

Analysis of Sydney Public-Private Partnership Road Tunnels

Geoff Phillips

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Introduction

The Sydney Cross City Tunnel and the Lane Cove Tunnel have generated controversy both before and since their completion. Despite the amount of public discussion, there has been very little in the way of objective analysis of the costs and benefits of these projects. This paper investigates the relationship between the toll price level, usage level and public benefit. Because of experiments with toll-free periods and various toll levels, there is information about price elasticity of demand, which can be used to make predictions about the financial viability of these tunnels and about the costs and benefits to the public of the tunnel projects. Parliamentary inquiries into the two tunnel projects provide historical and financial information in a usable form to assist the analysis.

Some basic economics concepts are a starting point for the discussion. A simple mathematical model is used to draw conclusions about the commercial viability of the Cross City and Lane Cove road tunnels. A very useful concept in microeconomic analysis is elasticity of quantity Q with respect to price P . Using our notation above, elasticity e is given by: $e = (dQ/dP)(P/Q)$.

This is the fractional change in quantity Q with respect to a percentage change in price P . Under normal circumstances, we can expect quantity to decrease as price increases, so the elasticity e will be negative. If the absolute value of e is less than one, quantity is said to be inelastic with respect to price. This has the effect of an increase in revenue if price increases. In the other case where $|e| > 1$, an increase in price will result in a fall in revenue when price increases.

Cross City Tunnel

Pricing for using the Sydney Cross City Tunnel has been a thorn in the side of the public, the government and not least the tunnel operator. Few people believe that a solution to please all parties is possible. In the first few months after the Tunnel was opened data were collected on traffic numbers for a \$3.50 toll, no toll and half toll of \$1.75. The numbers were as follows:

Toll \$3.50 corresponds to usage by 26,500 cars.

Toll \$1.75 corresponds to usage by 32,000 cars.

Toll \$0.00 corresponds to usage by 50,000 cars.

An approximate value for the elasticity of quantity with price, based on the first two of these results is $e = -0.3$. This is easily seen because a 50% change in price produced only a 16% change in usage, $e = -16/50$.

Hence demand for the tunnel is shown to be inelastic in the general pricing region being considered. Of course elasticity can vary with price (and equivalently with quantity), but even with the very limited information above, some analysis is possible.

The simplest model for constant elasticity of quantity with price, based on the numbers above is:

$Q = A / P^{0.265}$, where $A = 37,500$. This is illustrated in figure 1.

The model predicts immediately a traffic volume of 37,500 cars if the toll is set to \$1. The revenue R from the tunnel can now be found from the formula: $R = PQ = AP^{0.735}$.

As expected, the revenue will be zero if the toll is zero. The model has the obvious disadvantage that quantity tends to infinity as price tends to zero. However, the model calculates 50,000 cars using the tunnel at a toll of fifty cents. This disadvantage can be remedied by adding an extra parameter. The resulting curve, which is shown in figure 2, is given by the equation:

$Q = A / (P + 0.5)^{0.32}$, where $A = 41,500$.

A linear model is shown in figure 3. The straight line is made to go through the points corresponding to tolls of \$1.75 and \$3.50. The equation of this line is $Q = -3P + 37$, where Q is measured in thousands of cars per day. On the evidence presented, the linear model represents a pessimistic view of how demand will respond to an increase in price. The linear model is compared with the power law model in figure 4.

