costs in terms of wages paid for downtime or losses of returns per employee hour, it is much more difficult to assess the value of 'non-business' travel. The latter can vary:

– between commuting and non-work purposes

– between employed and retired persons

– between passengers and drivers

– between modes.

The UK Department of Transport's 'New Approach to Appraisal', for example provides the following guideline figures.

8 Much of Section 2 of this Report draws heavily on the excellent work contained in the Scottish Executive study, (2006), 'Costs of Congestion: Literature Based Review of Methodologies and Analytical Approaches', Edinburgh, for which full attribution is acknowledged.

Table 6 Examples of variations in travel time values

2002 Prices

TYPE OF TRAVELLER / TRIP	VALUE OF TRIP TIME
Car drivers	• £26.43 per hour
Car passengers	• £18.94 per hour
Bus passengers	• £20.22 per hour
Rail passengers	• £36.96 per hour
London Underground passengers	• £35.95 per hour*
Walkers	• £29.64 per hour
Cyclists	• £17.00 per hour

Source: DfT – UK / NZIER

Car drivers appear to value their trip times higher than do bus and car passengers and cyclists. This suggests that car drivers are likely to respond relatively positively to congestion charging that frees up road space. On the other hand, the estimates indicate that car drivers in general put a lower value on trip time than rail and London Underground passengers. This confirms that improved trip times for mass transit modes can play an important role in encouraging shifts from car commuting[9].

3.3.2 Basic marginal value of time in congested conditions

Time spent in congested conditions can be more onerous on the traveller than time spent travelling in free flow conditions. A recent review of the literature on this issue, for the Scottish Executive, (2006), notes the following findings for car travel:

- Wardman (2001) concludes for the UK that travelling in congested conditions is valued 48% more highly on average than time spent driving in free flow traffic
- Eliasson (2004) in a Swedish study found values of about 1.5 times the base for driving in queues
- Steer Davies Gleave (2004) found values ranging from 1.2 times the base (for busy conditions/light congestion) to almost twice the base for 'gridlock' conditions

[9] For New Zealand Base Values of Travel Time see LTNZ (2006) Economic Evaluation Manual – Volume 1, Appendix A4.2. The New Zealand figures are generally much lower and are less differentiated than those quoted for the UK above.

- Mackie et al (2003) found that travel time in congested conditions was about 40% higher than in free-flow conditions for commuters, whilst no significant effect was found for the 'other' non-work trip purpose

The above aggregate values implicitly include the valuation of reliability. Overall, they suggest that car drivers value time spent in congested conditions at a 40-50% mark up over time spent in free flow conditions. Reliability issues are given separate consideration below.

3.3.3 Marginal value of reliability

In addition, reliability or the lack of it, is considered to impose a significant cost on business travellers and commercial goods traffic (see for example SACTRA, 1999; McQuaid *et al.*, 2004). Travel time variability and large unexpected delays are two of the consequences of reliability problems. The distinction between them is that:

- travel time variability is considered 'predictable' as it occurs from day to day
- unexpected delay is uncertain and is therefore not generally amenable to avoidance or mitigation.

As noted in the work for the Scottish Executive, (2006), cross comparisons can be made by calculating a reliability ratio (RR). The reliability ratio concept gives a relationship between the value of one minute's standard deviation of travel time and the value of one minute's travel time. A reliability ratio of 1 implies that a reduction of the standard deviation of travel time of 1 minute has equal value to a 1 minute travel time saving.

Hamer et al., (2005), note that in a workshop of international experts convened by the transport research centre of the Dutch Ministry of Transport, the following representative reasonable reliability ratios for passenger transport were set:

Table 7 Representative reliability ratios by journey purpose – Netherlands

Journey purpose	**Mode**	**Reliability ratio**
Commuting (passenger)	Car	0.8
Business (passenger)	Car	0.8
Other (passenger)	Car	0.8
All (passenger)	Train	1.4
All (passenger)	Bus/tram/metro	1.4
Commercial Goods Traffic	Road	1.2

Source: Scottish Executive (2006) [Hamer *et al*. (2005), Kouwenhoven *et al*. (2005)] / NZIER

There is clearly a premium on high levels of reliability for commercial goods traffic.

Other studies have found a quite a large range in the reliability ratio, from 0.35 to 2.4 (Noland and Polak, 2000; Eliasson, 2004; De Jong et al., 2004a). No consensus on a reliability ratio for commercial goods traffic has been reached. Kouwenhoven *et al*. (2005) have also derived reliability ratios for commercial goods traffic. This has been derived from the Dutch guidelines on the relative value of a change in the percentage of goods that arrive on time (see Table 8 below).

Table 8 Relative importance of reliability for road trips by type of load - Netherlands

Type of goods	**Relative value of a 10% increase in reliability**
High value raw materials	1.31
Low value raw materials	1.01
Final products perishable	2.67
Final products non-perishable	2.51
Container	2.95
Average	1.77

Source: Scottish Executive (2006) [Kouwenhoven *et al*. (2005)]/ NZIER

The results show that commercial consignors and freight operators put high premiums on reliability – and that, not unexpectedly, there are particular gains from improved reliability on shipments of high value, perishable, and finished products.

Research has also found that the value of unexpected large delays is typically quite high. Eliasson (2004) in a large Swedish study found values around 3.5 times the value of in-vehicle-time (per minute of delay) for car drivers.

Fowkes (2001), cites evidence, gathered on behalf of the Highways Agency in the UK, that the ratio of the value of delay time to expected goods travel time is in the region of 2 for chemicals, paints, food, drink and groceries, and 3 for other commodities.

3.3.4 Marginal external costs of congestion

For the UK, Samsom et al. (2001) have estimated marginal external costs for roads in Great Britain (for 1998) that relate to a situation without road user charges in place. As can be seen from Table 9, congestion forms the largest proportion of quantifiable external costs - estimated to be around 77 per cent in 2000 (and forecast to increase to around 88 per cent of external costs in 2010).

Accident and emissions costs account for the remainder and, unlike congestion costs, are forecast to fall over time.

Table 9 Relative values of social marginal cost components - UK

COST CATEGORY	**Marginal external cost (pence per vehicle km, 1998 prices and values)**	
	Low	**High**
Infrastructure costs	0.42	0.54
Vehicle operating costs	0.87	0.87
Congestion	9.71	11.16
Mohring effect (see Note below)	-0.16	-0.16
Accidents	0.82	1.40
Noise	0.34	1.70
Air pollution	0.02	0.78
Climate change	0.15	0.62
VAT (i.e. GST) not paid	0.15	0.15
Total	12.32	17.05

Note: The 'Mohring effect' describes the tendency for congestion to block the possibility of intensifying public transport provision

Source: Scottish Executive (2006) / NZIER

Marginal external costs will vary widely across countries, within countries, with time and place, in line with congestion and other externalities.

3.3.5 National impacts

Assessing the overall impact of congestion demands moving from marginal analysis to an accounting framework. There are 2 possible approaches to frameworks of this type:

- Total Cost of Congestion (TCC) – this has as its baseline a state of zero congestion
- Excess Burden of Congestion - has its baseline a situation in which the optimal amount of road capacity is provided.

a) Total Cost of Congestion

According to the Scottish Executive study, the most frequently quoted estimate for the UK for TCC is that congestion costs the economy £20 billion per year. This is an update of the £15 billion estimate calculated in a 1989 Confederation of British Industry (CBI) study. OECD (1991) estimates put the cost of congestion as a proportion of GNP at 2.1% in France, 3.2% in the UK, 1.3% in the USA and 2% in Japan. The exact methodology used to calculate the cost of congestion as a proportion of GDP or GNP in the OECD study is unclear.

There is significant variation between estimates for the Total Cost of Congestion associated with the British road network. For example, the NERA study (Dodgson and Lane, 1997) estimate a figure of £7 billion whilst the Institute for Transport Studies study (Tweddle et al. 2003) estimate a figure of £15.2 billion. Both studies use similar modelling methodologies and both relate to 1996 traffic levels. Clearly small differences in modelling methods and assumptions can have a significant impact on the results.

The Total Cost of Congestion approach to measuring the cost of congestion is not unique to the UK. The total cost of road traffic congestion in the 15 countries of the European Union is estimated at more than 120 billion euros a year (EU, 2003). Every year the Texas Transportation Institute in the US estimates the cost of congestion in 85 of the largest urban areas in the US (Schrank and Lomax, 2005). Their latest estimate is that in 2003 the total cost of congestion was US$61.3 billion. This estimate includes delay costs and extra fuel costs only. Actual speeds are derived from reported traffic speeds in conurbations and compared to 'desired' speeds.

Quinet (1994) in a survey also identifies similar studies associated with Japan (Osaka conurbation and Tokyo conurbation), France (Paris conurbation), Switzerland (Berne and Zurich) and the Netherlands. All of these studies compare some estimate of actual speeds/travel times to desirable or reasonable speeds/travel times.

The results of currently available studies for the United Kingdom are summarised in Table 10 below.

Table 10 TCC estimates for the UK economy and Scotland

SOURCE	ESTIMATE	METHODOLOGY
Glanville and Smeed (1958) [cited in Goodwin (2004)]	£125M per year in urban areas, £45M per year in rural areas, £170M per year total	Delay only, but no allowance for non-working time to have a value
CBI (1989) [cited in Goodwin (2004) and CBI email to authors of Scottish Executive Study]	£15 billion total per year for GB (£5 per week per household per year)	The authors of the Scottish Executive study were unable to obtain a copy of this report. However, the CBI indicated that the estimate is based on a report produced for the OECD which estimated the cost of congestion as a share of GDP, suggesting it lay in a range from 2.6% to 3.1%.
Unknown	£20 billion per year (no date ascribed)	The CBI report that this often quoted £20 billion figure was produced "some years ago by updating the previous figure [the £15 billion CBI figure] to reflect movements in prices".
Newbery (1995) [cited in Goodwin (2004), Mumford (2000), Dodgson and Lane (1997)]	£19.1 billion per year for GB (1993 traffic levels and prices)	The approach adopted has been criticised (e.g. by Dodgson and Lane) as providing an incorrect measure of the total cost of congestion as it "multiplies a marginal cost by a total volume".
Trafficmaster (1996) [cited in Santos (2000)] Trafficmaster (1997) [sourced from internet press release]	£2.1 billion for 4th quarter of 1996 (on motorways) £1.5 billion for 1st quarter of 1997 (on motorways)	Comparison of measured vehicle speeds in current year compared against measured vehicle speeds in the year in which the measuring devices became operational. Costs reflect wasted time, extra fuel, missed deliveries and higher maintenance costs [as reported by Santos]

Dodgson and Lane (1997)	£7 billion per year for GB (1996 traffic levels and prices)	Comparison of costs at freeflow and estimated current speeds - modelled using link based methodology. Time and vehicle operating costs (fuel and non-fuel).
Mumford (2000)	£18 billion GB total (1999 prices)	A 'mid-point' of the CBI's estimate, Newbery's estimate and Dodgson and Lane's estimate updated to 1999 prices.
Tweddle et al. (2003)	£15.2 billion GB total (1996 traffic levels, 1998 prices) £19.2 billion (1998 traffic levels, 1998 prices) £24 billion (2005 traffic levels, 1998 prices)	Based on a comparison of estimated speeds and freeflow speeds. Traffic levels for 1998 and 2005 estimated by growing 1996 traffic levels. Modelled using link based methodology. Time costs only.
Scottish Executive (2005)	£71M per year over 10 areas of Scotland's trunk road network (2003 prices and traffic levels)	Measured speed compared to measured freeflow speed. Time costs only

Source: Scottish Executive (2006) / NZIER

It can be seen that figures of £15 – 20 billion per year are frequently quoted but that there are also much lower estimates.

The Scottish Executive study notes that Total Cost of Congestion estimates may not be particularly useful from a policy perspective. Primarily this is because the measure appears to imply that the British economy will be, say, £20 billion better off, or in the case of the Scottish trunk roads £70 million better off, from alleviating congestion.

Clearly this will not be the case in net terms as any policy associated with alleviating congestion will have a cost associated with it. Additionally any reduction in congestion will reduce the impedance of travel and result in an increase in travel demand and average trip length - which will not only increase the environmental, accident and maintenance burden but may also lead to an increase in congestion above the post adjustment zero congestion level.

b) Excess burden of congestion

The Scottish Executive study notes that the Excess Burden approach reflects the potential benefits associated with a reform of road prices. It is also associated with the challenge of identifying the level of transport infrastructure capacity that maximises economic output. The Excess Burden approach also differs from the Total Cost of Congestion in that, at efficient prices and at an optimum level of capacity (i.e. the baseline), it is highly likely that congestion will still be present on the transport network.

In theory, the price for road use should be equivalent to short run marginal cost (i.e. a charge equal to the marginal external cost of congestion should be levied on road users) and investment decisions should be based on social cost benefit analysis (Dings et al, 2002). Clearly there is an explicit trade off between the cost of investment in additional capacity and the benefits that that extra capacity will bring. If the benefits of reducing congestion are less than the costs of providing extra capacity, some congestion will be present at the optimal level of capacity even at efficient prices.

Table 11 summarizes some of the studies that give estimates of the Excess Burden of Congestion at the UK level.

Table 11 Examples of excess burden calculations for the UK under different congestion pricing scenarios

SOURCE	ESTIMATE	Pricing reform only	Type of prices	Impacts charged
Dodgson et al. (2002)	£2 billion per year (England) (1998 prices and traffic levels)	Yes	Congestion charge additional to existing fuel and VED taxes. Congestion charge varies by area, time of day, vehicle type and link type. Reflects delay costs only.	Delay, reliability [(3)]
Glaister and Graham (2003)	(a) £2.6 to £4.3 billion per year [(1)] (b) £2.9 to £3.8 billion per year [(1)](England) (2003 Prices and 2000 traffic levels)	Yes	(a) Fuel tax replaced by congestion and environmental charge that varies by area, time of day, vehicle type and link type (b) As (a) but mark-ups introduced to ensure revenue neutrality for the Exchequer	Delay, fuel, accidents, air pollution, climate change.
DfT (2004)	(a) £9 to £10.2 billion per year [(2)] (b) £7.8 billion per year (Great Britain) (1998 Prices and 2010 traffic levels)	Yes	(a) Fuel tax replaced by congestion and environmental charge that varies by area, time of day, vehicle type and link type (b) As (a) but revenue neutral for the Exchequer	Delay, fuel and non-fuel vehicle operating costs, accidents, air pollution, climate change, noise.
ECMT (2003)	€17 billion (=£11.7 billion [(4)]) (Great Britain) (2000 prices and traffic levels)	Yes	Fuel tax, VED, insurance tax replaced by congestion (including resource costs of parking) and environmental charge plus a charge that allows the government to recover lost VAT receipts. The charge varies by area, time of day, and vehicle type	Delay, fuel and non-fuel vehicle operating costs, accidents, air pollution and climate change.

NOTE: None of estimates includes cost of implementing and operating the schemes and no hypothecation is envisaged in any of the instances

Source: Scottish Executive (2006) / NZIER

It can be seen that there is a wide range in the estimates from £2.5 to £12 billion per year. Clearly, estimating the potential impacts of policy interventions involving congestion charging and improved traffic demand management is extremely demanding.

The most important conclusions from Table 11 are that:

- The cost of congestion as measured by the Excess Burden of Congestion is substantial (while substantial it is however significantly less than that measured using the Total Cost of Congestion approach).
- There is a substantial variation in the estimates of the cost of congestion. The results regarding the cost of congestion can therefore be seen to be heavily dependent on the values assumed for the external costs and the methodology used to model vehicle delay.

As noted in the Scottish Executive study, there are also numerous other UK studies that have looked at this problem at a city level (e.g. academic related or government sponsored studies of London, York, Leeds, Edinburgh, Cambridge, Northampton, Hull, Lincoln, Norwich, Bedford, Hereford, Bristol, etc.), and there is also a substantial number of studies undertaken elsewhere internationally. The primary difference between studies conducted at a national scale compared to those undertaken at a more local level is the nature of the modelling that underpins the study. The more tactical city wide studies typically use detailed network assignment models (e.g. Santos, 2000) whilst the more strategic national studies use the simpler link based form of modelling (e.g. Dodgson et al., 2002).

