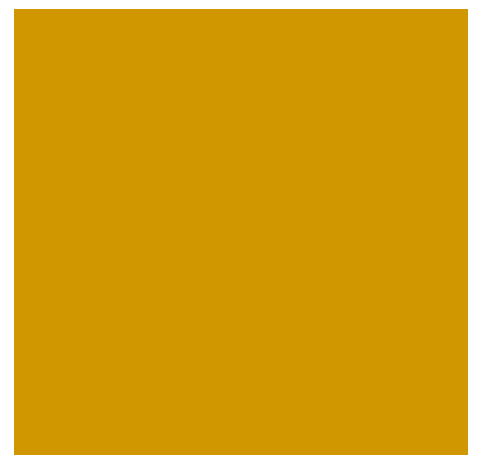
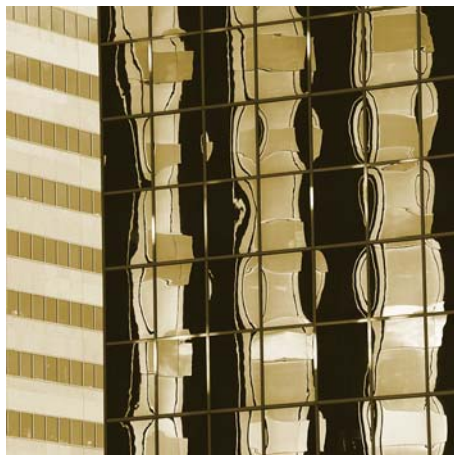


Assessment of Analysys Mason benchmarking Prepared for Telstra

Author: Mike Smart
Date 6 October 2009



About LECG

LECG is a global expert services firm with highly credentialed experts and professional staff with specialist knowledge in regulation, economics, financial and statistical theories and analysis, as well as in-depth knowledge of specific markets and industries. The company's experts provide independent testimony, original authoritative studies and strategic advice to both public and private sector clients including legislative, judicial, regulatory, policy and business decision-makers.

LECG is listed on the NASDAQ Stock Exchange and has approximately 1000 experts and professional staff worldwide. These experts are renowned academics, former senior government officials, experienced industry leaders and seasoned consultants.

SYDNEY

Level 14
68 Pitt Street
GPO Box 220
SYDNEY NSW 2000
Ph: (61 2) 9234 0200
Fax: (61 2) 9234 0201

For information on this report please contact:

Name: Mike Smart
Telephone: 612 9234 0200
Mobile: 61 407 246 646
Email: msmart@lecg.com

Table of Contents

1	Introduction.....	1
2	Summary of opinions	1
3	Comparability of product specifications	5
4	Unaccounted-for national differences	9
5	Sample selection	14
6	Price-cost relationships	17
6.1	Regulatory objectives	18
6.2	Patterns of regulatory error and bias.....	20
7	Treatment of common costs.....	22
	Annexure 1: List of documents reviewed	25
	Annexure 2: Instructions	26
	Annexure 3: Curriculum Vitae.....	27

1 Introduction

1. My name is Michael Smart. I am a Director of economic consulting firm LECG. I have been asked by Telstra to review certain documents and, informed by that review, to prepare a detailed critique of a report entitled “*International benchmarking analysis: Analysis of WLR, LCS, LSS and PSTN OTA*”, 18 August 2009, prepared by Analysys Mason (“the Analysys report”) for the Australian Competition and Consumer Commission (“ACCC”).
2. The ACCC employs the Analysys report and another benchmarking report prepared by Ovum as a cross check for cost estimates derived from the Analysys fixed network services cost model.
3. The list of documents I considered is contained in Annexure 1. My instructions are contained in Annexure 2. My curriculum vitae, including relevant qualifications and experience, is included in Annexure 3.
4. I have read the Federal Court’s practice direction ‘Guidelines for Expert Witnesses in Proceedings in the Federal Court of Australia’ and prepared this report accordingly, making all inquiries I consider to be appropriate, having regard to the instructions from Telstra.

2 Summary of opinions

5. Benchmarking in general, and international price benchmarking for telecommunications services in particular, can perform a useful function in testing the reasonableness of pricing. Before benchmarking results are relied upon, however, certain conditions must be satisfied. The Australian Competition Tribunal set out some preconditions for the acceptance of international benchmarking analysis,¹ including that it must take due account of:

¹ Re Optus Mobile Pty Limited & Optus Networks Pty Limited [2006] ACompT 8 (22 November 2006), @297.