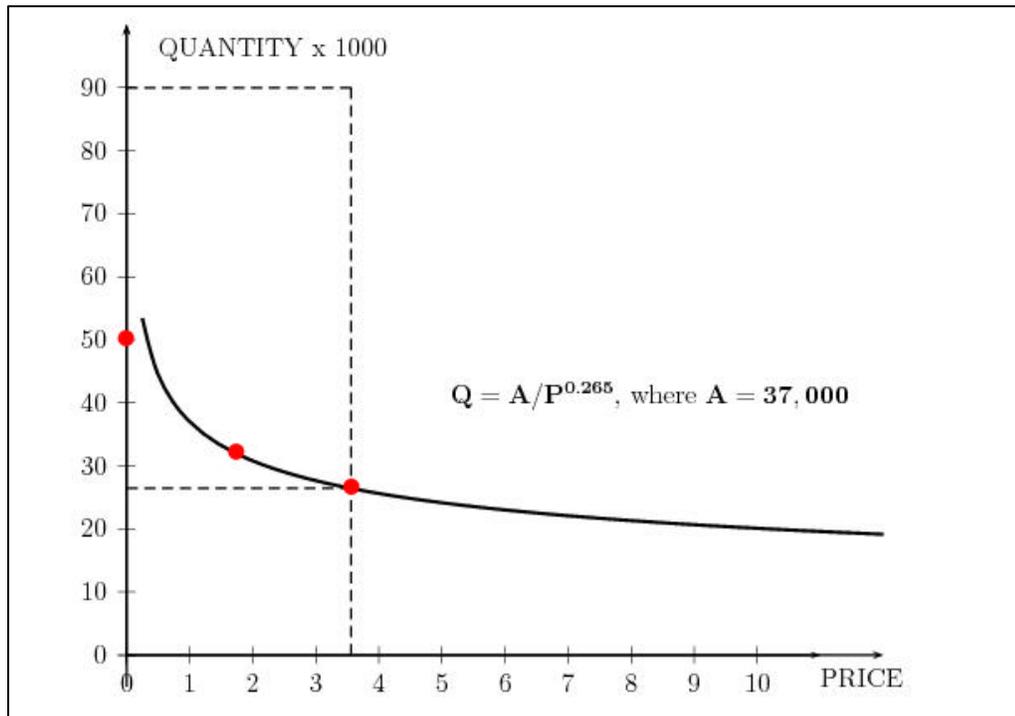


Figure 1: Cross City Tunnel Traffic Demand Curve Model.

The area indicated by the dotted lines shows the predicted and actual revenue for CCT.

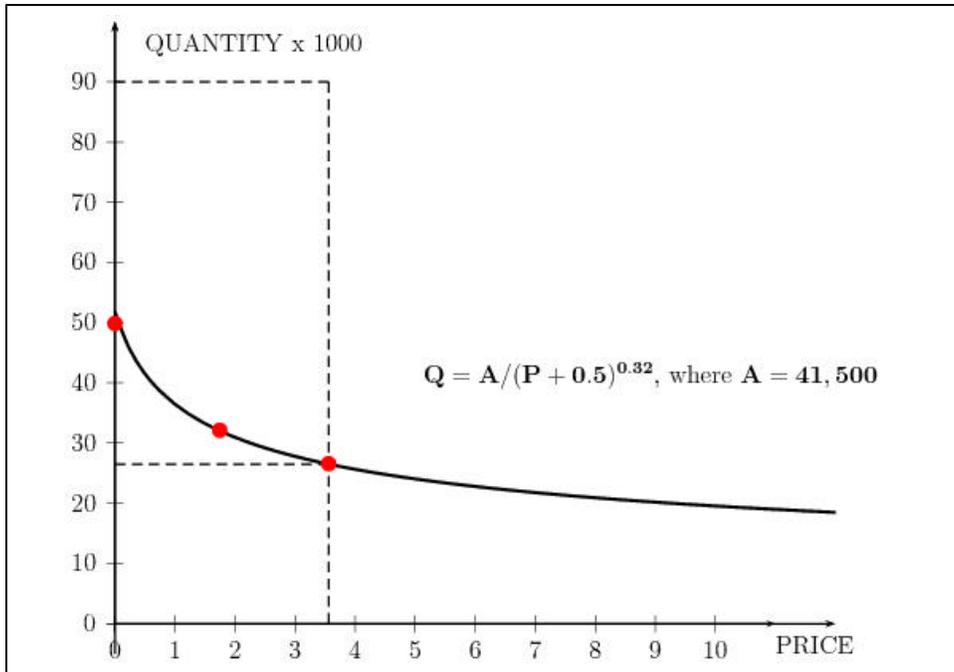


Figure 2: Improved Model of Demand for CCT.

