

# Assessing the Performance of BRT Systems: Econometric Modelling and Case Studies

Project LS1

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# Current status of LS1 objectives (2010-2012)

**Obj 1:** Review and evaluate methodological approaches within which to quantify the salient factors that define the dimensions of performance of BRT systems

**Completed**

**Obj 2:** Identify and review existing data sources to identify gaps in data needs, and a data collection strategy to obtain all necessary data

**Completed**

**Obj 3:** to set out the selected method in sufficient detail so as to ensure that it is capable of estimation so as to deliver an agreed set of performance metrics

**Completed**

**Obj 4:** to undertake model estimation of data from secondary sources, including compilation of very detailed data for selected systems as the basis of case studies

**Ongoing but subject to Data Concerns**

**Obj 5:** to use the evidence to define criteria for selecting BRT systems that should be included by invitation as members of a 'BRT cities club'.

**Not Commenced**

# Reminder: Key Elements completed in the 2010 Work Program

- › Identified the influencing dimensions within a framework broadly distinguishing internal and external factors.
  - The external factors emphasised the institutional, cultural, geographic influences including evidence on modal biases present in the population as a whole and key stakeholders.
- › Identified key externalities (noise, congestion, safety, emissions) and how they should be sourced and measured and built into the performance assessment framework.

# Key Elements completed in the 2011 Work Program

- › Commencement of Detailed Case Studies of three Australian Busway Systems (Liverpool-Parramatta and Rouse Hill to Parramatta/Blacktown Transitways in Sydney and the Brisbane Busway System).
- › Working closely with Embarq and PUC to resolve concerns about adequacy (inadequacy) of data items in the initial 71, and later 121, corridor observations
- › Set up data files for econometric modelling and data dictionary for 121 corridors
- › Undertook extensive modelling to understand data better with focus on passenger demand and service frequency (see initial models in later slides)
- › Special emphasis on lack of quality data, especially on key data including
  - Operation costs (annual) and Infrastructure costs
  - Feedkm, peakload, nopass, lonlocc, nostatns, disbwsta, notrunk, frequ, phspeed (defined on next slide)

# Critical Data with Missing observations out of 121

- › Feedkm = Total length of all existing bus feeder routes (km) (46)
- › Peakload = Peak load of the corridor (passengers/h/direction) (74)
- › Nopass = Total passenger corridor demand per day (pass/day) (49)
- › Lonlocc = Longitudinal location of contra-flow bus lanes (109)
- › Nostatns = Number of stations along the corridor (30)
- › Disbwsta = Average distance between stations (metres) (29)
- › Notrunk = Number of trunk lines (17)
- › Frequn = Frequency (bus/h/direction) (49)
- › Phspeed = Average commercial speed during peak hour (km/h) (59)

# Key Elements completed in the 2011 Work Program

- › Due to inadequacy of data, the only models we have been able to estimate that make sense (to date) are given below in next two slides.
- › In addition, we have compiled separate data set of 46 bus rapid transit systems: Hensher, D.A. and Li, Z. Ridership Drivers of Bus Rapid Transit Systems, submitted to *Transportation*, 29 September 2011.
- › From a large number of candidate explanatory variables (quantitative and qualitative), 11 sources of systematic variation are identified by Li and Hensher (2011), which have a statistically significant impact on daily passenger-trip numbers.
- › These sources are:
  - fare, headway, the length of the BRT network, the number of corridors, average distance between stations; whether there is: an integrated network of routes and corridors, modal integration at BRT stations, pre-board fare collection and fare verification, quality control oversight from an independent agency, at-level boarding and alighting, as well as the location of BRT.

# Natural Log of Passengers per Day (52 of 121 obs., a loss of 69 due to missing data)

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Ordinary least squares regression .....
LHS=LPASS Mean = 11.69954
Standard deviation = 1.08862
Number of observs. = 52
Model size Parameters = 5
Degrees of freedom = 47
Residuals Sum of squares = 17.2388
Standard error of e = .60563
Fit R-squared = .71478
Adjusted R-squared = .69050
Model test F[ 4, 47] (prob) = 29.4(.0000)
White heteroscedasticity robust covariance matrix.
Br./Pagan LM Chi-sq [ 4] (prob) = 11.34 (.0230)
Model was estimated on Dec 07, 2011 at 04:06:16 PM