- the regulatory environment within which prices were determined;
 - the state of the relevant markets; and
 - the socio-economic environment in which the benchmarked services were operative.
6. The Tribunal's comments were made in the specific context of prices for mobile call terminating access. In that case, the benchmarked service was reasonably well defined, so there was not really any issue about the comparability of the product offerings that were benchmarked. In the present case, which involves prices for fixed network services of various types, the question of comparability of product offerings is very much a live one. Comparability issues are so serious for LCS as to render the benchmarking on that product virtually meaningless and potentially misleading. There is no product in any of the European jurisdictions that has comparable specifications to the Australian LCS, so Analysys constructed an artificial hybrid service for its LCS benchmarking.
7. The Tribunal's preconditions require an investigation of the regulatory environment, the state of markets, and the socio-economic environment in each of the jurisdictions selected for the benchmark analysis. Sample selection bias is a well-known risk with any benchmarking study. The potential sources of bias mentioned by the Tribunal are:
- differences in regulatory approach between jurisdictions,
 - differences in the level of competition or, conversely, market power held by incumbents between markets, and
 - differences in demographics, geography, and consumer preference between jurisdictions.
8. Each of these factors affects the prices that are compared. It would be ideal if a sample of countries could be selected in which regulatory approach, market competition, and socio-economic environment were approximately the same as those in the target country. Unfortunately, such a sample rarely exists, so it is necessary to make corrections to the benchmarked prices to account for these differences.

9. The Analysys report makes the following corrections to the benchmarked prices before presenting its comparisons:

- Prices are converted to AUD equivalents using ten-year average exchange rates;
- Prices are further converted using a purchasing power parity (“PPP”) adjustment calculated for the 2008 year, to account for purchasing power differences between countries;
- Time-of-day variable prices are converted to a single weighted average price, using the relative hourly call volumes as the weights; and
- Timed local call prices are converted to a flat price using an assumed average call duration.

10. The Analysys report makes only limited adjustments to the prices it compares, despite acknowledging that further adjustments may be important.^{2 3 4} In my opinion, the failure to make these further adjustments introduces a bias that renders the Analysys benchmark comparisons unreliable.

11. The sample countries selected are all Western European nations which exhibit high urban population densities. It is difficult to understand the

² Analysys notes, p. 9, that a range of costing methodologies was employed across the comparator countries, but no adjustment was made for this fact because, “*we do not believe there is a realistic approach to adjust benchmark prices for costing methodologies.*”

³ Analysys notes, p. 10, that population density can affect the cost of deploying national telecoms networks, but no adjustment was made for this fact because, “*although it may be possible to identify simplified cost/volume relationships to allow adjustments for the cost drivers identified above, it is beyond the scope of this report to undertake such a detailed examination.*”

⁴ Analysys notes, p. 11, that network usage, and specifically the utilisation over time of each asset, will affect the cost of service, but no adjustment was made for this fact because, “*within this report we do not attempt to scale benchmark prices for cost/volume relationships.*”

omission from this sample of other jurisdictions that are frequently included in such benchmarking exercises, notably Canada, New Zealand and individual States within the USA. These excluded jurisdictions all have well-developed regulatory systems and transparent prices. Significantly, they have urban population densities that are much closer to Australian densities than any of the European countries that were considered.

12. In my opinion, this sample selection by Analysys has likely introduced a bias toward lower cost fixed network services. A primary determinant of fixed network service costs is the length of trench, conduit and copper local loop needed to serve each end-user. All else being equal, these lengths will be longer, hence costs will be higher, the lower the urban population density. This bias towards lower-cost, higher density comparators makes the Australian prices appear artificially high because relevant Australian cost penalties are not taken into account.
13. The Analysys report does not explicitly state how its results are intended to be used, nor does the ACCC Draft Pricing Principles document. From the context, however, it is clear that the price benchmarks will be used to validate costs estimated by the Analysys fixed network services cost model, which was developed for the ACCC.
14. I noted earlier that price benchmarking is often useful in establishing the reasonableness of prices. Using price benchmarking to establish the reasonableness of costs, however, introduces some methodological complexities that Analysys has not adequately dealt with, in my view. The difficulty, at its most basic level, is that prices are not equal to costs. Before prices can be compared with costs, it is necessary to account for all of the factors that make prices and costs diverge. These include, but are not restricted to the following:
 - Market power;
 - Regulatory objectives;
 - Regulatory errors and biases; and
 - Common cost allocations.