All the studies outlined use estimates of 'first-best' prices. That is the prices reflect the full marginal external costs of road travel. In practice such a charging structure would result in a myriad of different prices and for implementation reasons a more simple pricing structure would be required. Such 'second-best' charges (like the London Congestion Charge which does not distinguish between types of vehicles and types of trips) cannot be expected to deliver the same level of benefit as first-best prices.

This also raises the issue of the hypothecation (or dedication) of the revenues collected from congestion charging to improvements in road quality and the provision or upgrading of public transport.

A consequence of such hypothecation is that if there is a lack of good value for money transport projects, in which to invest revenue from road user charging, road prices may have to be set significantly lower than marginal external costs. This would be required to avoid the accumulation of unused revenues or the misuse of such revenues on ‘gold-plated’ or ‘white elephant’ projects (see for example Tricker et al., 2006).

The implication of these constraints on assessing the cost of congestion are that if the baseline for the Excess Burden of Congestion measure were to be defined in terms of a 'realistic' reform of transport prices rather than pure first-best prices, the cost of congestion estimates would be lower than those set out in Table 10.

In relation to transport capital investments (whether hypothecated or funded from general revenue), none of the studies assessed above have simultaneously considered transport pricing reform and investment in additional road capacity. The only study that has considered these issues simultaneously and within a rigorous framework at a national level is that undertaken by Dings et al. (2002)

for the Netherlands. This study appears to demonstrate that for the Netherlands an optimal investment strategy would include a substantial investment in additional road capacity.

The analysis also demonstrates that while capacity expansion does not increase welfare dramatically (once prices have been set to reflect the costs of congestion and on the environment), capacity expansion does bring about a substantial reduction in congestion (as measured by delays). The results also confirm that some congestion would still be present on the transport system at an optimal level of capacity.

3.4 Findings of the UK Eddington Report on congestion levels

The Eddington Transport Study (2006) has proven to be a major stimulus to UK and international debate on congestion effects and congestion policy options. Some of its major findings were that;

- The UK transport system as a whole supports 61 billion journeys per year
- The UK has high levels of connectivity and very few major new roads are needed (unlike, it can be argued, New Zealand which has an embryonic and fragmented motorway network
- The UK daily trip profile is highly uneven. The morning and evening peaks have traffic levels that are 2.5 times above average. The morning peak is largely composed of school and commuting trips, with business trips also commencing at this time. The evening peak has a wider mixture of school, commuting, leisure and personal trips.
- Total vehicle kilometers have risen by about 80 percent since 1980, in line with the expansion of the national economy. 55 percent of commuter journeys are to large urban areas and 89 percent of congestion delay is in urban areas
- Currently about 9 percent of traffic experiences ‘stop-start’ conditions. A 5 percent reduction in travel time for all business travel on the roads could generate around £2.5 billion per year cost savings (around 0.2% of GDP)
- Eliminating existing congestion would be worth some £7-8 billion of GDP per annum.
- 69 percent of business trips are less than 15 miles in length suggesting that the benefits of improved urban road management could be substantial
- Surveys of UK retailers and merchants in the period 2002 – 2006 indicate that between one third and one half of all shipments are delayed in transit to some degree
- By 2025, without action, there will be a 31 percent increase in road traffic, a 30 percent increase in congestion, and a relatively negligible decline in carbon dioxide emissions (with the small decline stemming from fleet improvements etc.)

- By 2025, the costs to businesses and freight movements will be £10 billion per year, and a further £12 billion of time will be wasted by households – and 13 percent of traffic will experience stop-start conditions.

These findings confirms the importance of congestion as a measure policy challenge world-wide and provide the context for the need for both reactive and pre-emptive action in the case of Auckland.

3.5 'Still stuck in traffic'

Anthony Downs' (2004) book 'Still stuck in traffic' provides some useful postscripts on the problems that surround curtailing congestion. He ranks critically assesses a wide range of policy measures that can be considered to ameliorate traffic congestion in the short, medium and longer terms.

On road pricing, Downs concludes that cordon or area-based pricing using smart card devices, or comparable vehicle monitoring techniques, has four main advantages over other tactics towards alleviating congestion:

- it can be put in place – at least in technical if not political terms – within the short to medium term (under 5 years)
- it results in immediate effects on all peak movements
- as it hits all drivers equally, it does not lead to mode inequities, gaming of trip routing, and bunching in off-peak periods
- it can produce significant revenues that can cover its costs and possibly provide dedicated funding for road and passenger transport improvements.

Overall, though, Downs is less sanguine about opportunities for introducing road pricing in the USA. He observes that:

> *In many US metropolitan areas, peak hour traffic congestion is a socially suboptimal condition that wastes billions of dollars worth of time and fuel each year and surely adds to air pollution. Its causes are rooted in several long-established goals and cherished behaviour patterns of Americans.*
>
> *The behaviour that is most to blame for peak-hour congestion is driving to work alone. Any effective tactics must change that behaviour among thousands of commuters. This means getting them to share rides, use transit, or travel at non-peak hours.*
>
> *All the workable means of accomplishing these objectives would raise the costs of solo commuting during peak hours. These means include peak-hour pricing, surcharges on peak-hour long-term parking, and the abolishment of the free-parking benefit for employees.*

In conclusion, Downs lays out the challenges clearly, noting that naturally, the patient does not enjoy the prospect of taking such bitter medicine and that whether peak-hour congestion can be significantly reduced boils down to three questions:

- Is traffic congestion widely perceived as being bad enough for most commuters to accept this medicine?

- Do they fully understand that only this rather painful cure will work and that less painful ones will not help much?
- Will their anti-congestion feelings be strong enough to cause elected politicians to overcome the entrenched resistance of local governments to regional (i.e. wider and cross-boundary) policies and interventionist anti-congestion tactics?

These are useful observations that can be borne in mind with respect to Auckland's congestion problems and the design of potential solutions to those problems.

3.6 Implications for New Zealand

There are problems in extrapolating the UK experience and UK statistics to New Zealand. Clearly, as illustrated below in Table 11, the United Kingdom is 15 times more populous than New Zealand. And per capita incomes in New Zealand are only 73 percent of those in the UK.

Table 12 Comparisons for New Zealand and the UK

	UNITED KINGDOM	NEW ZEALAND
Area	244,820 km2	268,680km2
Population	60.6 million	4.24 million
Population density	246 / km2	15 / km2
Urban population	90%	86%
Population in agglomerations over 1 million	24%	28%
Per capita income	US $ 37,300	US $ 27,220
Vehicles per 1,000 people	510	701
Total Cost of Congestion per capita	£250 - £333	*NZ $ 625 - $ 832*
Excess Burden of congestion per capita	£42 - £200	*NZ $ 105 – NZ $ 500*

NOTE : Congestion costs for New Zealand are simply scaled on UK figures

Source: World Bank / Wikipedia / NZIER

However, New Zealand has similar levels of urbanisation and higher levels of vehicle ownership per capita. This means that it is not totally unreasonable to cross-reference congestion costs between the two countries.

On this basis, the Total Cost of Congestion in the Auckland conurbation (1.24m people) would vary between $775 million and $1.03 billion per year – and the excess Burden of Congestion would vary between $131 million per year and $620 million per year.

The above figures can be compared to the estimates for New Zealand from the Surface Transport Costs and Charges Study (2005). These assess the Total Cost of Congestion in New Zealand at $961 million per year, of which $701 million arises in Auckland ($320 million peak and $381 million off-peak).

The proven possibility of cross-referencing the UK and Auckland figures on the costs of congestion provides confidence that, at least to some degree, there may also be a common range of policy options and solutions that allow New Zealand to learn from overseas experience.

3.7 Conclusions on the costs of congestion

The conclusions that can be drawn from the international literature on the economic costs of congestion are as follows.

Congestion can be viewed both in economic terms and as a physical phenomenon. Taking the latter approach, there may be opportunities in future to apply new forms of technology that reduce jams and fluctuations and raise free-flow and synchronised flows levels. For example, compulsory auto-piloting (even on a limited basis) could much improve traffic management. However, such restrictions on consumer choice and personal freedom are problematic.

In general then, there are significant potential advantages in taking an economic approach to traffic demand management that allows consumers to choose whether they are willing to pay for improved road access.

Congestion raises trip costs to road users through increased fuel usage, value of time losses and decreased trip reliability costs. There are also potential externalities associated with congestion that include increased road wear and tear, delays to other users, increased accident risk and environmental costs etc. In some circumstances, congestion creates major costs at the local, regional and national levels.

There is a sound economic rationale for congestion charges that attempt to moderate the social costs that excessive numbers of private trips impose on the economy and society. For a road segment that is prone to congestion, the social optimum usage occurs where marginal social costs equate with average benefits – and this implies some form of rationing of road space by raising the cost of private trips.

The measurement of the primary costs of congestion (i.e. those imposed on trips) is problematic. There are two approaches:

- *Short run marginal costs* are those associated with fixed capacity (i.e. excluding traffic demand management and /or investment in increased capacity)
- *Long run marginal costs* are calculated on the assumption that capacity can be freed or expanded (i.e. the cost of the expanding capacity itself forms a component of the long run marginal cost).

There are also issues surrounding the assessment of the wider impact of congestion on economic growth, given that economic growth often proceeds in tandem with increases in transport intensity. In a sense, congestion is one of the fruits of success. However, beyond a certain point, it can clearly act as a brake on further growth.

However, figures have been derived for the UK which suggest that because the average value of employer's business time is in the order of 4 times the average value of non-working time, roughly half of all travel time benefits are accounted for by employers' business time savings, even though this is only 1/6 of car traffic.

There is also evidence that:

- The value of road trip travel time for commuters in congested conditions is about 40 – 50% higher than in free-flow conditions
- Trip reliability is highly valued for some types of trips – especially those involving business trips and the movements of some types of higher value freight (e.g. perishables)
- The marginal external costs of congestion vary widely across countries, within countries, with time and place, in line with congestion levels and other associated social and environmental externalities.

With regard to the costs imposed by congestion, estimates of the Total Cost of Congestion (short run marginal cost) for the UK (this has as its baseline a state of zero congestion) range between £15 and £20 billion per year

Estimates of the Excess Burden of Congestion (long-run marginal cost) for the UK (which has its baseline a situation in which road pricing allocates road space on the basis of marginal costs) range between £2.5 and £12 billion

On the basis of pro rata allocations, the Total Cost of Congestion in the Auckland conurbation (1.24m people) would vary between $775 million and $1.03 billion per year using UK analogies – and the excess Burden of Congestion would vary between $131 million per year and $620 million per year. The above figures can be compared to the estimates for New Zealand from the Surface Transport Costs and Charges Study (2005). These assess the Total Cost of Congestion in New Zealand at $961 million per year, of which $701 million arises in Auckland ($320 million peak and $381 million off-peak)

The UK studies quoted use estimates of 'first-best' prices. That is the prices reflect the full marginal external costs of road travel. In practice more politically acceptable and administratively-effective 'second-best' charges would not be expected to deliver the same level of benefit as first-best prices

Further complications arise in attempting to assess long run marginal costs that make provision for capital expenditures on road improvements and the provision or upgrading of public transport. However, a study for the Netherlands suggests that an optimal investment strategy would include substantial additions to road capacity.

If the revenues from congestion charging are hypothecated (i.e. dedicated to investments in road improvements and the provision or upgrading of public transport) marginal cost pricing has to take account of the need to ensure value for money from the investments. However, if there is a lack of economically viable transport projects in which to invest, revenue from road user charges may have to be set below short run marginal external costs.

4. Overseas evidence on the impact of transport costs & congestion on firms

4.1 Background

Improvements in freight charges and capacity (including improvements originating from reduced congestion under congestion charging) can be expected to have important knock-on economic effects[10]. These can be classed in the following terms:

Effects on current traders and freight movers

Transport improvements most immediately benefit freight movers. However, if there is insufficient or ineffective competition, they may not pass on the benefits of lower operating costs to their customers. At the same time, any increases in freight movements from the release of suppressed demand may be insufficient to prevent competition driving some operators out of business as the industry adjusts to new operating realities.

Beyond that, lower costs and / or better service in freight movement have the potential to generate a positive effect on firms that are currently engaged in the manufacture and distribution of goods because reducing per-kilometre cost of carriage means that:

- any factory or distribution point can serve a wider market area, with potential gains from scale efficiencies
- a factory can draw supplies from a wider area with potential gains in terms of the cost and/or quality of parts and materials coming to the factory.

However, as some factories gain economies of scale by extending their hinterlands, other local producers may find that their hinterlands become depleted by competition – and may therefore suffer diseconomies or closure.

Expansion of trading

Lower costs and / or better service may encourage the development of new economic activities by allowing the mobilization resources that would otherwise have remained unused / underdeveloped. For example, the extension of a sealed road into an agricultural hinterland may make it possible for new producers to enter the commercial economy – and in turn increase the turnover of processing plants.

However, an increase in product supply could also lower product prices - and drive formerly viable producers to change crops or abandon farms.

[10] This section draws on the experience and professional knowledge of NZIER staff.

Diversification of production and trading

Lower costs and / or better service may make it possible for producers to develop more complex production functions that extend the number and type of products, enhance resource use and better utilize by-products. For example, factories that formerly produced one type of commodity (e.g. durable run of the mill metal sheets) may be able to produce special order / fragile metal meshes, if smooth and secure transport is available.

However, once again, there may be both losers and gainers as price relationships adjust.

Improved inventory and supply chain effects

Beyond lower dollar costs to shippers, reductions in transit time and/or increases in schedule reliability can have significant impacts. These gains in terms of time allow firms to manage their inventories and supply chains more efficiently. Increased reliability, for example, reduces the requirement for "buffer" stocks, inventory held to protect against delivery failure. Lower transit times reduce some costs, e.g., drivers' wages for a given trip length. Further, as with lower dollar costs, less time for a move extends the "reach" of a factory or warehouse.

The 'net' value of such effects may be difficult to calculate. One firm's gain may be another's loss. And, it may be hard to prove that transport has 'triggered' the effect. In fact, in some cases, firms may invest in logistics improvements to counter the effects of relatively poor transport – in which case the poor quality of transport is the 'trigger'.

Innovation, entrepreneurship and multiplier effects

It is easy to surmise that improvements in transport may have wider impacts in that they may:

- open areas and industries to new ideas
- encourage innovation and risk-taking
- encourage enterprise and investment
- generate cumulative beneficial economic responses (in a 'virtuous cycle').

However, it is also clear that net effects and effects that are triggered solely by transport effects may be relatively rare. Improvements in transport may therefore be a necessary or desirable condition for benign economic responses rather than a sufficient condition. That means that other complementary influences and effects may share causation (for example, there may be no responses to transport improvements if capital is unavailable or there is a lack of suitably skilled labour).

Comment

Looking at the potential 'secondary' effects of transport improvements (i.e. everything above other than the direct impacts on freight movers), Mohring and

Harwitz[11] caution that the whole of the apparently 'triggered' rise in the value of non-transport sector production may only be attributed to the transport improvement if:

- part or all of the induced investment in the non-transport sector industry would not have taken place in the absence of the change in the supply of transport
- the investment in question does not result in a reduction in the level of economic activity elsewhere in the economy
- the non-transport sector investment uses resources that would otherwise have been partly or totally unemployed.

These conditions are difficult to validate and may be relatively rarely achievable in practice.

Any search for net effects must also bear in mind that the ultimate benefits of new investments often arise from a combination of generative and distributive impacts, where:

- Distributive effects involve a redistribution of supply-demand relationships between producers and consumers that in turn affect income, population and employment (and which may or may not be associated with net gains in output)
- Generative effects which increase output by using resources more effectively and / or using resources that were previously underutilized.

4.2 Responses of business firms to transport costs – evidence from the UK

The UK Department of Transport's 2004 study 'The Importance of Transport in Business' Location Decisions (McQuaid et al, 2004) provides an excellent review of business / transport relationships in the UK. The study seeks to understand the role of transport in decisions made by businesses on where to locate or relocate and notes that this task is both crucial for planning purposes and extremely demanding.

The study concludes on transport cost – business viability issues that, foremost, this is a complex subject area. There are many types of businesses - each with their individual transport needs and considerations - and the task of unpacking and isolating the influence of transport is a complicated and difficult process.

As such, there is very little significant consensus concerning the overall effects of transport on business location and wider economic development and it is recognized that considerations need to be made almost entirely on a case-by-case basis.