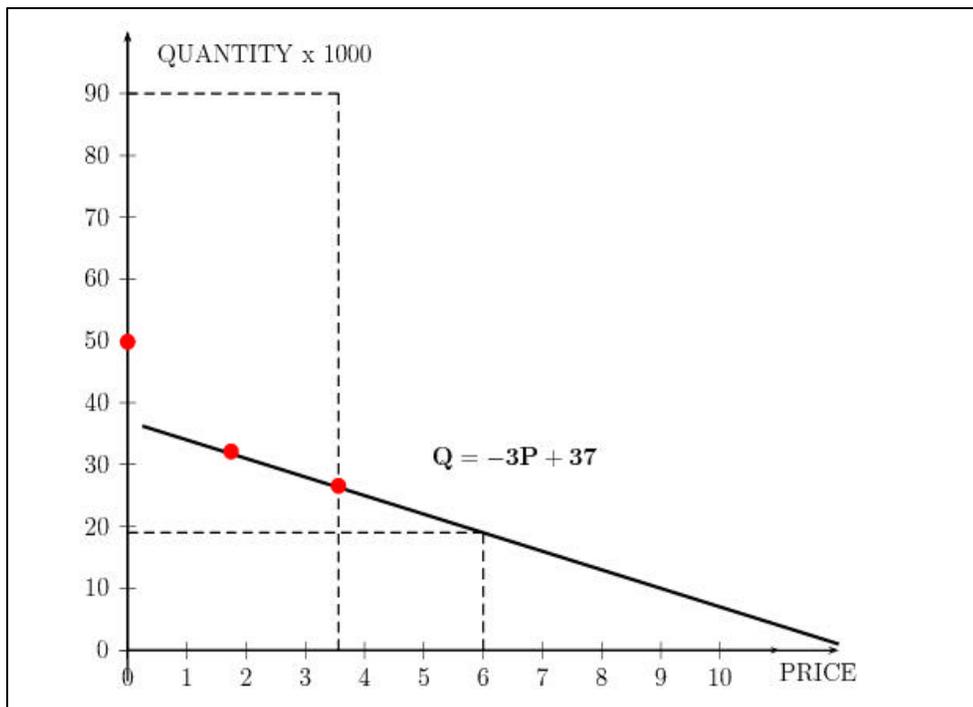


Figure 3: Linear Model of Demand.

Note that revenue is maximized at \$6 per trip compared to the agreed \$3.50 per trip.