15. These factors do differ between the jurisdictions considered in the Analysys report, further complicating the task of validating the Analysys cost model. In my view, unless it is possible to make meaningful corrections for these factors, the Analysys price benchmarking results should not be used to validate a fixed services cost model.
16. The remainder of this report provides the reasons for these opinions.

3 Comparability of product specifications

17. Little insight into the reasonableness of prices is afforded by benchmarking studies that compare different products. A raw comparison of the price of a Mercedes in Germany with that of a Holden in Australia would be unenlightening because differences in product specifications between the two car types would confound the analysis of national differences. The same risk applies to benchmarking of telecommunications services.
18. It is my opinion that, broadly speaking, the product specifications for the following benchmarked services are similar across jurisdictions: LSS, and (for those jurisdictions that offer the mandated service) WLR.
19. However, the Analysys report states (p. 16):
- “There is no directly comparable wholesale product [to LCS] in the selected EEA countries. We have therefore constructed two ‘equivalent products’ by adding the origination and termination charges for a local leg or a single-tandem leg to form a full route per-minute price, and then assumed an average call duration to calculate the price on a per-call basis.”*
20. Analysys has compared LCS prices with prices for an amalgam of PSTN Originating Access and PSTN Terminating Access that have further been manipulated through the application of an arbitrary assumed call duration. As in the Mercedes-Holden price comparison, the confounding factors render the resulting national comparisons meaningless.

21. The principal confounding factors in this case are that the Australian LCS is untimed (but the comparator products are timed), that the originating and terminating legs of the comparator services must be connected at a point of interconnection (but the Australian LCS follows a different path through the network), and that the comparator services are generally pre-selectable (but the Australian LCS is not).
22. In my view, it would have been more appropriate to acknowledge that no suitable international benchmarks were available for LCS and refrain from presenting the data contained in Figures 5.1 and 5.2, which are highly misleading. Those tables purport to show that Australian LCS prices are significantly higher, in PPP adjusted terms, than prices for comparable products in any of the other jurisdictions, but in fact there are no comparable products in any of these jurisdictions.
23. The LCS comparison raises two further points of concern. First, LCS is the only service considered in which the Australian price is unambiguously higher than that in all other jurisdictions.⁵ Presenting this flawed LCS comparison leaves the reader of the Analysys report with a spurious impression that Australian prices for this service are exceptionally high.
24. Second, the LCS price employed in the Analysys report is not the price that Telstra actually charges for the local carriage service. Rather, it is the ACCC-determined maximum price, which is not observed in the marketplace. I am instructed that the actual LCS yields to Telstra are significantly lower than the LCS price used by Analysys.
25. Nothing would be lost by the omission of the LCS section, as the PSTN OTA comparisons are presented separately in Figures 7.1 and 7.2. Those comparisons are more meaningful as they are based on relatively comparable products.

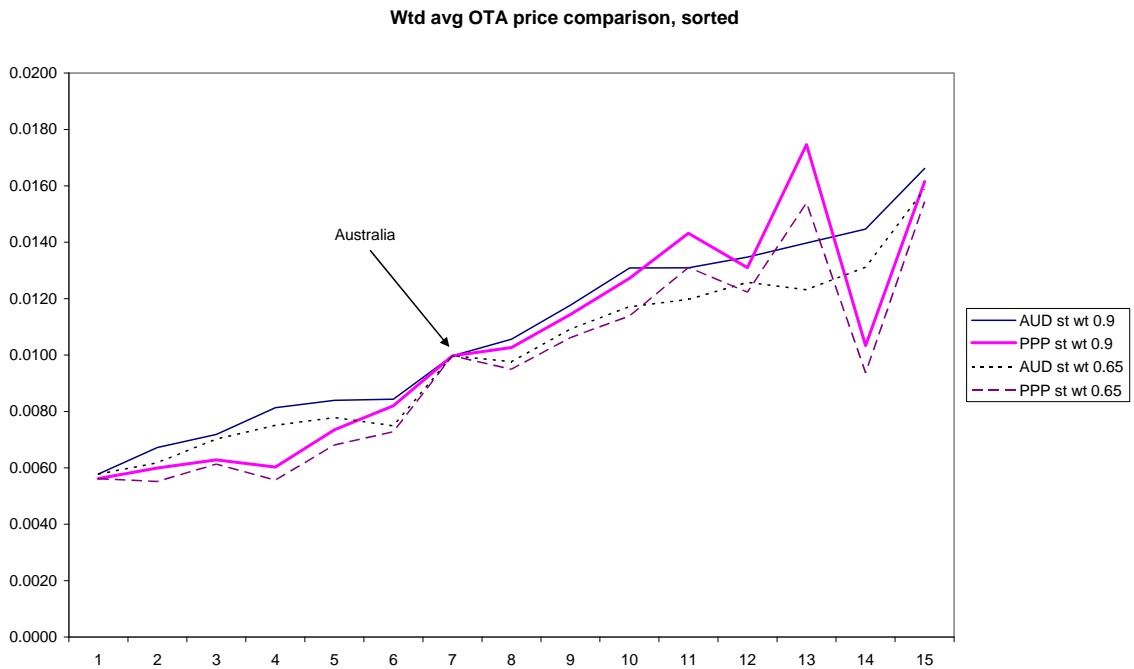
⁵ Recognising that the PPP-adjusted price for single-tandem origination/termination in Greece was slightly higher than the Australian LCS price.