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LPASS	Coefficient	Standard Error	t	Prob.  t >T*	95% Confidence Interval	
Constant	6.62361***	.53279	12.43	.0000	5.57936	7.66786
<b>Natural log of corridor length in both directions (km)</b>						
LCOLENGT	.32038***	.09581	3.34	.0016	.13259	.50816
<b>Number of trunk lines</b>						
NOTRUNK	.00654***	.00185	3.53	.0009	.00291	.01017
<b>Natural log of frequency (buses per hr per direction)</b>						
LFREQUN	.87759***	.09234	9.50	.0000	.69661	1.05857
<b>Preboard fare collection (1,0)</b>						
PREBOARD	.75625***	.22534	3.36	.0016	.31460	1.19791

# Natural Log of Frequency (Buses per hour per direction)

(61 of 121 obs., a loss of 60 due to missing data)

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Ordinary least squares regression .....
LHS=LFREQUN Mean = 4.09419
Standard deviation = 1.16816
Number of observs. = 61
Model size Parameters = 8
Degrees of freedom = 53
Residuals Sum of squares = 26.2172
Standard error of e = .70332
Fit R-squared = .67979
Adjusted R-squared = .63750
Model test F[ 7, 53] (prob) = 16.1(.0000)
White heteroscedasticity robust covariance matrix.
Br./Pagan LM Chi-sq [ 7] (prob) = 5.42 (.6087)
Model was estimated on Dec 07, 2011 at 04:05:37 PM
  
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LFREQUN	Coefficient	Standard Error	t	Prob.  t >T*	95% Confidence Interval	
Constant	2.89196***	.42924	6.74	.0000	2.05067	3.73324
<b>Natural log of population density</b>						
LPOPDEN	.12518***	.03778	3.31	.0017	.05114	.19922
<b>Number of trunk lines</b>						
NOTRUNK	.00799**	.00385	2.08	.0427	.00045	.01554
<b>Fare integration to feeder system (1,0)</b>						
FAREINT	.53814**	.23942	2.25	.0288	.06889	1.00738
<b>Preboard fare collection (1,0)</b>						
PREBOARD	-.62067***	.22760	-2.73	.0086	-1.06676	-.17458
Natural log of maximum fare (\$US)						
LMAXFARE	-3.72607***	.61811	-6.03	.0000	-4.93754	-2.51460
<b>Trunk lines with feeder routes: specific bus lines serving the corridor complemented by bus feeder routes to transfer stations or terminals.</b>						
TRUKFEED	-.64583**	.27117	-2.38	.0209	-1.17731	-.11434
<b>Overtaking lanes at more than half of all stations along the heaviest section of the corridor (1,0)</b>						
OVERLANE	.66133***	.21243	3.11	.0030	.24498	1.07769



- › Data collection with high completion rate on the ‘shallow’ questionnaire for two transitway corridors:
  - Liverpool to Parramatta
  - Rouse Hill to Parramatta/Blacktown
- › Liverpool to Parramatta data provided to Observatory
  - High completion rate but required face to face contact with operator
  - Whilst not part of LT1, modelling of longer term land value uplift using Geographically Weighted Regression following the implementation of the Transitway with BRT is completed and modelling of land value changes using other methodologies is underway
- › Rouse Hill to Parramatta/Blacktown
  - Data collection in final stages of collection before submission to Observatory.
  - Again operator contact required but more difficult as Transitway involves two operators
  - Difficulties in applying a corridor based definition to this Transitway which has trunk and branch structure

- › Data collection in progress for Busways in Brisbane (the most successful BRT in Australia). Hoping for a high (95+%) completion rate
- › Meetings and follow up data collection undertaken with Brisbane Transport, the major operator on the BRT infrastructure
- › Meeting and further work is now being undertaken with Translink, ( who co-ordinate and deliver transport across the Brisbane and SE Queensland conurbation) to capture all the BRT using the infrastructure.
  - Data collection complicated by definitions of corridors as design is predicated on trunk and branch network
    - This makes estimation of 'corridor use' difficult
    - Operators concerned that the trunk and branch network is what has produced the high corridor use and want to ensure that the data is not taken out of context
- › Discussions ongoing with the Department of Transport and Main Roads for their input re: infrastructure costs

- › Hensher, D.A. The relationship between bus contract costs, user perceived service quality and performance assessment, prepared for Thredbo 12, Durban, South Africa, September 2011, and submitted to *International Journal of Sustainable Transportation* special issue, January 12 2011, accepted 28 April 2011.
- › Hensher, D.A. and Li, Z. Ridership Drivers of Bus Rapid Transit Systems, submitted to *Transportation*, 29 September 2011.