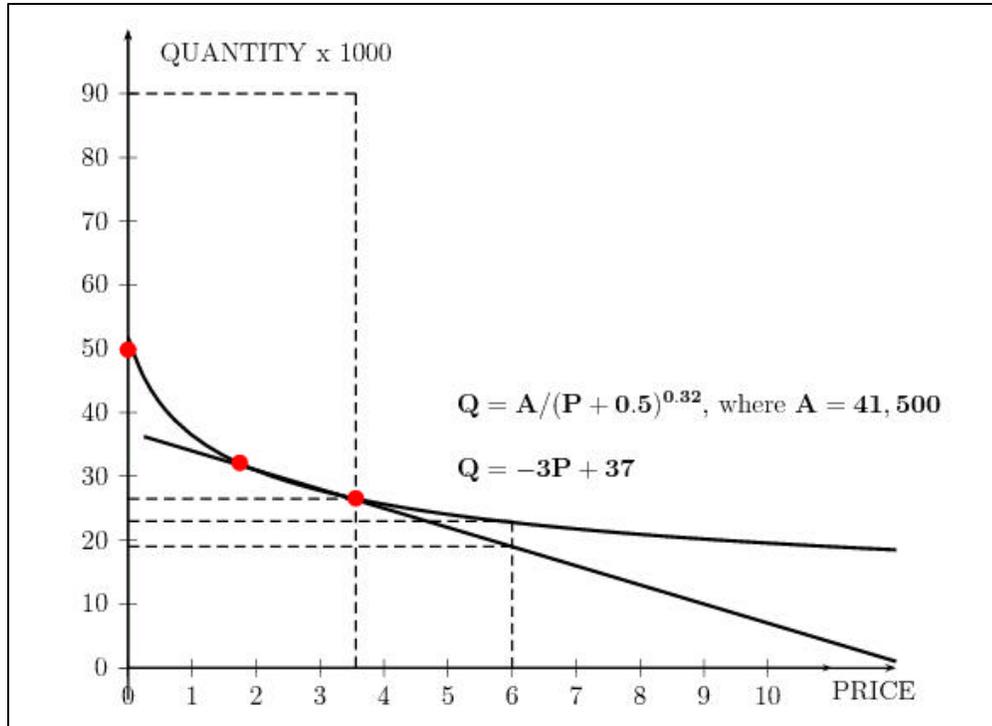


Figure 4: Comparison of Demand Models

Regulation and Contract Conditions

The Public Private Partnership concept as it applied to the Cross City Tunnel has a number of consequences. The price charged by the Tunnel Operator is set by regulation, so that the logical way for the Operator to increase revenue by increasing price is blocked. The Tunnel project had cost an estimated \$900,000, loans for which could not be financed by 26,500 cars paying \$3.50 each per day. Estimates of usage prior to tunnel construction suggested 90,000 car trips per day, corresponding to about ten percent return on investment.

The Contract for the Cross City Tunnel also included road closures affecting alternative routes to the Cross City Tunnel. These conditions aroused public resentment at a level apparently unforeseen by the State Government. Public pressure resulted in the partial reopening of roads which were closed as part of the contract. This was bitterly opposed by the Tunnel Operator because the Tunnel was already operating at a substantial loss. The Tunnel Operator went into receivership.

The Lane Cove Tunnel

The issues surrounding the Cross City Tunnel were revisited in the Lane Cove Tunnel Project, which cost an estimated \$1,100,000. Prior estimates of traffic numbers ranged from 90,000 to 110,000 car trips per day. An initial toll-free period resulted in 75,000 car trips per day. When the \$2.55 toll was introduced, usage fell to 50,000 car trips per day.

The NSW Government had made one of the terms of the contract that it would reduce Epping Road from three lanes each way to one lane each way plus a bus lane. The Lane Cove Tunnel

runs under and parallel to Epping Road. Because of the public backlash from a similar agreement for the Cross City Tunnel and the approaching State Election, the lane changes on Epping Road have been delayed and the State Government paid compensation of \$25,000,000 to Connector Motorways. The Government and Connector Motorways expect traffic numbers using the Lane Cove Tunnel to increase when the lanes on Epping Road are closed.

The comparison between the Cross City Tunnel and the Lane Cove Tunnel shows that the Lane Cove Tunnel is the better founded project. The comparison is illustrated in figure 4. If motorists can be coerced (by closing lanes on the free parallel Epping road) to increase numbers using the Lane Cove Tunnel, the project could be financially viable.

Further Analysis

So far we have considered the two Tunnel Projects from the point of view of the financial viability of the two Projects. The justification of using Public-Private Partnerships to carry out road development projects has been that private enterprise would provide additional funding and take a degree of risk in order to gain profits. The contract conditions would help to ensure these profits while keeping toll charges at (hopefully) a level acceptable to the public.

Two further forms of analysis are:

- (1) cost-benefit analysis
- (2) analysis of (Pareto optimality) equity among road users .

To provide a thorough cost-benefit analysis of the tunnel projects is beyond this paper, but even at a simple level it puts a different perspective on the comparison between the Cross City Tunnel and the Lane Cove Tunnel.