26. A final comparability issue arises, though, in connection with PSTN OTA prices. The Australian OTA prices do not distinguish between local and single transit-switched calls, whereas such a distinction does exist in each of the other jurisdictions considered. As a result, the Australian PSTN OTA price appears to be near the high end of the range of the European countries for local-switched calls, but near the low end of the range for single transit-switched calls.
27. This difference in product specification (i.e., geographically averaged prices versus switch-type-differentiated prices) clouds the international comparison of prices for PSTN OTA. The reader is left in some confusion as to whether the Australian price is relatively high or relatively low.
28. In order to perceive the OTA price comparison in a clearer light I inquired what proportions of Australian OTA services were provided through single tandem versus local switches then applied those proportions to determine a weighted average of comparator country OTA prices. I am instructed that the Analysys cost model assumes that 90% of Australian OTA services are single-tandem switched and the remaining 10% are locally switched. I am also instructed that [TC1 c-i-c commences] [redacted] [TC1 c-i-c ends] of Telstra's actual OTA services are single-tandem switched and [TC1 c-i-c commences] [redacted] [TC1 c-i-c ends] are locally switched.
29. If the 90%/10% weights implicit in the Analysys cost model are used, the 1 cent per minute Australian headline OTA price is below both the median and the mean of the comparator set, whether prices are expressed in AUD or PPP terms.⁶
30. If the [TC1 c-i-c commences] [redacted] [TC1 c-i-c ends] weights implicit in current actual Telstra traffic patterns are used, the 1 cent per minute Australian headline OTA price is equal to the mean, which is also

⁶ For France there was no single-tandem switched OTA price, so the weighted average was simply set equal to the local-switched OTA price for that country.

equal to the median when prices are expressed in AUD terms. When prices are expressed in PPP terms, the Australian headline OTA price is slightly higher than the median and mean (by approximately one seventh of a standard deviation).

31. These four weighted average price sets are presented in the chart below, in which countries were sorted in order of increasing AUD prices when single transit weights of 0.9 were used. Australia's rank in each set is shown.



32. This weighted averaging procedure helps, in my view, to make sense of the disparate tables presented in the Analysys report. On this basis—comparison of products with like specifications—it is clear that the 1 cent per minute Australian headline OTA price is close to the median and mean values of the comparator sets whether prices are expressed in AUD or PPP terms, and whether the averaging weights are 90/10 or [TC1 c-i-c commences ██████████ [TC1 c-i-c ends].

33. In summary, no weight should be given to the Analysys report's benchmarking of LCS prices because the international benchmarks reflect artificially constructed products that are not, in fact, comparable to the Australian declared LCS. The PSTN OTA price comparisons should be viewed with the understanding that the Australian declared service is charged on a different basis than the PSTN OTA prices in the other jurisdictions (geographically averaged price versus switch-type-differentiated price). When weighted averages of the European OTA prices are used to overcome specification differences, the 1 cent per minute Australian headline OTA price is close to the mean and median values.

4 Unaccounted-for national differences

34. Given the ACCC's intended use of the Analysys benchmarking to validate the Analysys cost model, it is important to consider whether factors that might lead to price differences between countries have been accounted for adequately in the benchmarking. The factors identified by Analysys in comparing benchmarks were as follows (s3.2):

- a) Currency exchange method
- b) Input costs
- c) Regulatory costing methodology
- d) Regulatory cost of capital
- e) Geography and demographics
- f) Network issues
- g) Service comparison.

35. In my opinion some, but not all of these factors were adequately taken into account by the Analysys report. I discuss each in turn below.