The study also notes that business surveys indicate that a range of potentially interlocking factors influence location and relocation decisions:

- the quality and scope of physical and business infrastructures

[11] Mohring, H., and Harwitz, M., (1962), Highway Benefits: An Analytical Framework, Northwestern University Press, Chicago

- factor cost and supply, especially labour availability
- market demand and links to international markets
- institutional infrastructure and networks
- a local 'culture' supporting 'civicness' and entrepreneurship
- indigenous company growth
- agglomeration economies
- technological development
- as well as more social factors such as climate, lifestyle, image and crime rates.

Although some of the above have an element of transport within them, none directly relate to transport per se. As a general rule, studies suggest that transport is only an important factor, once the decision to set up in an area has been taken. In other words it is a necessary but not sufficient condition for decision-making.

The study further notes that:

- within certain given parameters, such as, basic access to airports or major motorway interchanges where absolutely necessary - levels of transport provision are generally seen as ubiquitous within developed countries and as such transport is seen as a necessary, but not a sufficient condition for influencing business location
- transportation costs are typically found to be only a very small proportion of firms' total costs usually less than 5%. As such, any improvements to the transport infrastructure is likely to yield small cost savings and gains to firms
- a decision to relocate may be prompted by transport difficulties and inaccessibility. However, it is argued that the transactions cost to any change in transport may be too high to enable the firm to respond fully to a change in transport costs. Therefore the review notes that businesses are likely to change operations in discrete steps, and it is only when certain cost thresholds are reached that it becomes efficient to the firm to revise its number or location of depots.
- much transport investment (and this probably also applies in part to congestion pricing) influences business location and production decisions at the local and intra-regional levels but does not generate net national or regional growth
- congestion is a major problem in many urban areas – it can lead to trip unreliability, and added business costs, and can be a tipping factor that drives businesses from CBDs.

The study summarizes the evidence from the literature in a number of tables. The most relevant of these are presented below.

Table 13 How important is transport in location decision-making?

EVIDENCE	UNASWERED QUESTIONS
Corporation of London (2002): good air transport in particular is important for attracting business service firms as average spending per employee on air services by the financial services sector is six times the average for UK business as a whole. Gillis and Casavant (1994): highlight that investment in road infrastructure is a key to the location values of light industrial and commercial businesses and air freight has an increasing impact on the development of some areas of manufacturing. SACTRA (1999): business location is usually determined by fixed natural assets - transport costs are borne by the consumer. Button et al. (1995): road and air infrastructure have a greater impact on inward FDI investors than endogenous firms, with roads particularly important for UK headquartered inward investment and airports for overseas inward investment. Bus links had a greater importance for large firms. Almeida and Kogut (1997): transport factors among some high-tech manufacturing businesses are secondary to the need to be located in proximity to other firms in the 'cluster', due to the importance of face-to-face networking with suppliers and customers. Smyth (2003): the manufacturing sector only accounts for around 15% of demand for inter-industry air services in N. Ireland, and much of this demand can be accounted for by the higher' order activities within the sector that the regions are trying to attract.	What are the differing requirements of predominantly international and domestic owned firms (and how do these vary according to markets serves, industry and size)? Is there a potential long-term trend back to town and city centre retail development? The effects of transportation on tourism, particularly in fragile peripheral economies where it is of most importance. Which types of business can realistically be encouraged to locate in more centralized locations? How are the location requirements of businesses likely to change in the future and how will this differ between types of business?

Source: McQuaid et (2004) / NZIER

Table 14 What kind of businesses locate or relocate in response to transport issues?

EVIDENCE	UNASWERED QUESTIONS
Huws and O'Regan (2001): empirical study - the skills of the workforce and technical expertise in a region are the most important drivers of location and that this leads to a clustering of similar firms. Transport factors play a minimal role. Button et al. (1995): Poor transport infrastructure does not induce firm migration but will influence location decisions for firms on the move. Linneker and Spence (1996): when the component of accessibility change caused by the construction of the M25 motorway is isolated, then it can be demonstrated that such changes are positively related to changing levels of economic development. Ryan (1999): property prices of business locations found to be higher around transport hubs indicating a higher demand by businesses to locate there. Lawless (1999): Investment in a new tram system in Sheffield had a minimal effect on business (re)location and regeneration. Ellison and Glaeser (1997): observe that the presence of one firm in a location reduces transport costs for subsequent firms and this forms a driver for geographic concentrations. Welsh Economy Research Unit (1997): on economic development in Merthyr which implies that improved road access has been an important factor in influencing the location decisions of recent investors. As a result, in addition to direct transport cost savings for existing businesses, there have been even greater wider benefits in terms of income and employment from new business investment. McCalla et al. (2001): linkages between industry and transport terminals are weak, i.e. businesses in proximity to the terminals make little use of the facilities and proximity to the terminal was not a prime location consideration. The industrial location - transport terminal relationship is indirect, business located there because of high accessibility found in the terminal zones. Goodwin et al. (1998): measures to reduce traffic capacity can result in a reduction in traffic volume in the long run as people change jobs, location or mode of travel. McCann (1998): transport costs, although central to classical location theory, are empirically of very little significance in explaining overall costs faced by firms. Button and Costa, 1999: changes in the control and regulation of transport been at the forefront of transport policy in the United Kingdom, and in other EU states, which will affect the infrastructure and its management and may influence business location.	What are the drivers of change - what needs to be done to influence location decisions? How does transport provision influence business relocation, and how can this be forecasted? How important are transport costs to business location decisions? Are perceived costs more relevant? What is the role of transport in international, as well as regional, competitiveness? How does the distribution and services provided (e.g. flight destinations) of the airport system influence business location and competitiveness? What specific role do airports play in this?

Source: McQuaid et (2004) / NZIER

Table 15 Where is congestion important?

EVIDENCE	UNANSWERED QUESTIONS
Ernst & Young (1996): found that congestion and the unreliability of trips add to business costs, particularly for companies in the service sector and those serving urban areas. Scottish Executive (1999): congestion in urban areas can damage the viability and vitality of city centres by discouraging visitors and encouraging relocation to out-of-town areas. McKinnon (1998) effects of congestion on logistics are difficult to quantify. Most companies found the effect on operating costs, inventory levels and investment in materials handling and IT to be weak or non-existent. Congestion did have some effect on labour costs and was a factor behind strategic decisions to increase depot numbers.	A need to conduct a wide-ranging survey of the impact of congestion on logistics operations and supplement this with direct observation and measurement. Are measurements of congestion in different areas actual or perceived? For example is perceived congestion in say, Middlesborough as severe as in London? There is a need for reliable, comparable measures of congestion. The longer-term effects of city bypass schemes on business location and traffic levels within the bypassed area Do traffic calming and pedestrianisation measures lead to an increase or a decrease in business activity? Will this vary between the short and long run?

Source: McQuaid et (2004) / NZIER

4.3 Comments of the UK Eddington Report on business impacts

The 2006 Eddington Transport Study for the UK stresses that transport issues have a major impact on economic growth and that transport improvements can play major roles in:

- increasing business efficiency
- increasing business investment and innovation
- supporting clustering and agglomeration
- improving the functioning of labour markets
- increasing competition by open and extending markets
- fostering international trade
- helping to attract globally mobile activity (inward Foreign Direct Investment).

It comments that 28 percent of the UK's national income is internationally traded and that there is evidence that over the last 40 years, falling international transport costs have boosted trade, increasing the UK economy by 2.5%.

It reports a European Union sponsored survey in 2006 of European senior executives on business location drivers, in which: 63 percent of respondents regarded easy access to markets, customers and clients as 'absolutely essential', and 55 percent of respondents regarded transport links with other cities and internationally as 'absolutely essential'.

The Eddington Study also notes research on the relationship between transport investment and growth in GDP, indicating:

- a positive elasticity of output to public capital of around 0.20

- a positive elasticity of investment in infrastructure to GDP of around of around 0.08
- elasticities with respect to increases in infrastructure effectiveness (including demand management through measures like road pricing) are up to 7 times larger than elasticities relating output and public infrastructure investment.

The Report suggests that transport investments / improvements will have maximum effect when:

- macroeconomic and regional economic conditions are buoyant
- investment funds are readily available
- political and institutional conditions are stable and supportive.

However, the Eddington Report also cautions on taking a simplistic view of the potentially positive returns from transport investment, noting the SACTRA (1999) Report's proviso that:

> *'although the theoretical links are strong, the evidence is weak and by no means undisputed'.*

4.4 Responses of business firms to transport costs – evidence from the USA

The US Federal Highway Authority's Freight Cost Study (2001) also provides an interesting if somewhat dated review of transport and business cost relationships in practice. It points out that transportation investments / constraints often have direct effects on the spatial distribution of a region's or country's population and economic activity.

The FHWA Study notes that Wilson, Stevens, and Holyoke (1982) used survey data and factor preference indices to determine the relative importance of 13 factors on plant location decisions. They concluded that proximity to highways was the third most important factor in the location decisions of Canadian enterprises in the post World War II era (to 1960). Highway access was preceded by proximity of raw materials, owner-manager residence, and closely followed by proximity to markets—all of which can be influenced by efficiency in the transport system. For the full sample time period (1945-69), proximity to highways ranked sixth in importance for secondary manufacturing industries but it was preceded by labour availability, proximity to prospective markets, government financial incentives, owner-manager residence location, and accessibility to railways.

Logically, investment in transportation will affect some economic sectors more than others, although the evidence is mixed. Stephanedes and Eagle (1986) document immediate employment gains in manufacturing and retail trade from highway investment. Data used in their analysis indicate that a 10 percent increase in highway expenditure generates a 0.3 percent increase in manufacturing employment in the following year. However, the intermediate and longer-term effects are smaller. They also found that the same 10 percent increase in highway expenditures generates a 0.17 percent increase in retail trade in the same year. The effects are more dramatic in counties near large cities, attesting to the drawing power of metropolitan areas when access is improved. Some evidence indicates that tertiary industries (including government as well as services) have been more affected than other sectors (Rephann, 1993).

The US FHWA study stresses the need to ask 'Will development / change in a particular area be a net gain for the region or country (i.e. generative)? Or is this development at the expense of another area (i.e. distributive only)? The study notes that in part, the answer depends on the unit of analysis—small state or city, or whole country. Something that is generative in a state or limited region may be only distributive in a national context because one region benefits at the expense of another.

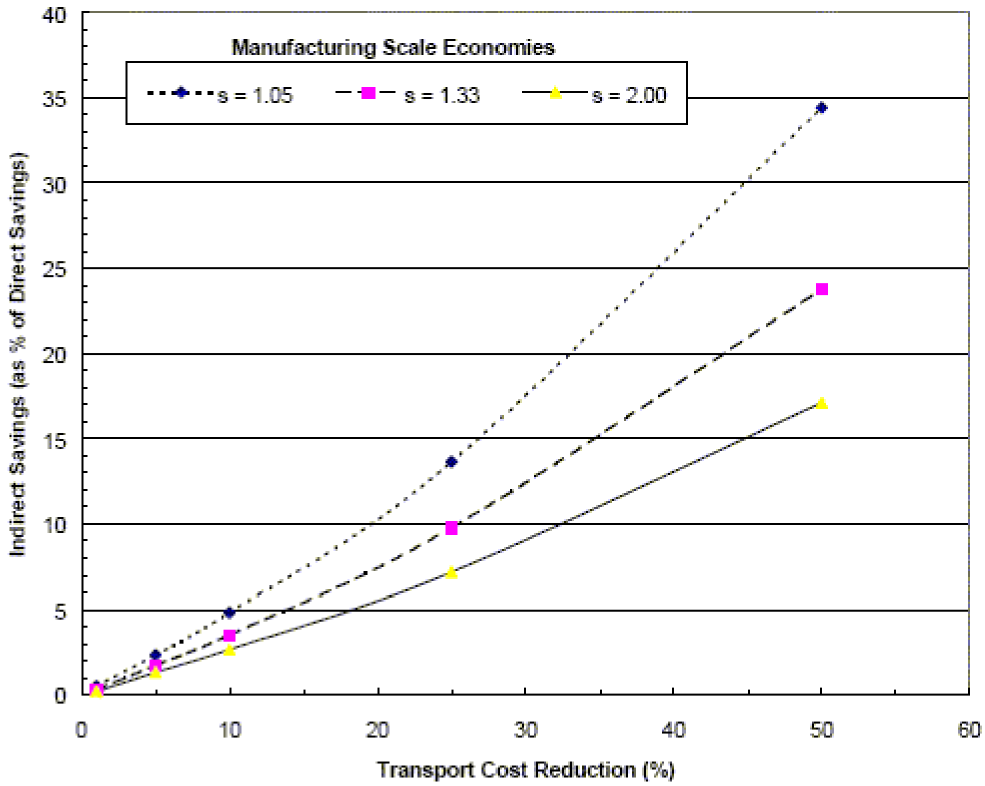
Redistribution seems predominate in selected US examples. One econometric study, which compared counties in the state of Minnesota (Stephanedes and Eagle, 1987), concluded that increases in highway expenditure promote intra-state shifts in employment favouring economic centres in the state *and* away from adjacent counties and rural areas.

Stephanedes (1989) also notes that economic development is a cause as well as an effect of highway funding, that is, transportation planners respond to economic growth by providing funding for transportation needs, thus reinforcing geographic differences. This could also be true for congestion schemes – high priority schemes by early adopters (e.g. the London Congestion Charge) could reinforce London's economic primacy at the partial expense of provincial centres.

The US FHWA study also provides evidence that smaller manufacturing firms suffer most from poor connectivity and reliability. It appears that smaller firms can gain from the "reorganization" benefits that can be triggered by improved mobility.

In work developed by Mohring (1977) and later reviewed by Blanchard (1996), indirect savings from transport improvements were calculated for firms of different scales. Based on Mohring's work, Blanchard has provided estimates for Canada of indirect savings as a fraction of direct savings for different scales of firms (as shown in Figure 2).

Figure 2 Small firms may gain more from transport improvements than large firms (evidence from Canada)



Source: US FHWA 2001 [Blanchard (1996)] / NZIER

The main insight is that, the greater the manufacturing scale economy (i.e. the larger the plant in relative terms), the lesser the relative importance of the indirect benefits.

This result, which on the surface may be counter-intuitive, is explained by Blanchard in the following terms. Industries with large scale economies have a more transport intensive cost structure. Before the cost reduction, they would already be operating from fewer plants, each with a large market area. As a consequence, there is relatively little room for restructuring their production and accruing indirect savings following improvements in transport.

This highlights the important trade-offs that exist between economies of assembly and distribution (i.e. transportation) and economies of scale in processing and manufacturing. Again, the economic landscape is not fixed – its actors can adjust to relatively poor and relatively benign transportation systems – but at a cost.

Clearly though, the aggregate importance of indirect benefits from transportation improvements is greatest for industries with small-scale economies, as they are a very significant portion of the US economy. This is likely to be particularly true in the case of New Zealand where firms are relatively small on average.

Looking more specifically at potential logistics improvements, the US FHWA study notes that:

> *The literature directly relevant to the relationship between transit time service improvements (mean and variability) ostensibly related to highway improvements and logistics restructuring is exclusively qualitative or incidental in nature such that empirical generalizations do not exist.*
>
> *The principle of dynamic changes in logistics inputs and some examples of logistics restructuring exist but this phenomenon generally has not been related to one variable such as transit time improvements other than in a conjectural sense.*
>
> *There are a number of reasons why the desired measures of cost savings are difficult to obtain. First and foremost are the complicated interrelationships among the operations within the plant and between these operations and the logistics operations. For example, savings in inventory costs due to faster delivery time and reliability affect not only the costs of holding inventories (storage, insurance, pilferage, and interest costs) but also handling costs (labour and equipment)*
>
> *Second, the impacts of improvements to the highway system on industry cost savings take place over time as firms and plants structure their operations to take advantage of the potential savings. Some of the major cost savings occurred as the interstate system was put in place years ago. Current officials take this system for granted and are hard pressed to estimate what it meant to their operations.*
>
> *Finally, the major impacts of deregulation and advances in communication and computer technologies over the past decades are intertwined with the impacts of highway improvements and are difficult to separate in the cost savings estimates that current officials have witnesse).*

It is evident then that the complexities surrounding the interactions between transport, logistics, production and distribution decisions are such that unambiguous answers are unlikely from even the best structured studies – which may in turn explain why so few good studies currently exist.