- › We see the LS1 activity. begun in 2010. continuing throughout 2012 plus other elements of the objective set using the funding that has already been agreed.
- › Key activities in 2012 (as set out in LS1 Proposal 2010-2012):
  - Continue working with Embarq and PUC in the refinement of baseline data for studying the performance of 121 plus selective BRT systems (at a system level)
  - Continue modelling using data as it comes in, to establish a set of key performance indicators as a means of benchmarking all systems, and developing procedures to meaningfully compare operations given differences in operating environment, and what is and is not under the control of the operator, the regulator and the market.
  - Preparing case studies for two Australian BRT systems, noting that much of the data has been collected through interviews and survey instruments.

- › Contribute to the framework for investigating stakeholder perceptions – going wider than the original ‘user’ satisfaction measures (LT3)
- › Develop guidelines, based on the modelling in LT1, as to the information that is needed in order to draw a proper comparison between BRT and its ‘competitors’ (namely metro and LRT)
- › Note: LRT may be a problem since to date we (ITLS) have had difficulty in sourcing data.
- › But more fundamentally what are we comparing LRT with given limits of BRT data?
  - We suggest that Juan Carlos ask the meeting about this issue and where we might source data from.
  - However, even with LRT data, we may not be able to do a meaningful comparison given quality of BRT data base.

- › **Valuation of service reliability and crowding under risk and uncertainty: neglected drivers of demand for public transport**
- › ARC-DP grant 2012-2014. The reliability of public transport services, and the amount of crowding at stations and also on trains and on buses, have come under strong criticism. This study identifies the role that improved service reliability and reduced crowding play in influencing the switch from car to public transport for the commute.
  - The research will develop a new set of demand-side behavioural specifications of the influence of crowding at stops/stations and in buses/trains that line up with supply side design definitions used in planning
  - We will suggest how travel time reliability (or time variability) and crowding are built into new modal choice models that include BRT as an alternative.
- › We also plan to undertake an SQI survey on the Brisbane Busway system (we have external funding)

- › Tirachini, A. and Hensher, D.A Multimodal transport pricing: first best, second best and extensions to non-motorised transport, *Transport Reviews*, Online 30 November 2011: DOI:10.1080/01441647.2011.635318
- › Li, Z., Tirachini, A. and Hensher, D.A. Embedding Risk Attitudes in a Scheduling Model: Application to the Study of Commuting Departure Time, accepted for presentation at the *4th International Symposium on Transportation Network Reliability*, July 22-23, 2010, at the University of Minnesota, McNamara Center, Minneapolis, to appear in *Transportation Science*, accepted 18 August 2011.
- › Carrigan, A. Hensher, D.A., Hidalgo, D., Mulley, C, and Muñoz, J.C. (2011) The Complexity of BRT Development and Implementation, FUT 10 Years. VREF.
- › Hensher, D.A, and Wong, G. (2012) Different approaches to public transport provision, LTA Journeys, January.

- › Hensher, D.A. and Mulley, C. (drafted) High quality public transport: gaining acceptance of bus rapid transit systems, in *Handbook of Sustainable Travel: People, Society and Transportation Systems*, edited by Garling, T., Ettema, D. and Friman, M., Springer, Berlin.
- › Hensher, D.A., Truong, T.P., Mulley, C. and Ellison, R. Assessing the wider economy impacts of transport infrastructure investment with an illustrative application to the North-West Sydney rail project (full draft completed July 2011) submitted to *Journal of Transport Geography*, October 26 2011.
- › Hensher, D.A., Mulley, C., and Smith, N. A., simplified bus contract payment formula, presented at the 12<sup>th</sup> International Conference on Competition and Ownership of Land Passenger Transport (*Thredbo 12*), Durban, South Africa September 2011. Latest version: 20 March 2011, submitted as 'Towards a simplified performance-linked value for money model as a reference point for bus contract payments' to *Research in Transportation Economics*, September 213, 2011.





# The VreF BRT Team in Durban at Thredbo 12 (Note Dario's Smile)