Currency

36. I have reviewed the currency conversion calculations performed by Analysys. A ten-year average of exchange rates between 2000 and 2009 was used to convert prices in each country's local currency units to Australian dollars. Exchange rates tend to be volatile, so the choice of measurement periods can sometimes lead to biases in the results. However, in my view, the use of a long-term average exchange rate is reasonable. The relative prices cited by Analysys are not particularly sensitive to differences between these ten-year average exchange rates and, say, the annually average exchange rates for 2008 or 2009.

Input costs

37. The Analysys report employs a purchasing power parity (PPP) adjustment to the currency exchange rates and claims that it can be considered to reflect the impact of local land and labour costs.⁷ It is fairly common to use PPP adjustments in benchmarking studies. The PPP conversion factor is the number of units of a country's currency required to buy the same standard bundle of goods and services in the domestic market as a U.S. dollar would buy in the United States. It is as though it is this standard bundle of goods and services that is exchanged, rather than currency. The standard bundle is a broad cross-section of goods and services across the entire economy.

38. The inputs required to produce fixed network telecommunications services represent a very different bundle of goods and services than the bundle upon which the PPP adjustment is predicated. For example, neither food nor residential housing is an input to telecommunications services.

39. In the circumstances, it is not valid to assume that the PPP adjustment adequately captures all of the relevant input cost differences between jurisdictions, even in an approximate way.

⁷ Analysys report, pp. 7-8.

40. No other input cost differences are incorporated in the Analysys price comparisons. Analysys does acknowledge the potential importance of some other input cost differences, such as in network purchasing power of the incumbent operators in each country, but makes no adjustment for them, citing the inadequacy of public data.⁸

Regulatory costing methodology

41. There are important differences between jurisdictions in regulatory objectives and costing methodologies, none of which are taken into account in the Analysys price comparisons. These are discussed in more detail in section 6 below.

Regulatory cost of capital

42. The asset intensive nature of telecommunications networks makes the weighted average cost of capital highly influential in regulatory pricing outcomes. In this connection, Analysys states:

“For prices determined through the use of a cost model, a cost of capital will have been used which may vary between countries. ... However, we would expect that the ACCC’s cost of capital range corresponds to the (real-terms) values adopted in recent cost models developed in European countries and other developed nations, and so explicit adjustment for this effect has not been implemented in this report.”⁹

43. Analysis does not provide explicit substantiation of this statement. The claim that the WACC values employed by European regulators are essentially the same as those employed by the ACCC is contradicted by a November 2007 report by the Commission for Communications Regulation.¹⁰ That report presents a cross country analysis of nominal

⁸ Ibid., p. 8.

⁹ Analysys report, p. 10.

¹⁰ Review of Eircom’s Cost of Capital, ComReg 07/88, November 2007, pp. 32-33.

pre-tax WACC values established by European telecommunications regulators from October 2002 to June 2007. In June 2007, the lowest WACC reported was for the Netherlands (7.6%) and the highest was for Portugal (13.32%). Clearly, these dispersed WACC values cannot all be similar to the ACCC's preferred WACC value for Australian telecommunications prices.

44. I note that the ACCC's August 2009 Draft pricing principles document bases its indicative prices on a nominal pre-tax WACC of 10.77%,¹¹ which is higher than seven of the comparator countries, lower than three, and approximately equal to three.
45. Further doubt is cast over the Analysys claim by a December 2008 report¹² which states that the long-term equity premium (a key driver of the WACC) was higher in Australia than in any of 16 comparator countries, including most of those in the Analysys report. The range in this parameter was from below 3% (Belgium and Denmark) to above 6% (Australia).
46. The cost of capital, which is highly influential on fixed network costs, is higher in Australia than for most of the comparator countries—in some cases substantially. Analysys has made no adjustment for this fact, incorrectly stating that these differences were not material.

Geography and demographics

47. Under the heading "geography and demographics" (s3.2.3) the Analysys report notes that population density and variations thereof can affect the cost of deploying national telecoms networks. Figure 3.2 of the Analysys report highlights the fact that Australia has the lowest population density by far of any of the countries selected. Among the European

¹¹ "Draft pricing principles and indicative prices for LCS, WLR, PSTN OTA, ULLS, LSS," ACCC, August 2009, p. 72.

¹² "Commentary on the use of international benchmarking in setting interconnection rates", Ingenious Consulting Network, December 2008, pp. 7-10.

comparators, Norway had the lowest population density: 15.5 people per square km. Nine of the fourteen European countries had population densities above 100 people per square km. Australia's density is 2.8 people per square km. Nevertheless, Analysys does not make any adjustment to its benchmarks to reflect this point.