4.5 Impacts of congestion on transport intensity

The Scottish Executive study raises the issue of the relationship between congestion and decoupling. The question posed is ‘Will road pricing, on balance, intensify or moderate the transport intensity of an economy (i.e. its relative dependence on people and freight movements)? This question has to be answered against a backdrop of current trends and fluctuations in the contribution of transport expenditures to GDP.

As quoted in the Scottish Executive study, Tapio (2005) presents quantified evidence of the ongoing ‘decoupling’ of transport activity and economic growth in the EU15 countries, based on EUROSTAT and IEA statistics for 1970 to 2001. The results for road passenger growth indicate transport volumes closely followed GDP in the 1970's, exceeded GDP growth in the 1980's and grew rather slower than GDP in the 1990's.

For freight a different pattern is evident. Freight traffic volumes followed GDP growth in the 1970's, fell below GDP growth in the 1980's and showed clearly higher growth than GDP in the 1990's. This contrasts to the results of a similar analysis for the USA (Bannister and Stead, 2002), which indicates that in the US freight sector tonne-kilometres carried have increased at a rate well below GDP, particularly, since 1985.

However, work by Graham and Glaister, (2004) provides empirically observed elasticities that indicate that if congestion is reduced, then there will be a tendency for transport demand to increase. If incomes increase then there is also a tendency for vehicle kilometres (transport demand) to increase. A summary of the evidence in their paper is as follows:

- in terms of responses to changes in travel time, car trips had a short run elasticity of -0.6, (long run = -0.29) whilst car vehicle-km short run elasticity was -0.74 (long run = -0.20)
- with respect to changes in income, car vehicle-km had a short run elasticity of 0.3 and long run elasticity of 0.73. (In the case for Scotland, work by Laird (2006) on wage rages and commuting in Scotland supports these findings).

To this extent, congestion pricing (particularly if it is accompanied by hypothecated funding of new roads) could result in perverse and unintended effects. It could halt or delay the ‘decoupling’ of transport activity and economic growth.

In terms of the factors that may be used to explain or influence decoupling, some historical explanations for the case of Finland are given by Tapio, including:

- the high cost of car purchase
- income changes
- adoption of a green urban lifestyle and
- impacts of technology.

The role of particular transport instruments formed the core element of the research by Tight et al (2000). This gathered evidence on the potential effectiveness of instruments from experts across the EU and some international bodies. Thirteen of the most promising measures were studied in detail, reporting their potential impact on transport intensity, environmental load, CO2 emissions and 'possible unexpected effects' - a 'reality check' with the expert panel was also included.

The prevailing outcome was that packages of instruments would hold the greatest promise for decoupling, however the seven individual instruments emerging (in no order) were:

- urban road pricing
- hydrogen fuel cell vehicles
- controlled parking zones
- car sharing as part of combined mobility
- high speed rail
- road pricing for freight traffic and
- combined measures relating to traveller attitudes/traffic behaviour.

This therefore suggests that congestion pricing can play a positive role in encouraging decoupling.

The Scottish Executive study concludes that there is strong evidence that growth in vehicle-kilometres is a function of income and travel impedance or generalised cost as well as 'the need to travel'. Evidently transport policy that increases incomes and reduces travel impedance (e.g. reducing congestion) has to use other measures to prevent an increase in vehicle demand (e.g. which points to the need for road pricing to lock in de-congestion benefits) or reducing the need to travel. Some of the measures needed to prevent the increase may be quite difficult to implement politically, such as road pricing.

However, any inferences on the potential role of congestion pricing in strengthening decoupling also have to be set in the context of ongoing changes in the role of transport in the economy.

In a recent review of the evidence on decoupling for the UK, Mackinnon (2006) concludes that between 1997 and 2004, GDP increased in real terms by a fifth while the volume of road freight movement remained stable – which suggests that the long-awaited decoupling of economic and freight transport growth has begun, possibly leading to a new era of sustainable logistics.

Mackinnon also observes that, had the growth of freight movements by British registered trucks paralleled the growth in the economy as a whole, the freight industry would have carried an extra 21.4 billion tonne-km in 2004, equivalent to around 3,000 fully-laden trips per day by 44 tonne trucks linking London and Edinburgh.

Mackinnon identifies and evaluates 12 possible causes for the reduction in demand and loss of custom by the road transport industry:

- changes in systems of accounting
- dematerialisation (i.e. shifts to lighter inputs, components and products)
- changes in the composition of GDP

- decline in road's relative modal share
- increased entry by foreign truck operators
- displacement of freight trucks to vans
- reductions in the number of links in the supply chain
- diminishing spatial concentration
- improvements in vehicle routing
- domestic supply chains becoming fully extended
- erosion / export of economic activity to other countries
- increases in the real cost of road freight transport.

In his analysis, Mackinnon concludes that around two thirds of the observed decoupling is dues to a combination of:

- increased entry by foreign truck operators
- a decline in road's relative modal share
- an increase in the real cost of road freight transport (i.e. freight rates).

However, several other factors appear to be playing some role in the shift, including:

- the relative growth of the service sector
- diminishing centralisation (i.e. decentralisation)
- the erosion / export of economic activity to other countries (i.e. off-shoring).

Mackinnon's work confirms that real freight costs (which can include the costs of congestion) and increased decentralisation (which can reflect location adjustments by firms to avoid congestion) may be playing a role in decoupling. Whether or not congestion charging will or will not accentuate decoupling – and whether or not this would be a good thing or a bad thing on aggregate (given that it could, in some circumstances, delay decentralisation as a response to congestion) – remain moot points.

Mackinnon's study also confirms that where transport costs and charges play a role in reducing transport dependence (i.e. in the process of decoupling), this is generally as an adjunct to other trade, factor and resource use shifts in the wider economy.

4.6 Conclusions on the impact of transport costs and congestion on firms

The conclusions that can be drawn on the impact of transport costs and congestion on firms are as follows.

In general, transport costs (and hence congestion costs and congestion charging) can exert very wide and pervasive economic effects on business firms, over both the short term and longer run but hard evidence of generic relationships is sparse.

The effects can generally be placed in 2 categories:

- Distributive Effects involving the with sector and / or inter-sectoral and / or geographical redistribution of supply-demand relationships
- Generative Effects which increase net economic output at the firm, local, regional or national levels by using resources more effectively and / or using resources that were previously underutilized.

Transportation costs are typically found to be only a very small proportion of firms' total costs usually less than 5%. As such, any improvements to the transport infrastructure is likely to yield small cost savings and gains to firms. There are likely to be relatively few cases where transport investment is both a necessary and a sufficient condition for the successful development and operation of a non-transport business.

As a general rule, studies suggest that transport is only an important factor, once the decision to set up in an area has been taken. In other words it is a necessary but not sufficient condition for decision-making on locating or relocating enterprises. A decision to relocate may be prompted by transport difficulties and inaccessibility. However, businesses are likely to change operations in discrete steps, and it is only when certain cost thresholds are reached that it becomes efficient to the firm to revise its number or location of outlets, plants or depots

Distributive effects are likely to significantly outweigh generative effects in most instances.

With respect to congestion pricing, much transport investment (and this probably also applies in part to congestion pricing) influences business location and production decisions at the local and intra-regional levels but does not generate net national or regional growth.

Congestion is a major problem in many urban areas – it can lead to trip unreliability, and added business costs, and can be a tipping factor that drives businesses from CBDs. Congestion charging schemes (like capital investments in transport projects) may also reinforce prior locational differentiation (for example, high priority schemes by early adopters (e.g. the London Congestion Charge) may reinforce London’s economic primacy at the partial expense of provincial centres).

In practice, there are many complexities surrounding the interactions between transport, logistics, production and distribution decisions are such that unambiguous answers are unlikely from even the best structured studies – everything depends ultimately on the energy of entrepreneurs and the interplay of a potential spectrum of intended and unintended effects.

If congestion is reduced, there will be a tendency for some types of transport demand to increase as road space is freed. If incomes also increase then there will be an additional tendency for transport demand to increase. Such increases in transport intensity will appear to delay the decoupling of economic growth from increased transport activity.

However, there is accumulating evidence of the increased decoupling of economic growth from increases in transport intensity stemming from a wide range of influences on modern economies. If congestion charging leads to higher value road uses (and road pricing locks in these gains), it can accentuate decoupling – whether or not they do will depend on the individual characteristics of the scheme and its milieu and its interaction with the factors that are driving decoupling in particular instances.

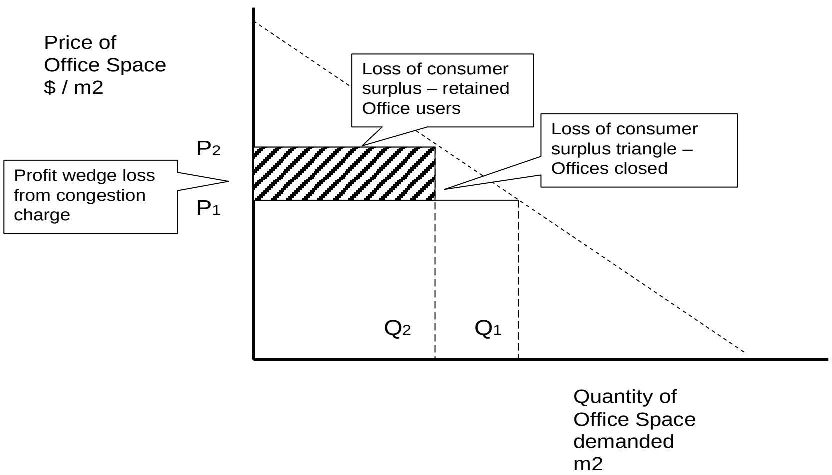
5. Overseas evidence on the general impacts of road pricing

5.1 Impacts of congestion pricing on firm profitability – the theory

As described in Section 3.2.1 of this Report, congestion pricing is generally designed to reduce traffic to the level at which generalised marginal social costs are equivalent to generalised marginal social revenues. However, congestion pricing will affect different road users and transport-using firms in different ways.

Congestion pricing alters basic market relationships[12]. At the simplest level, a cordon toll imposes the potential equivalent of a tariff or deadweight cost on movements across the cordon. In theory, this will inevitably affect demand responses for industries that use transport services (see Figure 3).

Figure 3 Simple illustration of the theoretical impact of a cordon toll on an economic activity (e.g. office space provision)



Source: NZIER

Figure 3 considers the most simple case – the impact of a cordon toll on one type of business / land-use, namely office services in a city centre. It concerns the demand for ‘transport-serviced’ offices - and sees a congestion charge initially as a market intervention that imposes a cost or ‘excess burden’ that would not have existed under free market conditions. (The potential offsetting ‘social benefits’ of congestion charging are considered as the next step in the analysis).

[12] As with section 3.1., this section draws on the experience and professional knowledge of NZIER staff.

In Figure 3, overall demand for office space (under pre-cordon charging conditions) is conditional on its price (i.e. office rental level). As the price rises (as it generally will towards the city centre i.e. the Central Business District or CBD), low premium office users (e.g. call centres and accounts processing units) are forced out by higher premium office users (e.g. company headquarters and central government departments).

In other words, the demand curve for office space as a whole is downward sloping.

In Figure 3, the total amount of office space initially demanded (Q_1) is determined by a market floor price of P_1, set by market relationships between landlords and tenants. The portion of the demand curve above P_1 therefore represents the composite 'consumer surplus' that arises under pre-congestion pricing conditions.

If a cordon congestion charge is put in place, it imposes an additional burden on office tenants stemming from the extra costs it places on movements of goods and people to meetings etc. It could also lead office tenants to compensate their workers by higher wages if they commute by car – in the fear that the workers might otherwise seek employment alternatives outside the charging zone.

The overall 'price' of office space + associated transport costs (i.e. the price of 'transport-serviced' office space) therefore shifts upwards to (P_2) and demand is choked back to Q_2. Other things being equal, this results in:

- a loss of consumers' surplus on office operations by tenants that retain offices in the CBD (i.e. the shaded rectangle in Figure 2)
- a loss to office users due to a certain amount of office space being essentially 'taken off the market', as the increased costs of travel to the CBD make less desirable office accommodation more 'marginal' (this is the 'consumer surplus triangle' shown in Figure 2).

The loss of consumer surplus triangle can also be viewed as a potential deadweight loss to the national economy, as economic activity that was formerly viable has become less viable.

The actual realisation of the conclusions that have been outlined above will be conditional upon a number of factors. Of these, the following may be noted here:

- the degree of adjustment (or indeed the need for adjustment per se) will be dependent on the elasticity of demand for the service (i.e. the degree to which demand is regarded as essential or non-substitutable)
- the possibility that there may be compensating actions by other economic actors in the sector (e.g. landlords may chose to absorb some of the extra costs incurred by tenants by moderating rents)
- the timing of adjustments may vary – there are likely to be lags in adjustments, depending upon the availability / cost of resources for redirections of economic activity, impediments to change (e.g. planning / zoning controls), business inertia etc.

- the adjustments may have a limited net impact when the wider economies of the city or the nation are taken into account. While locations like the centre of the CBD have unique characteristics, it may be possible to trade these off in many instances against the lower office rents that are achievable in alternative cities or substitute suburban centres outside the CBD
- the overall impact of the congestion charge on office rents may be overridden or swamped out by other economic considerations. For example, if the economy of the CBD is growing strongly, commercial office renters may simply shrug off the impact of the congestion charge on profit levels (which may be subsumed within rising profits)
- it may be necessary to take behavioural issues into account (e.g. the commitment of office workers to persevering with car commutes or shifting to alternative modes of transport)
- There are likely to be 'systemic' offsetting and positive adjustments involving 'social prices' (see below).

Although Figure 3 is concerned with losses, it is clear that there may be compensating benefits to some office businesses – or to the office sector in general if the analysis is widened to include other sectors that compete for CBD land and whose transport movements compete for CBD road space. These include the business benefits (positive externalities) of:

- improved trip timing and reliability in less congested conditions (as they affect input and output movements and employee journeys to work)
- quicker and more easily attained association with similar and complementary businesses (i.e. agglomeration economies)
- potential gains from improved access to international trade / information
- positive impacts from the attraction of globally mobile investment / economic activity (i.e. agglomeration at the expense of international rather than national city competitors).

And, if the revenue from the cordon tolls is hypothecated, this may further accentuate business benefits as public transport becomes more widely available.

However, looking at the business sector as a whole, there are likely to be gainers and losers.

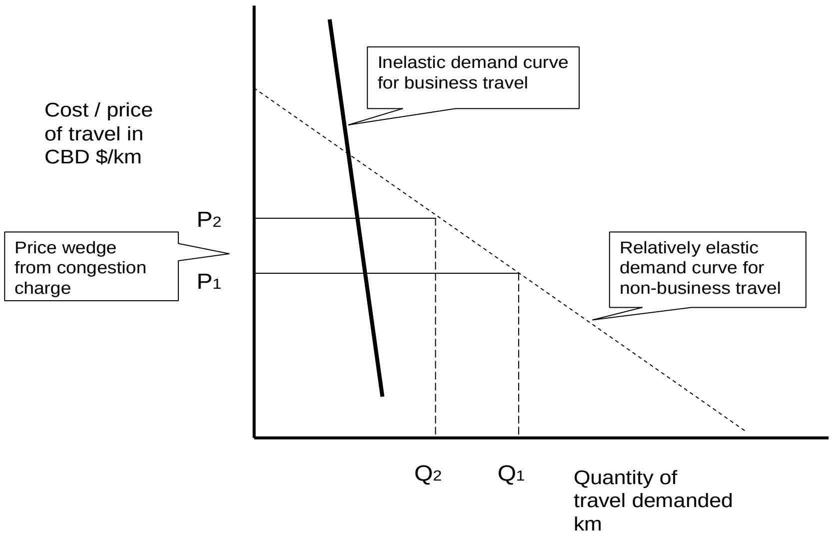
Figure 4 illustrates the possibility that most of the traffic that is diminished by a charging scheme is associated with losses of less productive economic activities / land-uses.

Consider first the case where businesses are more than willing to pay for road space if it helps to guarantee the timeliness of component deliveries or product distribution. In other words, demand is relatively inelastic with respect to price. The congestion charge will therefore make little difference to the viability of this sector – even if the positive externalities are small.