Costs and Benefits – Cross City Tunnel

The cost of the Cross City Tunnel construction was about \$900 million. Because of the failure of the tunnel to achieve the traffic numbers originally estimated, the company went bankrupt and new owners bought out the tunnel for \$700 million. The ongoing costs to motorists are \$3.50 per car trip through the tunnel. The charge of \$3.50 is indexed to the greater of the Consumer Price Index (CPI) and 4% per annum.

There are real benefits to those who use the main part of the Cross City Tunnel in reduced fuel costs and travel time. This can be quite significant at peak traffic times, travel time from Rushcutters Bay to Pymont could take 15 minutes rather than 50 minutes in the worst situation.

Some other links of the Cross City Tunnel offered less benefit to motorists, for example the link from Rushcutters Bay to roads leading north, where there was little time saving. That was until the State Government closed off the roads allowing the free equally convenient alternative to the Cross City Tunnel, as agreed by the Government in the terms of the contract for the Tunnel. The strong public opposition subsequently resulted in partial reversal of road closures.

Costs and Benefits – Lane Cove Tunnel

The cost of the Lane Cove Tunnel cost \$1,100 million dollars. The ongoing cost to motorists is \$2.55 per car trip plus indexation. Although the charge is lower than that of the Cross City Tunnel, the financial viability looks better because the State Government agreed to substantially

reduce lanes on the free alternative by using Epping Road, thereby ensuring about 90,000 car trips per day.

Without the road closures, there were significant time and fuel saving to motorists. Unfortunately, when the road closures are fully implemented in a few months time, the three lanes each way on Epping Road will be replaced by two tunnel lanes, one lane on Epping Road plus one Bus Lane (which did not exist before). Because there will be little difference in the capacity of this already overloaded stretch of road, there will be little benefit in fuel or time saving to motorists. Bus travelers will gain some advantage from the dedicated Bus Lane.

There will be a group of motorists who will be greatly disadvantaged. They are motorists who would never have used the Lane Cove Tunnel because it does not go to their destinations. They will face a very congested single lane on Epping Road. So as with the Cross City Tunnel there is a substantial disadvantaged group of motorists.

Pareto Analysis

Pareto Efficiency, or Pareto Optimality, is an important notion in neoclassical economics with broad applications in game theory, engineering and the social sciences. The term is named after Vilfredo Pareto, an Italian economist who used the concept in his studies of economic efficiency and income distribution.

Given a set of alternative allocations and a set of individuals, a change from one allocation to another that can make at least one individual better off, without making any other individual worse off, is called a Pareto Improvement or Pareto Optimization. An allocation of resources is Pareto Efficient or Pareto Optimal when no further Pareto improvements can be made.

It is commonly accepted that outcomes that are not Pareto Efficient are to be avoided, and therefore Pareto Efficiency is an important criterion for evaluating economic systems and public policies.

The use of road closures to improve the financial benefits to the operators of the Cross City and Lane Cove Tunnels was an essentially Pareto inefficient choice. There is a substantial disadvantage to one group of motorists while others may be better off. Projects which are Pareto inefficient are likely to give rise to public resentment and opposition.

Conclusion: Final Assessment

The Cross City Tunnel offers some real benefits although in a Pareto inefficient way. Its financial viability is still questionable, even with the lower cost base following the failure of the original operator.

The Lane Cove Tunnel will be financially viable with the final road closures. However, these road closures will mean that the only extra capacity will be the dedicated Bus Lane in each direction. It is hard to see how one Bus Lane each way for two kilometres could be worth over a billion dollars.

The road closures are the issue underlying the Pareto inefficiency of the two projects. If the two tunnels had been built with public funds rather than as public-private partnerships, any road closures would have been assessed for public rather than private benefit.

Postscript (April 2008): The number of cars per day using the Lane Cove Tunnel is currently about 60,000, a number well below the original expectation of 110,000. The other 40,000 cars will add to congestion on alternative fee-free routes.