48. While the raw national population density is not necessarily the most appropriate measure to use in adjusting costs for differences in patterns of settlement, it is unsatisfactory that Analysys should emphasise Australia's uniqueness among the comparison set along this dimension and then fail to account for it.
49. In section 5 below, I consider the question of sample selection bias in more detail and suggest alternative density measures that may correlate better with fixed network costs.

Network issues

50. Analysys notes its expectation that benchmark prices will be based on similar network technologies. Given the comparator countries selected, that expectation appears reasonable in my view.
51. Analysys recognises that network usage and asset utilisation will affect the cost of service, however no attempt is made in the Analysys report to scale benchmark prices for cost/volume relationships.
52. Given variations in population density between countries, universal service obligations of incumbent operators are acknowledged by Analysys to impact the cost of the access network, yet no adjustment is made in the Analysys report for this factor (s3.2.4).
53. Analysys' treatment of national differences in network issues is inadequate, in my view. Important factors, that will affect relative prices, were not taken into account.

Service comparison

54. I considered the comparability of product specifications in section 3 above.

5 Sample selection

55. The comparator countries selected by Analysys were: Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Spain, Sweden, and the United Kingdom. All are Western European nations with transparent prices derived from a regulatory process that resembles the process undertaken by the ACCC in Australia.

56. Australia represents an extreme outlier within this comparison set on the measure of population density. The Analysys report notes this fact, but does not take account of it in any quantitative comparisons. The decision not to include such jurisdictions as Canada, New Zealand, and individual states of the USA is unexpected, in my view. These jurisdictions appear to meet the other selection criteria, while being a much closer match on cost-related factors such as population density. In fact, other telecommunications pricing benchmark studies do include them.¹³

57. Total national population densities may not be an ideal explanatory variable for fixed network costs, as large uninhabited spaces (like the Gibson Desert, Great Sandy Desert, and the Simpson Desert) tend to reduce overall densities without contributing much to overall costs. Urban population density is likely to be better correlated to fixed network costs because it will exhibit a strong inverse relationship to the average length of trench, conduit and local loop wiring needed to serve a given urban population.

58. Urban population density comparisons are available from Demographia World Urban Areas (World Agglomerations) Population & Density, August 2008.¹⁴ An excerpt of Table 5 from that report is reproduced in

¹³ For example, “*International Benchmarking Report: a comparative review of interconnection pricing*,” New Zealand Commerce Commission, September 2002.

¹⁴ Downloadable from: <http://www.demographia.com/db-worldua2015.pdf>

Table 1 below. It presents comparative urban densities for several world regions based on cities with a threshold population of 500,000 inhabitants. The second-last column shows urban population densities normalised to that of the United States.

Table 1. Excerpt of Demographia Table 5

GEOGRAPHICAL SUMMARY: ALL LISTED URBAN AREAS
Threshold Population 500,000

Geography	Cases	Population (Millions)	Average Population per Square Mile of Urban Area	Average Population per Square Kilometer of Urban Areas	Density Compared to United States Urban Density	Density Compared to Hong Kong Urban Density
HIGH INCOME WORLD						
Western Europe	67	112.1	8,200	3,150	2.93	0.108
Western Europe: Outside UK	57	93	7,700	3,000	2.75	0.101
Western Europe: UK	10	19.1	10,600	4,100	3.79	0.139
United States	65	142.1	2,800	1,100	1	0.037
Canada	8	15	4,100	1,600	1.46	0.054
Western Hemisphere except Canada & US (†)	1	2.2	2,500	950	0.89	0.033
Australia	5	11	3,700	1,450	1.32	0.049
New Zealand	1	1.1	5,500	2,100	1.96	0.072
Japan	23	79.1	10,900	4,200	3.89	0.143
China (Hong Kong & Macao)	2	7	68,300	26,350	24.39	0.896
China: Taiwan	6	14.9	17,900	6,900	6.39	0.235
Asia: Outside China & Japan	16	39.2	18,100	7,000	6.46	0.238
Total/Average	194	423.7	8,100	3,150	2.89	0.106

59. Australia's urban population density, based on Table 1, is 32% higher than that of the United States, and slightly lower than that of Canada. Australia's urban density is less than half that of Western Europe, and approximately one third that of the UK. The sample used for that table included only Sydney, Melbourne, Brisbane, Adelaide, and Perth.

60. Many of the band 2 ESAs in Australia lie outside these capital cities, so it is instructive to repeat the urban density comparison with the population threshold removed. Table 2 below, presents an excerpt of Table 6 from the Demographia report, which presents the same information as Table 5, but widens the sample of urban areas by removing the population threshold.