However, if a congestion charge also successfully nets out a significant amount of non-business travel (which is likely to have low or negligible positive externalities), it may free road space with minimal impacts on the overall level of economic activity. This could occur regardless of the need to consider externalities (both those that affect individual businesses in financial terms and those that have a wider 'social' context like reducing environmental pollution).

Indeed, the availability of freed road space is likely to enable more productive activities to expand (i.e. pushing the demand curve for business trips outwards) – and eventually, the pattern of land use may also change as business prospers. These are the potential long-term positive externalities that can arise from congestion charging. As they are potential rather than actual they can only be portrayed ex ante in terms of social accounting prices (i.e. 'shadow prices').

Figure 4 Potential differential impact of road pricing on demand for business and non-business trips



Source: NZIER

Evidence from the introduction of the London Congestion Charge suggests that these types of differential responses do indeed occur. And that they are reflected most immediately in changes in the composition of trips.

According to Transport for London's LCC Third Monitoring Report (2005), between 2002 and 2004, all vehicle-kilometres driven with the LCC zone fell from 1.64 millions to 1.38 millions (i.e. by around 16%). However, individual car trips (presumably many of these may be regarded as 'less essential' in economic terms) fell by 39%, whereas truck trips remained broadly constant and taxi trips rose by around 11%.

The results were that the overall composition of traffic changed markedly, as indicated in Table 15 below, with car contributions to total trips falling from 47% (before the LCC) to 34% by 2004, and the 'commercial traffic' (trucks, vans and taxis) contribution rising from 41% in 2002 to 50% in 2004.

Table 16 Differential impact of LCC on vehicle types

Percentage of traffic vehicle km

Vehicle Type	2002	2003	2004
Cars	47%	35%	34%
Vans	18%	19%	19%
Trucks etc.	4%	5%	5%
Taxis	16%	21%	21%
Buses & coaches	3%	5%	5%
Motorbikes etc.	8%	9%	10%
Cycles	4%	6%	7%
TOTAL	100%	100%	100%

Source: TfL 3rd Annual Monitoring Report (2005) / NZIER

Apparently, the truck and taxi segments of the transport sector were major gainers at the expense of private car owners – as planned.

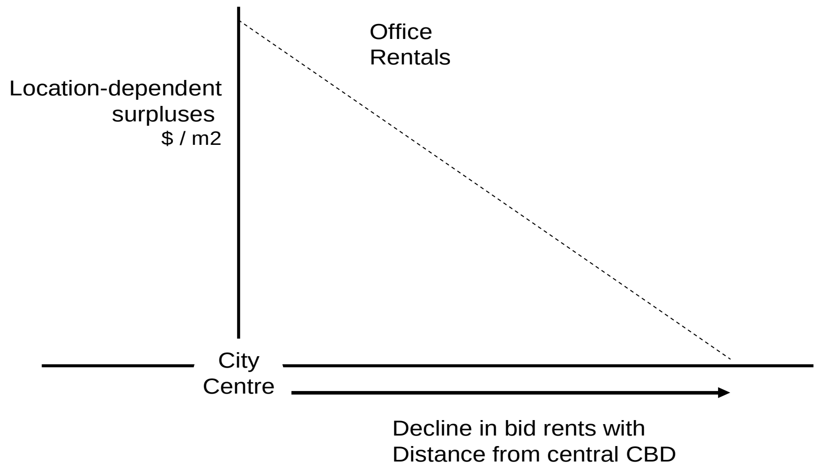
And, as shown later in this Section, this led on in all probability to differential impacts on businesses – with potential gains by financial sector office users and potential losses by businesses in the restaurant and café and retail sectors of the economy.

5.2 Insights from Location Theory

As already implied, the imposition of a congestion charge not only has the potential to redistribute economic activity within and between economic sectors, it also has the potential to redistribute economic activity between locations. It is therefore useful to also look at insights from Location Theory.

Figure 5 presents a non-standard representation of supply-demand relationships that plots price / economic surplus per unit of area against distance from the central CBD.

Figure 5 Theoretical variations in bid rents for office space by location



Source: NZIER

Figure 5 illustrates the likelihood that office rents (and the associated surpluses that drive them) will decline as distance from the central CBD increases. The underlying surpluses that stem simply from location can be viewed as embodying differentials in ‘economic rent’[13]. Such surpluses arise from a variety of sources, such as:

- the tendency for the central CBD to represent the point of maximum accessibility for consumers and producers trading in complex and ‘high end’ goods and services within a large city or conurbation (e.g. Central London is strategically and centrally located with respect to the 8 million people within Greater London and the 20 million people in South East England)
- the tendency for the central CBD to be a transport hub – particularly providing port functions and rail interchange functions (for example, even though Auckland and Wellington are eccentrically located with respect to their hinterlands, their positions as ports has clearly provided them with strong comparative advantages over smaller centres like Hamilton and Palmerston North)
- the tendency for some forms of economic activity to ‘agglomerate’. In some cases, this reflects the advantages that businesses in one sector can gain from grouping together at a particular location (e.g. the information gains that drive

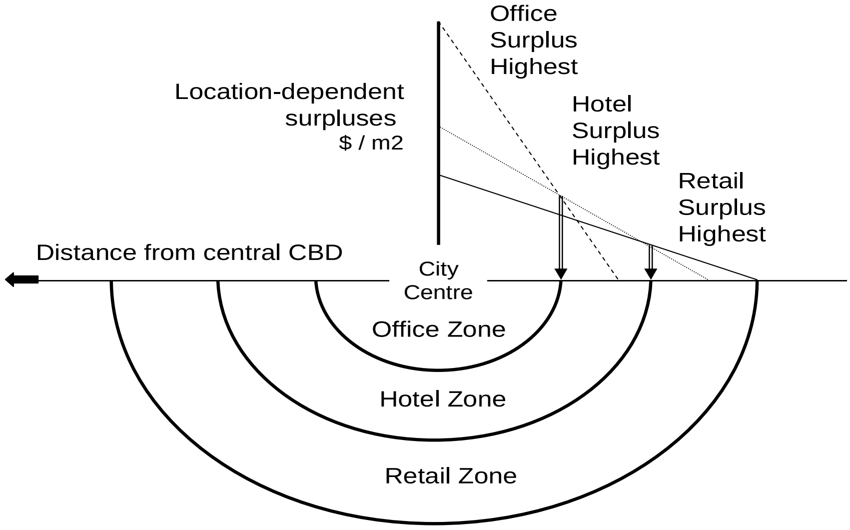
[13] Economic rent occur where changes in supply are not possible and there is a difference between the current return on a factor of production and the lower level of return that is necessary to keep it in its current use / occupation. ‘Location rents’ are economic rents that arise because well-located land is limited in supply (e.g. the land in the centre of a CBD which is likely to have maximum accessibility from the city or conurbation as a whole).

fashion houses and garment manufacturers to cluster together). In other case, it may reflect the advantages that arise from complementarities between industries (including the nearby presence of specialist services like legal and banking services). More recently, agglomeration appears to be driven by proximity to 'portals' to the international market (like the City of London and Heathrow Airport).

The declining gradients away from the CBD result from competing land-users bidding for land. It is readily apparent that bid-rent theory can be generalised to a theory of urban land use (see Alonso (1964) and Muth (1969)). Within this theory, patterns of land use are determined by land values that are, in turn, related primarily to transportation costs in relation to the CBD.

Figure 6 illustrates the theoretical overlapping of bid rent functions in a CBD. Office blocks provide the most lucrative land-use, followed by prestige hotels and specialist 'high end' shopping (i.e. department stores, fashion outlets, jewellers etc.). Typically, luxury / up-market apartments provide the next innermost land-use in modern Western cities.

Figure 6 Theoretical land-use differentiation by intersecting bid rent gradients



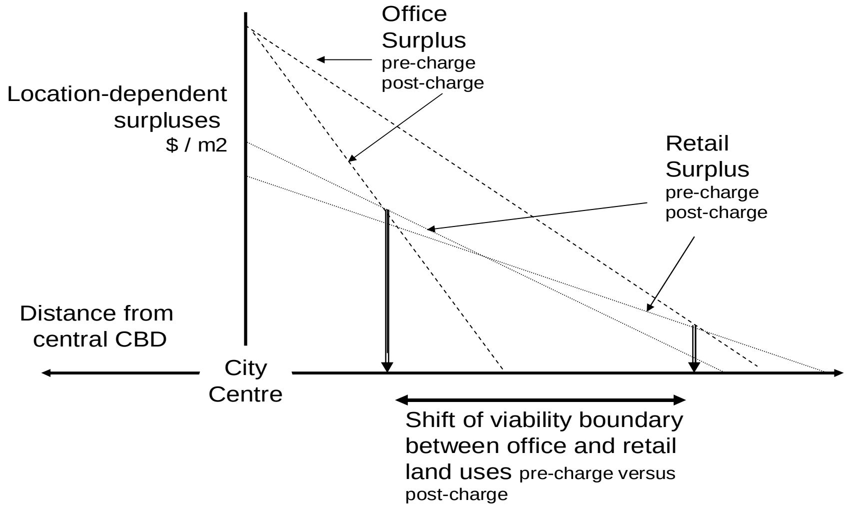
Source: NZIER

Again, it is apparent that the imposition of a cordon congestion charge will raise sector gradients selectively – depending upon where the cordon is placed. This issue is further explored in the next section.

5.3 Boundary effects of cordon congestion charging

There are a number of different types of theoretical land use outcomes that can result from the imposition of a cordon congestion charge. Figure 7 illustrates the case where both land uses lie within the cordon but the competing sectors respond differently to the new pricing relationships. In this example, the office sector retains its position as the premier land use and maximum rents remain unaffected. However, the charge has a more serious impact on the high end retail sector and its boundary of viability shifts away from the centre of the CBD. It is possible that this tendency has been felt in Oxford Street, London where there have been complaints from retailers (e.g. the department store John Lewis') that the LCC has significantly reduced custom (consequent on a decline in shopping trips by car).

Figure 7 Theoretical impact of cordon congestion charge on land-use boundaries



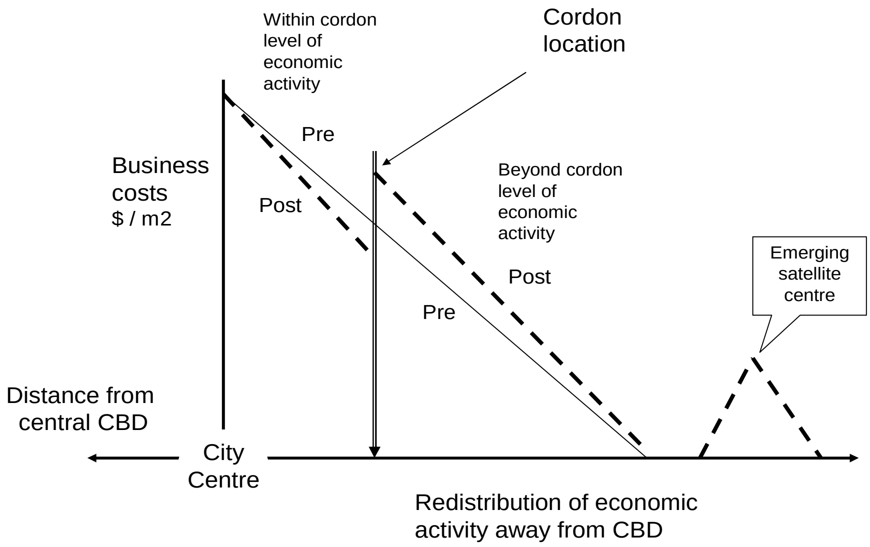
Source: NZIER

The question then arises as to whether, over the longer term, there would be sufficient demand in the competing sector (in this case offices) to supplant retailing in the zone affected by the boundary of viability shift? It seems quite likely that, in many cases, there would not in fact be sufficient suppressed demand in the office sector to make good the shortfall in retail tenants. One outcome then is clearly that rents and land values for retail businesses will adjust downwards (by near to the aggregate burden imposed by the cordon charge) to retain the original pattern of viable businesses.

However, it is also clear that such effects could be generative – that is there need not be any adverse impact on the national or indeed the local economy as a whole. Figure 8 illustrates this possibility. Here businesses that appeared to have been forced out of the CBD by a cordon charge, prosper by expanding beyond the boundary or developing new loci in suburban / peri-urban locations (by intercepting trips that would have otherwise been made to the CBD).

Indeed it is quite possible that such apparently 'forced' relocations could be well-timed in terms of technological and taste changes such that the net result is highly positive in generative terms (e.g. a coincidence of cordon charging that penalises grocery shopping in the CBD with the development of hypermarkets in the periphery of a conurbation that widen choice, gain economies of scale and permit drive and park shopping).

Figure 8 Possible redistribution of economic activity - decentralisation



Source: NZIER

This analysis reinforces once again the dangers of taking a geographically limited and short term view of impacts – and the difficulties that are faced in attempting to measure effects and net out causes.

5.4 Impacts on firm profitability – the evidence

The London Congestion Charge (LCC) is the only scheme for which substantial data has been generated on firm profitability impacts – although the results and interpretations have been contested.

Overall, the Transport for London (TfL) Third Annual Monitoring Report concludes with respect to impacts on business and the economt that:

- Congestion charging has had a broadly neutral impact on business performance

- Studies of commercial and residential property markets have not found any significant overall impact from the charge.

However, the Report also notes that the sectoral evidence on impacts on business performance is inconclusive.

Despite the above conclusion, it is possible to draw together evidence from the Report that indicates that there have been real sectoral differences in effects – that are consistent with the analysis presented in section 3.3. above (see Table 17 below).

Table 17 Differential responses to LCC by sector

	Financial	Wholesale / Distribution	Hotels & Leisure	Restaurants & Cafes	Retail
% of Businesses	54%	8%	2%	5%	7%
Sales decrease 2002-2004	7%	27%	20%	39%	43%
Increase in costs at site	27%	30%	31%	47%	40%
Transport difficulties experienced 2002-2004	9%	19%	14%	34%	31%
Continued positive support for LCC in 2004	57%	46%	66%	39%	43%

Source: TfL 3rd Impacts Monitoring Report (2005) / NZIER

The evidence presented in Table 17 suggests (not at all surprisingly) that the financial sector has been the biggest overall gainer from the LCC, reflecting its positive impact on the convening of meetings and transfers of business documents etc. The hotels and leisure sector also appears to be a major gainer from improved access by relatively high income clients. Conversely, the evidence for restaurants, cafes and retail establishments is less clear.

Indeed, the main contested area concerns retail sales and profitability. In August 2003, the John Lewis Partnership announced that in the first six months of the charge's operation, sales at their Oxford Street store fell by 7.3% whilst sales at other stores in the Greater London area but outside the Congestion Charge Zone rose by 1.7%.To partly compensate for the loss of revenue they extended opening hours and introduced regular Sunday opening for the first time.

Newspaper reports in May 2005 again claimed that the number of shoppers had declined by 7% year-on-year in March, 8% in April and 11% in the first two weeks of May. TfL countered that an economic downturn, the SARS outbreak and threat of terrorism were likely factors.

Quddus et al (2007) have investigated the impact of the congestion charge on the retail sector using a variety of econometric models. They applied the modelling to a total retail sales index for central London (monthly) and weekly retail sales data for the John Lewis Oxford Street store within the congestion charging zone. The analysis suggests that the charge had a significant impact on sales at the John Lewis Oxford Street store over the period studied. However, it also suggests the charge did not affect overall retail sales in central London, an area larger than but encompassing the congestion charging zone.

Taking business as a whole, an independent report six months after the charge was implemented suggested that most businesses were then supporting the charge. London First commissioned a study which reported that 49% of businesses felt the scheme was working and only 16% that it was failing. The Fourth Annual Review by TfL in 2004 indicated that business activity within the charge zone had been higher in both productivity and profitability and that the charge had a "broadly neutral impact" on the London wide economy. The Fifth Annual Review continued to show the central congestion zone outperforming the wider London economy.

With respect to boundary effects, there were prior estimates that due to the West London extension in February 2007, 6,000 people would eventually lose their jobs. In May 2007, a survey of 150 local businesses stated they had seen an average drop in business of 25% following the introduction of the charge, which was disputed by TfL which stated that there had been "no overall effect" on business and that it had outperformed the rest of the UK in the central zone during 2006.

Unfortunately, the evidence from the LCC then is neither beyond dispute nor necessarily amenable to wider generalisation. Overall though, it tends to support the conclusion that congestion charging is likely to give rise to fairly widespread distributive short term effects. However, it also provides evidence that the overall generative impacts of congestion charging are likely to be relatively small or even positive, as long as the overarching regional economy is buoyant (particularly over the longer run).

5.5 Business redistribution impacts and urban form

As noted by Wachs (2003), it is important to compare ‘like with like’ in assessing road pricing opportunities and effects. In particular, Wachs notes that:

> *Road pricing in the US has a noticeably different complexion than it has in Europe. Most of the highly publicized applications of road pricing in Europe are area pricing schemes similar to the original application of pricing in Singapore, involving cordons about central city locations. Fees are paid, as in London or Trondheim, to cross the cordon in order to enter a central congested area during peak periods. In America, by contrast, there are few applications of area pricing schemes. Instead, most applications are*

located on highway facilities, where fees are required to enter certain lanes during periods of congestion.

In part, this prominent difference between the growth of area schemes elsewhere and facility-based schemes in the US reflects the extent of urban decentralization in America over the past several decades. Many American downtowns are thriving, but those that are successful have given greater emphasis to tourism and economic activity such as conventions and trade shows that cater to visitors, while they have generally all been losing employment and retail sales relative to suburban areas that provide ample freeway access and acres of free parking. In an environment of vigorous competition for commercial employment and retail trade, few American CBDs could achieve a consensus that area or cordon parking is an appropriate technique by which to control traffic congestion. They fear that cordon pricing in the centre will only accelerate migrations of economic activity to outlying suburban centres. In their pursuit of economic growth, American downturns can be said to fear road pricing much more than they fear congestion.

It is also the case that the steady decentralization of residences and employment in America for more than eighty years has resulted in the fact that congestion has been growing more dramatically on regional freeways than on central city surface streets. Naturally then, congestion pricing has in the US been both more facility based and located in suburban settings.

This presents a challenge to the introduction of congestion pricing in central Auckland, given the observation by Mees and Dodson (2002) that:

Historically, Auckland's transport planning has followed the most extreme pro-car American models, far more closely than has been the case in Australian or Canadian cities, or even many cities in the U.S.A. The Auckland transport system has been centred around freeways for much longer than other comparable cities, and this is one of the major reasons for the extremely low usage of public transport. Current proposals, which involve substantially expanding the freeway system at the same time as an attempt is made to establish a rapid transit system, are likely to fail.

There is therefore a possibility, as previously noted, that congestion pricing in central Auckland may:

- spur the growth of secondary centres (e.g. Waitakere, Manukau) through decentralisation
- intensify road usage on some road segments, and by some types of users, and
- prejudice the continued growth some sectors of the economy of downtown Auckland.

On the other hand, it is important to bear in mind that increased decentralisation across the conurbation could have positive generative benefits for the wider Auckland economy.

And improved management of traffic in central Auckland could also significantly improve the CBD’s attractiveness as an international and national business and leisure hub, by sieving lower premium land uses and creating an environment that favours corporate offices and such sectors as international finance.

In a relatively limited modelling study for Auckland Regional Council (Abraham and Hunt, 2000), the results suggest that the overall net effects of congestion pricing could be some reductions in urban sprawl and some decentralisation of the existing mix of commercial activities. However, the study concludes that the net effects of road pricing on the urban economy as a whole are likely to be small.

It seems then that actual outcomes could depend, to a large degree, on the opportunities that are created to use resources more efficiently - and the energy and enterprise that is demonstrated by entrepreneurs and households in taking up and adapting to those opportunities. If Auckland’s growth accelerates, its international standing rises, the mix of land-uses shifts to higher value activities, and agglomeration economies become increasingly evident, the net longer term results may well be positive.

5.6 Comments of the Eddington Study on congestion pricing impacts

The 2006 Eddington Report suggest that in the UK, without action, there will be a 31 percent increase in road traffic, a 30 percent increase in congestion, and a relatively negligible decline in carbon dioxide emissions (stemming from fleet improvements etc.) by 2025.

It concludes that:

- getting prices right across the transport sector offers potential benefits of up to £28 billion per year by 2025 (of which £15 billion are direct GDP benefits)
- the best transport projects have Cost to Benefit Ratios of 1: 5-10 and that for many smaller projects the ratio is higher than 1: 10.
- on average, the inclusion of environmental externalities results in returns being reduced by £1 for every £1 invested (in some cases this rises to £3-4)

The Eddington Study also emphasizes the wider impacts and relevance of transport investment and improved transport management, noting that good transport systems:

- support the productivity of urban areas
- deepen labour markets and boost productivity
- allow businesses to reap the benefits of agglomeration.

It suggests that:

- agglomeration benefits account for up to 50 percent of the benefits of large transport schemes in London

- the efficiency with which existing transport networks are used is at least as important as the underlying level of investment
- the evidence of the study suggest that there is a role for public transport, especially where there are agglomeration effects - of course such public transport services could become more viable with the introduction of road pricing.

It also argues that, wherever possible, future Cost-Benefit Analyses of transport investment and management projects should include formerly 'missing' GDP impacts such as:

- agglomeration benefits
- reliability impacts
- labour supply effects
- competition and trade effects.

In conclusion, the Eddington Study emphasizes the need to adopt a policy framework that makes the most of existing infrastructure by tackling congestion and capacity issues and utilizes the potential inherent in applying appropriate mixes of pricing, targeted investment, and better usage measures.

5.7 Productivity gains including agglomeration impacts

The Scottish Executive study notes that there is an increasing policy interest in the productivity impacts of transport. Through transport efficiency improvements the productivity of the economy can increase. In text book economics there is an equality between the economic benefits that occur in the transport market (time savings, reliability improvements, etc.) and the economic impacts that are felt in the general economy (including productivity gains from efficiency improvements). That is the marginal economic impact of reducing congestion would be the sum of the marginal values of the different congestion related impacts (i.e. the sum of time savings, reliability benefits, etc.).

Such an equality, however, relies on a number of technical economic conditions relating to perfect economic markets. The consequences of departing from these conditions are now the subject of some debate. If these conditions do not hold then for example agglomeration benefits may occur as may additional benefits in the labour and product markets. There is no direct evidence on the impact of congestion *per se* on agglomeration and other wider economic impacts. However, the fact that reduced levels of congestion imply quicker journey speeds it is possible to utilise the evidence base on the impact of journey speeds to understand the impact that congestion has on the wider economy.

There is a small but growing evidence base that increased journey speeds, can have a significant effect on regional productivity (Rosenthal and Strange, 2004; Rice and Venables, 2004; Graham, 2005). Rice and Venables estimate for the UK that the agglomeration economies from a 10% reduction in commuting time will lead to an increase of 1.12% in labour productivity. Graham estimates an average elasticity of productivity to effective employment density of 0.04, though this disguises significant variation by region and industrial sector. An elasticity of 0.04 implies that if employment density (number of people living within a certain journey time) increases by 10% productivity would increase by 0.4%.

In a review of the available evidence on the additional economic impact that imperfect markets might have on total economic impact, Laird *et al.* (2005) find a range of -15% to +147%. That is total economic impact is -15% to 147% higher than that measured using a conventional economic appraisal (i.e. travel time savings and reliability improvements). It should be noted that the upper end of the range is only associated with projects that have a very significant impact on accessibility (e.g. a new high speed rail network/line).

The broad findings of the Scottish Executive study are mirrored by the recommendations of the UK Eddington Transport Study (2006). This points to the desirability of extending conventional cost-benefit analyses of transport improvements (focussing on operating costs, time savings, and improved reliability) to include:

- the 'full GDP benefits of freight movements'
- agglomeration economies
- gains from international trade
- impacts from attracting globally mobile investment / economic activity.

However the Eddington Study also notes that there is currently very little literature on these effects and that measurement and modelling techniques are still in their infancy.

The main relevance of these concepts to assessing congestion charging lies in their reinforcement that full evaluations of the interplay of causation and of both intended and unintended net effects are extremely challenging.

5.8 Overall reallocation of resources

The foregoing discussions touch on many of the issues that would arise in providing a full ex ante assessment of congestion charging effects. The most obvious approach to taking into account overlapping and interdependent effects is the development of integrated modelling that links trip generation to land-use and regional economic growth.

Safirova et al (2006) describe the complexities and challenges surrounding this approach, as applied to forecasting the impacts of different levels of congestion pricing on the Washington, DC region. The study attempts to integrate a spatially disaggregated general equilibrium model of the regional economy 'LUSTRE' (that incorporates the decisions of residents, firms, and developers), with a spatially disaggregated strategic transportation planning model 'START' (that incorporates mode, time period, and route choice) to evaluate the potential economic effects of congestion pricing.

Importantly, the model includes the hypothecation of toll revenues to expand public transport provision for the benefit of non-road users.

The balance of aggregate gains and losses for a lower cordon toll ($2.28) is shown in Table 18 below.

Table 18 Washington DC modelling – Estimated welfare gains and losses for a $2.28 Downtown cordon toll (2000 US$)

WELFARE SHIFT	Income Quartile 1	Income Quartile 2	Income Quartile 3	Income Quartile 4	All Quartiles
Wages	5.5	16.2	29.3	64.5	21.8
Re-distributed Toll revenue	17.3	12.3	10.9	15.7	14.0
Real Estate Values	6.1	4.3	3.8	5.5	4.9
Prices	-5.3	-7.8	-12.6	-24.4	-10.2
Rents	-0.92	-1.5	-2.8	-6.4	-2.3
Commuting Costs	-1.80	-5.5	-11.0	-18.1	-7.3
Cost of shopping trips	-0.34	0.04	0.35	3.3	0.4
Model correction term	-0.90	-1.5	-3.5	-11.1	-3.0
Net Welfare Gain $ per capita	$19.6	$16.5	$14.4	$29.0	$18.4

Source: Safirova et al (2006) / NZIER

Interestingly, the average net gains per capita from a much higher cordon toll ($4.70), are not proportionately greater ($22.00 per capita as opposed to $18.40 per capita) – a result that may also have relevance to Auckland.

Overall, the most striking result of the Washington DC modelling is the preponderance of distributive effects over generative effects. Congestion charging creates complex patterns of losers and gainers – between sectors, between industries and firms, and between geographical locations. However, the second and equally important inference is that – when all these distribution effects are washed out – the net generative effects are relatively small but positive. These conclusions probably apply more widely, given:

- hypothecation of toll revenues to improvements in public transport
- sustained growth in the regional economy in question that is fuelled by non-transportation related investments
- sufficient time for the process of adjustment to unwind.

Safirova et al (2006) reported the results of the Washington DC modelling exercise in the following terms.

First, although the study found only modest long-term welfare gains (only about 0.05 percent of annual income on average for our representative agents), they were several times larger than the short-term welfare gains computed using START alone from the same policy. This result primarily is attributable to the response of the labour market. In LUSTRE, the cordon toll leads a scarcity of labour and therefore brings about higher wages. The wage increase is an important source of welfare gains that exceed welfare losses due to employment decline.

Second, modelling several skill levels of economic agents reveals different mechanisms of welfare gains from congestion pricing for different representative agents. The major source of welfare gains from congestion pricing for upper skill levels is higher wages induced by tolls, while less skilled agents primarily enjoy the benefits of the redistributed toll revenues. As a consequence, given a choice, less skilled workers would favour higher tolls than their higher-skilled counterparts.

Third, the simulations show that although the welfare gains from congestion pricing are positive regardless of the choice of the toll redistribution scheme, the magnitude of the welfare gains is highly sensitive to the redistribution mechanism.

Finally, the study found that while retail production in the cordoned area decreases slightly (0.008 percent), the effect is not significant for three reasons:

- first, customers like to shop near home, so the density of residents in and near the cordoned area protects retail activity.
- second, retail firms in the core benefit from the lower costs of shopping travel resulting from decreased congestion.
- third, people primarily shop during the off-peak and the afternoon peak hours, when the cordon is not in effect.

The first and second reasons corroborate the arguments of proponents of the London cordon, though the third suggests that the concern over the time window of the toll was justified.

In summary though, Safirova et al end by stressing the particularities of the study, such that:

This reinforces yet again the very significant difficulties that arise in developing robust results that can be generalised.

5.9 Cautions on comparability

Many of the conclusions that have been drawn from the literature that has been reviewed in this Report are to a greater or lesser extent case-specific. This stems in part from variations in theoretical assumptions, data availability, analytical methodology, and modelling procedures. At the same time, each country, region and proposal has distinctive features which make it difficult to generalise on prospective outcomes or to relate the results directly to potential schemes such as an Auckland Congestion Charge.

Table 19 compares Auckland to London, Stockholm and Singapore in terms of key indicators. The table also provides data for Copenhagen (which has a similar population to Auckland) and the Netherlands (which at the national scale has a population density that is much more like that of the Auckland conurbation). It can be readily appreciated that Auckland has much lower population densities than the other cities – but that, on the other hand, it has much higher levels of car ownership.

Table 19 International context of Auckland congestion charging

Characteristic	London	Stockholm	Singapore	Copenhagen	Netherlands	Auckland
Population	8.5m	1.21m	4.68m	1.21m	16.3m	1.24m
Area	1,600km2	375km2	704km2	456km2	41,500km2	1,086km2
Population density	4,761/km2	3,230/km2	6,370/km2	2,659/km2	395/km2	989/km2
Cars / 1000 people	365	386	300	275	376	500
Forecast traffic growth 2006 - 2020	11%	6%	restricted	21%	28%	28%

Notes: Traffic growth for London & Stockholm includes effects of congestion schemes
Source: Commission for Integrated Transport (2006) /NZIER

How far such differences invalidate cross-referencing and extrapolation remains moot.

5.10 Conclusions on the potential impacts of road pricing

The conclusions that can be drawn on the potential impacts of road pricing are as follows.

Looking at its impact on transport users at the simple level, congestion pricing alters basic market relationships. If a congestion charge successfully nets out a significant amount of low value / non-business travel (which is likely to have low or negligible positive externalities), it may free road space with minimal impacts on the overall level of economic activity.

The positive externalities realised on high value trips may very well outweigh any dead weight losses (even when the cost of the congestion charge is taken into account). Indeed, the availability of freed road space is likely to enable more productive activities to expand (i.e. pushing the demand curve for business trips outwards) – and eventually, the pattern of land use may also change and intensify as business prospers.

In the case of the London Congestion Charge between 2002 and 2004, all vehicle-kilometres driven with the LCC zone fell from 1.64 millions to 1.38 millions (i.e. by around 16%). However, individual car trips (presumably many of these may be regarded as 'less essential' in economic terms) fell by 39%, whereas truck trips remained broadly constant and taxi trips rose by around 11%. The taxi and road transport sectors therefore appear to have been overall gainers.

Congestion charging creates gainers and losers (indeed this is at the heart of the differential responses of different types of traffic). Over the longer term, this will influence the location of activity and there are likely to be boundary effects and shifts in land-use

Evidence for the LCC suggests (not at all surprisingly) that the financial sector has been the biggest overall gainer, reflecting its positive impact on the convening of meetings and transfers of business documents etc. The hotels and leisure sector also appears to be a major gainer from improved access by relatively high income clients. Conversely, the evidence for restaurants, cafes and retail establishments is more problematic.

With respect to Auckland, there is the possibility that congestion pricing in central Auckland could:

- spur the growth of secondary centres (e.g. Waitakere, Manukau) through decentralisation
- intensify road usage on some road segments, and by some types of users, and
- impact to some degree on the continued growth of some sectors of downtown Auckland economy.

On the other hand, increased decentralisation across the conurbation could have positive generative benefits for the wider Auckland economy.

And improved management of traffic in central Auckland could also significantly improve the CBD's attractiveness as an international and national business and leisure hub, by sieving out lower premium land uses and creating an environment that favours such higher value adding activities as corporate offices and such sectors as international finance.

With respect to the wider and longer term effects of road pricing, there is a small but growing evidence base that increased journey speeds, can have a significant effect on regional productivity. It is not possible to identify such effects at present from the monitoring work that has been done so far due to: measurement problems and costs; the technical problems that arise in calibrating impacts against a 'without intervention scenario'; and the short time periods that have so far elapsed.