Table 2. Excerpt of Demographia Table 6

GEOGRAPHICAL SUMMARY: ALL LISTED URBAN AREAS
Threshold Population 0

Geography	Cases	Population (Millions)	Average Population per Square Mile of Urban Area	Average Population per Square Kilometer of Urban Areas	Density Compared to United States Urban Density	Density Compared to Hong Kong Urban Density
HIGH INCOME WORLD						
Western Europe	190	138.7	7,400	2,850	3.22	0.097
Western Europe: Outside UK	123	107.9	5,900	2,300	2.57	0.077
Western Europe: UK	67	30.8	10,200	3,950	4.43	0.134
United States	245	179.2	2,300	900	1	0.03
Canada	48	20.2	2,700	1,050	1.17	0.035
Western Hemisphere except Canada & US (†)	9	3.4	2,700	1,050	1.17	0.035
Australia	61	15	2,100	800	0.91	0.028
New Zealand	9	2.3	4,500	1,750	1.96	0.059
Japan	35	83.5	10,400	4,000	4.52	0.136
China (Hong Kong & Macao)	2	7	68,300	26,350	29.7	0.896
China: Taiwan	6	14.9	17,900	6,900	7.78	0.235
Asia: Outside China & Japan	17	39.3	17,100	6,600	7.43	0.224
Total/Average	622	503.5	5,200	2,000	2.26	0.068

61. Australia's urban population density, based on Table 2, is 9% lower than that of the United States, and 26% lower than that of Canada.

Australia's urban density is less than one third that of Western Europe, and approximately one fifth that of the UK. The sample used for Australia in this table comprises 61 urban areas that include, in addition to the capital cities, 56 regional centres.

62. These urban density comparisons highlight the likely bias introduced by the decision of Analysys to exclude Canada, the United States, and New Zealand from the comparison set. With urban densities that are a factor of two or more higher than Australia, it is highly probable that the chosen Western European comparators have significantly lower fixed network costs per connection than Australia.

63. Somewhat more concretely, the lower urban population densities in Australia correspond to higher percentages of detached housing stock. Among the countries for which relevant data are available, including Denmark, Finland, Netherlands, Norway, Sweden, UK and USA, Australia has the highest percentage of detached housing. An April

2009 Telstra submission states, “*All things being equal, the unit cost to provide fixed telecommunications services to an area dominated by apartment blocks or shared buildings is lower than that for areas dominated by detached housing.*”¹⁵ I agree with that assessment.

64. In summary, data on both urban population densities and detached housing stock indicate that the sample selected by Analysys is likely to be biased toward jurisdictions that have lower fixed network costs per connection. This bias makes the Australian prices appear artificially high because relevant Australian cost penalties are not taken into account.

6 Price-cost relationships

65. The ACCC August 2009 report¹⁶ lists as the first of its broad pricing principles that “*the access price should be based on the cost of providing the service.*”¹⁷ The Analysys fixed network services cost model is used by the ACCC as the primary tool for estimating TSLRIC+ cost levels for each of the fixed network services. The indicative prices are based on these cost levels.¹⁸

66. International benchmarking, consisting of the Analysys report and the Ovum Report, is used as a cross check for model estimates.¹⁹ The international benchmarking presented in the Analysys report consists of price comparisons for a range of European countries for WLR, LSS, PSTN OTA, and LCS. The countries chosen for the Analysys report

¹⁵ “*Telstra’s Ordinary Access Undertaking for the Unconditioned Local Loop Service: Response to Ovum Advisory Notes,*” Telstra, 8 April 2009, pp. 15-16.

¹⁶ “*Draft pricing principles and indicative prices for LCS, WLR, PSTN OTA, ULLS, LSS,*” ACCC, August 2009.

¹⁷ Ibid., p. 4.

¹⁸ Ibid., pp. 8-10.

¹⁹ Ibid., p. 12.

were selected, in part, because they “*have a well developed approach to regulation of the considered services, and cost-oriented prices.*”²⁰

67. The ACCC compares modelled costs to price benchmarks. Implicit in this procedure is an unstated assumption that the price benchmarks are closely aligned with costs that are measured in a standard way. However, that assumption is not valid, in my opinion, for the following reasons. First, regulatory objectives differ between jurisdictions, and often between services within a single jurisdiction. The price-cost relationship depends on the objective and, reflecting that, the chosen regulatory price methodology. Second, regulatory decision-making is affected by errors and biases in some cases. It is conventional to assume that regulators are unbiased decision-makers and that regulatory errors are randomly distributed about a mean value that represents the theoretically ideal price. However, when robust econometric studies reveal systematic patterns of bias across regulatory jurisdictions, those facts should not be overlooked when benchmarking affected regulatory prices.