Ultimately though, comprehensive assessments of effects should attempt to encompass:

- the 'full GDP benefits of freight movements' (including influences on factor markets e.g. labour availability and wage rates)
- the potential for agglomeration economies
- possible gains from / through international trade
- impacts from attracting globally mobile investment / economic activity.

Congestion charging tends to create complex patterns of losers and gainers – between sectors, between industries and firms, and between geographical locations. However, the second and equally important inference is that – when all these distribution effects are washed out – the net generative effects are relatively small but positive.

Overall though (as noted in Section 3 of this Report), it is important to recognize that cordon or area-based pricing has four main advantages over other tactics towards alleviating congestion:

- it can be put in place – at least in technical if not political terms – within the short to medium term (under 5 years)
- it results in immediate effects on all peak movements
- as it hits all drivers equally, it does not lead to mode inequities, gaming of trip routing, and bunching in off-peak periods
- it can produce significant revenues that can cover its costs and possibly provide dedicated funding for road and passenger transport improvements.

6. Reviews of individual overseas schemes

6.1 London Congestion Charge

6.1.1 Background and data sources

Most of the material that is quoted in the following section is drawn from the extensive online Publications website for Transport for London, located at:

http://www.tfl.gov.uk/roadusers/congestioncharging/6722.aspx#2a

Given the volume of the material and its frequently overlapping nature, the text that follows does not reference individual documents.

London is a pre-eminent world city that has undergone considerable growth in the last decade. It is surrounded by South East England which has high levels of household incomes. London and SE England have combined population approaching 20 million. Current GDP per capita figures for 'central London' (the area bounded more or less by the North and South Circular roads) are three times higher than the average for the European Union as a whole.

Average per capita incomes are not available for the cordon area (largely 'the City' – the ancient core and financial centre, and the 'West End' – the upmarket office and residential zone to the west). However, it is unarguable that the inhabitants of the cordon zone have per capita incomes which are considerably in excess of those recorded for 'central London'.

6.1.2 The problem of congestion

The original central London congestion charging zone (LCC) - the original zone - was 8 square miles, or 21 square kilometres, in extent, representing 1.3 percent of the total 1,579 square kilometres of Greater London, with 174 entry and exit boundary points.

In 2002, prior to the LCC traffic speeds in the original zone averaged 8 mph – which was very similar to the speeds attained 100 years ago. Congestion in central London was assessed as being six times worse than in a typical UK city (according to DfT figures, in the Delivering Better Transport progress report December 2002).

In 2002, over one million people entered central London by all forms of transport each morning peak, 85% of them by public transport. Each weekday, 6,500 buses accommodated 4.8m passenger journeys on more than 600 routes across the whole of the capital.

Roughly 250,000 vehicles made 450,000 movements into the original zone during the period 7am-6.30pm with 40,000 vehicles an hour driving into the congestion charging zone during the morning peak (7am - 10am) - the equivalent to 25 busy motorway lanes. On average drivers in the original zone faced 2.3 minutes of delay for every kilometre they travelled prior to the LCC. In many instances drivers spent half their time in queues which much reduced the reliability of arrivals and deliveries.

Any attempt to assess firm responses to congestion in terms of land-use, relocations, and the allocation of resources is severely constrained in the case of London by the persistent buoyancy of the economy. In 2006, the London economy outperformed that of the UK as a whole. Analysis of comparative business performance (including independent external audit of the TfL and GLA monitoring of impacts) covering changes in job levels, business numbers and business turnover, continues to show no evidence of any differentials between the LCC zone and comparator locations.

It is hard then to envisage a counterfactual situation in which the balance of effects of the LCC on the business sector, as a whole, is negative in absolute terms. Indeed, given the pressures on resources that continued growth creates, it can be argued that both congestion costs and congestion charges may perform a not altogether negative function in rationing access to overstretched resources (and to the high value but spatially limited agglomeration opportunities provided by the CBD).

6.1.3 Road pricing rationale

a) Objectives and expectations

The objectives of the LCC (consistent with the Mayor's Transport Strategy) were to:

- reduce congestion;
- make radical improvements to bus services;
- improve journey time reliability for car users;
- make the distribution of goods and services more efficient.

Furthermore, by reducing traffic levels it was also expected to contribute to reduced vehicle emissions.

Congestion charging was predicted to cut traffic levels inside the original zone by 10-15% and congestion by 20-30% (to the equivalent of school summer holiday levels).

It was also expected that one third (13,300) of the approximately 40,000 households in the original zone would be unaffected as they owned cars that they never drive within the expected hours of operation and that approximately 20,000 people a day would transfer to public transport as a result of congestion charging, an increase of approximately 2% (equivalent at most to one extra person per underground rail carriage).

6.1.4 Economic evaluation

Congestion charging was introduced into central London in February 2003. In February 2007 the original central London congestion charging zone was extended westwards, creating a single enlarged congestion charging zone.

The current impact of the LCC can be summarised in the following terms.

Throughout 2006, congestion charging continued to meet its principal traffic and transport objectives; and the scheme continues to operate well. Traffic patterns in and around the charging zone remained broadly stable during 2006. Traffic entering the charging zone (vehicles with four or more wheels) was 21 percent lower than in 2002, creating opportunities over this period for re-use of a proportion of the road space made available.

Traffic circulating within the zone and on the Inner Ring Road, the boundary route around the zone, remained comparable to previous years following the introduction of the scheme.

During 2006, TfL has observed a sharp increase in congestion inside the LCC zone. This has occurred despite the fact that traffic levels have continued to remain stable. Congestion levels are being influenced by an increase in activity that has affected the capacity of the road network for general traffic – particularly an increase in roadworks in the latter half of 2006, notably by utilities.

In addition, there is some evidence, as first reported in TfL's Fourth Annual Impacts Monitoring Report, of a longer-term 'background' trend of gradual increases to congestion. This is likely to reflect a combination of traffic management programmes that have contributed to fewer road traffic accidents, improved bus services, a better environment for pedestrians and cyclists, and improvements to the public realm and general amenity. But these interventions have also reduced the effective capacity of the road network to accommodate general vehicular traffic.

The impact of congestion charging therefore needs to be assessed in the context of parallel changes in traffic demand management. The reduced levels of traffic mean that, when compared to conditions without the scheme, congestion charging is continuing to deliver congestion relief that is broadly in line with the 30 percent reduction achieved in the first year of operation.

The factors discussed above mean that a comparison of congestion levels in 2006 against pre-charging baseline is potentially misleading. However, carrying this comparison through, congestion was 8 percent lower in 2006.

The scheme generated net revenues of £123 million in 2006/2007 (provisional figures). These are being spent on transport improvements across London, in particular on improved bus services.

Public transport continues to successfully accommodate displaced car users; and bus services continue to benefit from the reduced congestion and ongoing investment of scheme revenues

The overall buoyancy of the London economy has contributed to growth in public transport patronage, although volumes of travel to the charging zone by Underground in 2006 were only slightly higher than those that prevailed in 2002.

Further economic trend data and comparative analyses continue to demonstrate that there have been no significant overall impacts from the original scheme on the central London economy. General economic trends are considered to have been the predominant influence on the performance of central London businesses over recent years. The central London economy has performed particularly strongly since the introduction of congestion charging, with recent retail growth (value of retail sales) in central London at roughly twice the national growth rate.

Reductions in road traffic casualties and in emissions of key traffic pollutants in and around the charging zone continue to be apparent, alongside continuing, favourable 'background' trends in both of these indicators for 2006.

The operation and enforcement of the scheme continues to work well, with several further improvements and innovations introduced during 2006, alongside TfL's introduction of the western extension scheme in early 2007.

In general, charging is seen to have helped accentuate trends that were positive, such as reduced road traffic accidents and emissions; to have helped counteract trends that were negative, such as increasing congestion; whilst having a broadly neutral impact on general economic performance.

A cost-benefit analysis (based on 2005 prices) of the central London scheme suggests that the identified benefits exceeded the costs of operating the scheme by a ratio of around 1.5 with an £5 charge, and by a ratio of 1.7 with an £8 charge.

The sources and distribution of cost and benefit items in the overall assessment framework is presented in Table 20. The table illustrates that:

- car travel time savings and travel time reliability gains for those using the LCC are the major sources of benefits, and that the gains to Business Travellers are about 2.5 times greater than those that accrue to individuals making private trips. Both groups also benefit from reductions in fuel and operating costs
- there are also substantial time and reliability gains for bus passengers but that these are offset to some degree by the need to purchase additional buses and by increments in operating costs
- losses from deterred trips are relatively minor
- there were also losses to individuals and businesses arising from the deadweight costs imposed by compliance (i.e. registration and compliance costs)
- there are substantial positive societal impacts from reductions in accidents, and reductions in vehicle emissions
- the financial and fiscal balances between affected institutions are complex
- assessments of the balances between benefits and costs are also complex and depend in part upon the opportunity cost viewpoint taken (particularly with respect to the treatment of net financial impacts).

Table 20 LCC Assessment framework and benefit – cost matrix (2005 values and prices, GBP millions)

	BENEFIT / COST ITEM	Benefit/ Cost Ratios	Direct Impacts on National Economy E Vehicles / Occupants Occupants	 F Buses / passengers	 G Operating Cost Impacts	Financial Impacts I	Net effects on resource use K
A	**INDIVIDUAL TRAVELLERS**						
A.1	Travel time		54	35			
A.2	Travel time reliability		5	8			
A.3	Vehicle operating costs - fuel				5		
A.4	Vehicle operating costs - non-fuel				4		
A.6	Chargepayer payments					-72	
A.6	Disbenefit to deterred trips						
A.7	Vehicle registration & transaction costs						-6
B	**BUSINESS TRAVELLERS**						
B.1	Travel time		142				
B.2	Travel time reliability		22				
B.3	Vehicle operating costs - fuel				10		
B.4	Vehicle operating costs - non-fuel				7		
B.6	Chargepayer payments					-143	
B.7	Disbenefit to deterred trips						
B.8	Vehicle registration & transaction costs						-16
C	**DIRECT BUSINESS EFFECTS**						
C.1	Bus Revenues					18	
C.2	Bus operating costs					-18	
C.3	Net car park revenues					-10	
D	**DETERRED TRIPS**						
D.1	Business						-8
D.2	Individuals						-12
E	**GOVERNMENT (TFL, Boroughs etc.)**						
E.1	Fuel duty					-25	
E.2	VAT					-13	
E.3	Charging				-109	215	
E.4	Additional buses				-18	19	
E.5	Infrastructure						-25
E.6	Parking Revenues					-15	
F	**SOCIETY IMPACTS**						
F.1	Accidents						14
F.2	CO2						2
F.3	NOX and PM10						1
	OVERALL TOTALS		223	43	-101	-44	-50
	BCR (excludes financial impacts)						
	Formula: E + F + K / G	**2.1**					
	BCR (includes financial impacts)						
	Formula: E + F + K / I + G	**1.5**					

Notes: (1) Charge Payer Compliance Costs (i.e. A5 and B5) not estimated

Source: LCC / NZIER

6.1.5 Independent evaluations

The principal economic evaluations of the congestion charge from outside TfL are those prepared by:

- Prud'homme, R., and Bocarejo, J.P., (2005): The London congestion charge: a tentative economic appraisal, *Transport Policy* 12
- Mackie, P., (2005): The London congestion charge: a tentative economic appraisal. A comment on the paper by Prud'homme and Bocarejo, *Transport Policy* 12
- Santos, G., and Shaffer, B., (2004): Preliminary results of the London congestion charging scheme. *Public Works Management and Policy* 9
- Litman, T., (2006), London Congestion Pricing – Implications for Other Cities, *Victoria Transport Policy Institute Paper*, Victoria, B.C.

Prud'homme and Bocarejo conclude that:

- Charge proceeds are about three times larger than the value of congestion
- The yearly amortisation and operation costs of the charge system appear to be significantly higher than the economic benefit produced
- The LCC is a great technical and political success but its outcomes are more problematic from an economic point of view
- The ambivalence about the economic effects stems from their assessment that the costs of congestion before the scheme was introduced represented a mere 0.03 percent of the output / GDP of Greater London.

On the other hand, it can be argued that the associated direct costs are also minute in relation to the size of the London economy (less than 0.1 percent) and that any additional adverse downstream impacts will also be small – and quite possibly offset by longer term gains from improved efficiency in key export-oriented industries (e.g. the finance sector).

Mackie substantially endorses the main conclusions of Prud'homme and Bocarejo but has reservations about their treatment of time savings, the absence of trip reliability benefit estimates in their work, and their failure to include environmental effects (both quantitatively and qualitatively).

Santos and Shaffer provide an alternative elasticity of demand for trips (-1.3) as compared to -1.6 for the TfL studies. This would reduce the loss of consumer surplus from charging. They also question the TfL treatment of Small Time Savings arising outside the charging area.

TfL has offered refutations for the comments provided in the independent evaluations considered above and none of the comments appear to invalidate the general conclusions drawn by the TfL.

Litman notes the following distribution of winners and losers:

Table 21 LCC 'winners and losers'

Winners	Losers
• Downtown bus riders • All transit riders (due to increased funding) • Taxi riders and drivers • Motorists with high value trips • Most city centre businesses • Overall city productivity • Pedestrians and cyclists	• Motorists with marginal trip values • City centre businesses that depend on low-cost weekday car access • Residents and motorists in border areas who receive spill-over impacts • City centre parking revenue recipients

Source: Litman (2007) / NZIER

Litman concludes that:

- the success of the LCC indicates that private automobile travel is more price sensitive than most experts had previously believed, and that 'this is good news for congestion reduction but bad news for revenue generation'
- compared with other cities, London has a particularly small portion of car commuters and many of them reside and work outside the LCC zone. This means that a relatively high proportion of voters perceive that they receive direct benefits (from improved spending on public transport). This finding may not apply widely elsewhere.

6.1.6 Changes and emerging trends

The western extension to the central London congestion charging zone was successfully introduced on schedule on 19 February 2007. From this date, the extension zone operated alongside the existing central London zone, creating an enlarged central London congestion charging zone.

The current assessment is as follows.

From the outset all major operational elements of the scheme functioned well, and there were no traffic or other problems of significance. Traffic entering the extension zone over the first three months of operation was typically down by between 10 and 15 percent against equivalent levels in 2006. The volume of traffic circulating within the extension zone was typically down by 10 percent against comparable values in 2006.

Traffic on the free passage route running between the original and extended zones (Edgware Road to Vauxhall Bridge via Park Lane) was effectively unchanged in aggregate terms by the extension scheme. Traffic on the remainder of the western extension boundary route increased in aggregate by a small amount (generally up to 5 percent), as expected by TfL. There is no evidence of any significant traffic operational problems on this key route

There is some evidence from counts of traffic entering the original central zone of small increases (generally up to 4 percent) following the introduction of the scheme, as anticipated by TfL. However, indicators of traffic circulating within the original charging zone are tending to indicate small reductions.

TfL's current assessment would therefore be that aggregate traffic volumes in the original central zone have not changed significantly as a result of the extension scheme. Similarly, congestion levels in the central zone during this period are commensurate with those in 2006, and do not appear to have been affected by the introduction of the western extension zone

The first comprehensive survey of congestion in the western extension suggests that congestion has reduced by between 20 and 25 percent against comparable values in 2005 and 2006. A value for excess delays of 1.2 minutes per kilometre for March/April 2007 compares to a value for equivalent months in both 2005 and 2006 of 1.5 minutes per kilometre

Overall, these early results are highly encouraging. TfL's monitoring of the impacts of the western extension will continue throughout 2007, including:

- Specific impacts on sectors of the economy (e.g. retail, road transport)
- Business location impacts (other cities or offshore)
- Productivity gains including agglomeration impacts
- Reallocation of resources
- Out of pocket costs for businesses and compliance costs
- Boundary impacts (i.e. considering the impact of road pricing not just in the areas charged, but areas outside)
- Economic externalities (e.g. improved amenity for tourists).

As previously noted, in 2006, the London economy outperformed that of the UK as a whole, despite the presence of the LCC. Analysis of comparative business performance (including independent external audit of the TfL and GLA monitoring of impacts) covering changes in job levels, business numbers and business turnover, continues to show no evidence of any differentials between the LCC zone and comparator locations.

6.2 Stockholm congestion charge

6.2.1 Background and data sources

This section draws mainly on the material that is available on the official website of the City of Stockholm Council (Stockhomsforsoket) at:

http://www.stockholmsforsoket.se/templates/page.aspx?id=12555

The general context of Stockholm's congestion problems and the trial and subsequent adocption of a cordon congestion charge around the CBD is that:

- the city of has about 800,000 inhabitants, which is about 8.5 percent of the population of Sweden.
- the congestion charge area is 34.5 square kilometers.
- 71 percent (227,000) of people working in the area travel in to work
- Stockholm CBD has a constricted site, bounded by water on three sides – in consequence, whist London has 200 routes into the city and Stockholm has only 18. The geography of the city therefore accentuated congestion but also made it easier to introduce cordon charging.

6.2.2 The problem of congestion

Pre-trial surveys for 2004 put the total number of trips across the cordon during one weekday day at 1,188,000.

The modal shares of these trips were as follows:

- Public transport 709,000 (59.6%)
- Cars 377,000 (31.7%)
- Cycle 40,000 (3.4%)
- Pedestrians 21,000 (1.8%)
- Other 41,000 (3.5%).

It is therefore very important to note that Stockholm already had very high levels of Public Transport patronage prior to the congestion charge trial – much higher than those of Auckland. It must also be borne in mind that levels of car entry were much lower than those recorded for Auckland – suggesting a much lower tolerance of congestion in Stockholm (probably associated with a heightened concern for environmental improvements).

6.2.3 Road pricing rationale

Stockholm decided to trial congestion charges in 2005, and at the same time improve public transport. The scheme operates between 6.30am and 6.30pm motorists must pay to drive in or out of town. The fee varies between Swedish Krona (SEK) 10 and SEK 20 (USD 1.25-USD 2.50) depending on the time of day, with a limit of SEK 60 per day. Evenings and weekends are free of charge.

The goal was to reduce the number of vehicles crossing the cordon during the morning and evening peaks by 10-15%.

The expectation was that more car drivers would use public transport or, alternatively, avoid traveling during peak times. A poll was held in September 2006 and the scheme was maintained in place despite voters registering resentment at some of the implementation measures.

The scheme makes allowances for cars that run on ethane, electricity or other environmentally friendly fuels. Sales of environmentally friendly cars are now increasing in Sweden and especially Stockholm. Motorbikes, emergency vehicles, certain commercial vehicles and cars registered abroad are also exempt from the tolls.

6.2.4 Economic evaluation

Since the congestion charges were introduced more Stockholmers have chosen to take public transport. Stockholm Transport has reported passenger increases of up to 10 percent on some services. All types of transport – underground, trains and buses – are carrying more passengers.

The modal shares of trips into the zone in 2006 were as follows:

- Public transport 734,000 (+4%)
- Cars 286,000 (-24%)
- Cycle 9,000 (-78%)
- Pedestrians 22,000 (+6%)
- Other 27,000 (-9%).

The figures suggest that the charge resulted in a good deal of trip suppression, as the overall number of trips fell by 110,000 (-9%) as compared to 2004. The overall drop in car trips of 24% is much higher than the anticipated figure of 10-15%.

It appears that much of the trip suppression reflected adjustments in recreational, school and child / young adult training and sporting trips. This opens the possibility of putting in place policies (e.g. encouraging the decentralization of sporting and recreational centres) to ameliorate the effects.

As a result of the charge, accessibility rose and travel times fell for those who were prepared to pay the charge. These shifts were accompanied by signifcant enviornmental and health gains.

There is some evidence that the shift to public transport was hindered by reduced train commuter services in the winter of 2005-06, consequent on bad weather and other problems.

The shifts in vehicle types entering the cordon zone is illustrated in Table 22 below. It shows clearly that the charge had a considerable impact on car usage, and lesser but still substantial impacts on other types of vehicle use (including ligh commercial vehicle trips).

Table 22 Differential impact of Stockholm congestion charge on vehicle types

(vehicles recorded on all CBD approach routes during charge period)

Vehicle Type	Pre trial 2004 versus Trial 2006 difference in Numbers	Percent change
Cars	-89,167	-30%
Vans / light goods vehicles	-10,136	-22%
Trucks etc.	-1,465	-13%
Motorbikes etc.	-545	-54%
TOTAL	-101,313	-28%

Source: Stockholm Stad (2006) / NZIER

In autumn 2005, about 55% of all Stockholm County residents thought that the trial was a 'rather bad / very bad decision'. In April-May 2006, this percentage had dropped to 41% and 53% believed that it was a 'rather good / very good decision'.

The cordon location created boundary effects and there were marked differences of views between the residents of the CBD and the residents of outlying subsurbs. The relatively wealthier residents of the centre who don't have cars or, if they do have cars, don't use them to go to work, were pleased that the streets were emptier and more pleasant.

On the other hand, the relatively poorer (and often younger) residents of the less favoured outer suburbs resented the charge. Their views were reflected in the political responses to the Trial with strong negative votes being registered in the referendum in many of the outer suburbs.

The short-term distributive effects have been summarised in Table 23 below. It is intersting that the Swedes include reduced commercial driver stress in the gains and increased public transport passenger reaction to enhanced crowding and congestion as losses.

Table 23 Stockholm 'winners and losers'

Winners	Losers
• Public transport travellers who get improved services • Those who drive 'within cordon' and therefore get faster trips at no cost • People who value their time highly and are prepared to pay for time saved • Commercial vehicles, including taxis (with benefits also accruing to drivers also in the form of reduced stress) • Pedestrians and cyclists	• Motorists with marginal trip values (i.e. those who have to drive across the cordon boundary because they cannot adapt their travel and feel that the gains do not outweigh the charge) • Those who are 'forced off' the roads • Established public transport patrons who experience intensified public transport crowding and congestion

Source: Stockholm Stad (2006) / NZIER

Commercial companies have been 'united in their criticism of the inconvenience and administrative costs the congestion charge bears in its current form' but opinions have gradually become more moderate on its potentially negative impact on enterprise viability and development.

Overall, 'the short-term effect on the retail market and other sectors studied shows only small average effects' and 'the congestion charge has had only a marginal effect on company total transport costs'. Any changes are generally outweighed or occluded by general economic growth and modelling suggests that the effects are 'not greater than normal price / output variations between two quarters'.

An analysis of the effects of the charge on the tourism industry could not establish that there had been any direct effects or that 'tourism developed more weakly or more strongly during the initial months of the trial'.

The Expert Group that evaluated the congestion charge notes that it is consistent with the view that reduced congestion is necessary if businesses are to continue to develop in cities like Stockholm and New York. In this regard, it concludes that:

> *Recent research shows that a city's attractiveness is of greater importance when seeking skilled personnel, who in turn attract companies and create growth. Seen in this perspective, the Stockholm Trial and a permanent congestion-tax system would increase Stockholm's attractiveness.*

A summary cost-benefit analysis of the scheme is available from a presentation by the Expert Group (2006) convened to evaluate progress.

The results of the analysis are presented in Table 24 below.

They suggest that:

- 74 % of the benefits arose from shorter timed / more reliable trips
- 15 % of the benefits arose from improved traffic safety

- 11 % of the benefits arose from environmental and health gains.

The study does not present quantified data on the impact of the scheme on transport operators or businesses and land-uses.

From a technical point of view, it may be noted (as previously observed for the LCC) that the methodology of the analysis may be open to question. In particular, in this case, the relative large ‘shadow price’ adjustments to costs may be queried.

Table 24 Cost – Benefit Analysis of the Stockholm Congestion Charge

BENEFIT / COST ITEM	Value Millions Swedish Kr per year
Shorter timed / more reliable trips	590
Congestion charges payments	-760
Health & environment	90
Traffic safety	120
Revenues from congestion charges	760
Other revenues / net costs	190
Maintenance and running costs	-220
NET BENEFIT	770
Investment and running costs 2006	-2,000
Shadow price adjustments	-1,100
TOTAL INITIAL COST	-3,100

Source: SCC Expert Group Summary (2007) / NZIER

Overall though, the Expert Group concludes that:

- there have been marginal effects on land-use, real estate prices and the regional economy
- there have been no identifiable effects on the retail sector at the aggregate level.

6.3 Singapore Area Licensing Scheme

The Singapore Area Licensing Scheme (SALS) was introduced in 1975 to manage traffic demand. This was the first urban traffic congestion pricing scheme to be successfully implemented in the world. These scheme created a 6-square-kilometer area in the Central Business District called the "Restricted Zone" (RZ). This was later increased to 7.25-square-kilometer to embrace areas that became commercial in nature[14].

[14] This note has been compiled from Wikipedia entries and is provided for easy reference. We have been unable to identify economic studies that meet the requirements of the Terms of Reference of this Report for assessments of business effects.

http://en.wikipedia.org/wiki/Image:Yap_Singapore_Experience_RZ_Location_Fig_3-p8.jpgThe introduction of congestion pricing was one of a number of anti-congestion policies implemented in Singapore since the 1970s, in recognition of the country's extremely constricted land area, drive for economic competitiveness, and recognition that traffic gridlock was imminent if economic growth continued at past rates. The other measures included have included:

- high annual road tax, custom duties and vehicle registration fees
- regulation of the supply of motor vehicles since 1990, through a Vehicle Quota System
- use-related charges, such as fuel taxes (50% of final sale price) and high parking rates.

On the other hand, there has been heavy investment in public transportation (including a park-and-ride scheme, with thirteen fringe car parks) to provide car users with a real incentive to switch travel modes.

At the early years of introduction, passenger cars having four or more occupants, taxis, public transportation buses and service vehicles were allowed into the zone without charge. Carpooling was exempted too. From 1989, only buses and emergency vehicles were exempted.

The SALS, despite its simplicity, succeeded in effectively restraining congestion in the RZ for more than 20 years. Before the implementation of ALS and the other complementary measures, the motor vehicle fleet was growing at an annual rate of 6%, and in 1975 the traffic volume entering the RZ was about 100,000 vehicles. After the government intervention, the fleet slowed down to a moderate 4% rate of growth, and traffic entering the RZ was limited to only 230,000 vehicles in 1994.

In September 1998, the Area Licensing Scheme was terminated as Singapore upgraded to the current Electronic Road Pricing system, which is completely automatic and allows passing the control gantries at normal speeds.

http://wikimediafoundation.org/The scheme covers Singapore's central business district and heavily peak-trafficked expressways and arterial roads. A device known as an In-vehicle Unit (IU) is affixed on the lower right corner of the front windscreen within sight of the driver, in which a stored-value card, is inserted for payment of the road usage charges. It is mandatory for all Singaporean vehicles to be fitted with an IU if they wish to use the priced roads. Charges are activated when vehicles pass under boundary gantries.

The ERP system, although understandably unpopular among most road users, has helped to control road usage patterns since its implementation. The Land Transport Authority reported that road traffic decreased by nearly 25,000 vehicles during peak hours, with average road speeds increasing by about 20%. Within the restricted zone itself, traffic went down by about 13% during ERP operational hours, with vehicle numbers dropping from 270,000 to 235,000.

It has been observed that car-pooling has increased, while the hours of peak vehicular traffic also gradually eased and spread into off-peak hours, suggesting a more productive use of road space. In addition, it has been noted that average road speeds for expressways and major roads remained broadly stable, despite rising traffic volumes since 1998.

There appears to have been very little economic analysis of the wider impacts of the Singpore SALS and ERP schemes. This is partially understandable in terms of the relatively directive approach that has been taken by the Singapore government. But this in turn is underpinned by the very special conditions that exist in Singapore.

In essence it is:

- a city that is an independent state
- a city that has no hinterland in the conventional sense
- an entrepot economy that depends almost entirely for its survival on international trade
- an economy that occupies an extremely small and confined space, with a population of 4.68 million contained within a land area of 704 km2 (compare Auckland with a population of 1.24 million in an area of 1,086 km2).

Given the realities of the Singapore economy, fostering the international core of the state (i.e. the CBD) and assisting international business and commerce are imperatives. This means that congestion pricing can play a direct role in maintaining economic growth by sustaining the efficiency of the CBD and its entrepot functions.

If congestion pricing has had any adverse impact on economic growth, it is very difficult to identify. In 1980, when the SALS was still new, Singapore's GDP was S$ 25 billion. In 2007, Singapore's GDP was S$ $224 billion - and the exchange rate has strengthened from 1 US $ = S$ 2.14 to 1 US $ = S$ 1.51 over the same period. Current GDP per capita is over US $32,000 and recent economic growth has been around 7-8 percent per year.

Clearly, such bouyant economic conditions provide an ideal backdrop for the introduction of congestion pricing, given rapidly rising incomes and the relatively marginal role that transport costs play in personal expenditure in Singapore as a consequence of its confined area.

6.4 Conclusions from reviews of individual overseas schemes

The following general conclusions can be drawn from the reviews of the literature relating to the London, Stockholm and Singapore schemes. These conclusions also draw on references to the LCC in Sections 3 and 5 of the Report.

In the first place it is clear that all three schemes have very different contexts and that the factors that underlie and have conditioned the design and implementation of the schemes are partly case-specific. These factors include the geographical setting, economic growth and household income characteristics, vehicle ownership and usage levels, passenger transport infrastructure provision and mode-sharing levels, and even differences in the aspirations and responses of the target populations.

Secondly, there is a common recognition across the three cities that congestion is an important problem and that congestion charging is an effective and appropriate means of addressing the problem. In all three cities, levels of public acceptance have risen following implementation. However, in both the London and Stockholm cases, there has been relatively widespread public criticism of the means of implementation. This confirms the need for careful planning with regard to the technical and behavioural dimensions of a congestion scheme in Auckland.

Thirdly, there is a general acceptance that the schemes have met their objectives in terms of reducing congestion, improving accessibility, lessening adverse environmental and health effects, and enhancing the quality of life within the cordon areas.

Fourthly, there is a consensus that, taken overall, the schemes have had a barely perceptible impact on overall economic growth. In the cases of all three cities, the effects were small and background economic growth appears to have 'washed out' any adverse effects on their overall urban economies.

However, difficulties arise in all cases in matching effects to causes because of unforeseen / 'confounding' effects. For example, in the case of the LCC, potential gains in accessibility from lower traffic levels were negated to some degree by increased road works and traffic management installations within the cordon area. Again, in the case of Stockholm, bad winter weather adversely impacted on passenger transport patronage in 2005-06.

In both the LCC and Stockholm cases, there were significant boundary issues. In the former, these concern the advantages and disadvantages of extending the scheme into the West End. In the case of Stockholm, they concern the perception by commuters from the outer suburbs to the CBD that they had been asked to bear the bulk of the charge, whereas inner city residents within the cordon zone had gained disproportionately from the improvement of the city centre environment.

Fifthly, there is significant confirmation that, while the wider growth or generative effects were small in aggregate, there were complex patterns of gainers and losers (i.e. distributive effects) in the short term. In all of the schemes, there is evidence of reductions in the levels of less-essential / low willingness-to-pay car trips. On the other hand commercial vehicles like trucks and vans, and the users of taxis, were generally gainers. It was noted in the case of Stockholm that established passenger transport users lost out from increased levels of usage and ‘congestion’ on buses and trains due to the addition of new patrons.

With respect to the short to medium term impact of the schemes on businesses, there was again a general recognition, that overall, there were low net effects. However, there it was evident that some sectors may register net gains while others may have higher levels of losses. In particular, the financial and office sectors of all three cities appear to have been major gainers. By contrast, there is more concern about the potential for congestion charging to adversely affect CBD retailing, particularly if passenger transport improvements lag. In other sectors, gains generally appear to outweigh losses.

The general economic background to the introduction of congestion charging is also important. In all three cases, the economies of the cities have experienced considerable economic growth during the introduction and implementation of congestion charging that emanates from their status as world cities. This growth is founded on drivers that have little relationship to either levels of congestion or measures to ameliorate congestion. Clearly, it is advantageous, in terms of public acceptability and impact on local businesses, to introduce congestion pricing against a background of economic buoyancy.

Looking longer term, all three cities appear to have confidence that congestion charging will have a positive impact on their international images (including their attraction of tourism and tourism expenditure) and that it is likely to stimulate and accentuate the attractiveness of the cities for new investment in higher value added activities. Such ‘agglomeration’ benefits are difficult to measure but there is increasing recognition worldwide that a city’s capacity to attract and retain internationally mobile highly skilled labour is a major key to continued growth.

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