6.1 Regulatory objectives

68. The objectives of different regulators differ subtly, and the choice of price-setting methodology reflects those objectives. It is a common theme that, in order to prevent an incumbent operator earning monopoly rents, prices should be set to permit zero economic profit. This objective finds its expression in cost of service regulation, including revenue caps and TSLRIC+ methodologies. An alternative objective is to incent regulated firms to vigorously reduce costs and prices. This objective finds its expression in price caps, RPI-X, and other high-powered incentive methodologies. A further objective is to protect entrant firms from the misuse of market power by the incumbent. This objective finds its expression in efficient component pricing-type rules, including RMAC methodologies.

²⁰ Analysys report, pp. 3-4.

69. It is only under cost of service methodologies (and then only when the regulator has reasonably complete, accurate information) that regulated prices will closely approximate prices. Under RPI-X and RMAC methodologies, prices may diverge significantly from costs.
70. Regulators in the benchmarked countries employ different cost methodologies to set prices. Figure 3.6 in the Analysys report tabulates the costing methodologies in use for the various fixed network services across the sampled countries. The salient feature of that table is the variety of different price methodologies used for each service. While the prices may be “cost-oriented”, they each reflect different estimation methods.
71. The Analysys report does not make any adjustment for these methodological differences. Many of these European cost methodologies are different to the methodologies the ACCC proposes to use. In the circumstances, these benchmark comparisons are flawed.
72. One striking example is the comparison made between LSS prices, which range from AUD 3.53 to 15.58/month (see Fig 6.1, last column). This wide range of values is partly explained by the fact that in some countries the LSS price includes an allocation of line rental costs and in others it does not.
73. The Australian comparison price presented in Figure 6.1 lies near the bottom of the range. As noted in the Analysys report (p. 20), indicative LSS prices for Australia do not include any allocation of the line costs, which remain with the voice access service.
74. Consequently, in Australia the line costs must be recovered fully from the voice access services WLR, LCS and PSTN OTA, whereas these line costs are recovered partly from LSS in many of the EU comparator countries. In these comparator countries, the prices for WLR, LCS and PSTN OTA will therefore be lower than they would have been had the Australian LSS costing methodology been consistently applied across all the countries.
75. Because the different regulators in the Analysys sample use different price methodologies, it is invalid to assume, as Analysys implicitly does,

that the benchmark prices are good proxies for costs. In fact, the benchmark prices do not even exhibit a consistent relationship to costs across countries. This fact alone renders the enterprise of validating a cost model with the given set of unadjusted benchmark prices untenable. As I note below, however, there are further reasons to doubt the appropriateness of the price-cost comparisons that Analysys makes.

6.2 Patterns of regulatory error and bias

76. I have just shown that regulators do not always intend to set prices equal to costs. Even if that was their intention, the possibility of error and bias affects the comparisons that Analysys and the ACCC seek to make. Commonly the notion of regulatory bias is dismissed out of hand on the grounds that regulators are more neutral than the parties that they regulate. The present situation requires a more careful statistical examination of the possibility of regulatory bias. To the extent that such bias did exist and differed between jurisdictions it would affect the results of the benchmarking study.

77. There is some peer-reviewed econometric analysis of this question available in the recent literature on telecommunications pricing. Factors other than cost have been shown to be statistically significant in regulatory pricing outcomes. Figueiredo and Edwards (2007)²¹ regress Zone 1 UNE Loop Prices (US equivalent to ULLS) for all 50 of the United States against a number of explanatory variables. After adjusting for cost differences, three variables were found to have an influence on prices that was statistically significant at the 1% level:

- Whether the form of regulation was price cap (lower prices) or rate of return regulation (higher prices);

²¹ De Figueiredo, R.J.P. and G.A. Edwards, “Does Private Money Buy Public Policy? Campaign Contributions and Regulatory Outcomes in Telecommunications,” *Journal of Economics & Management Strategy*, Vol. 16, No. 3, pp. 547-576, Fall 2007.

- Whether the incumbent copper loop provider was vertically integrated into long-distance services (lower prices); and
- The percentage of campaign contributions made by telecommunications entrants to candidates for the state legislature (lower prices where entrants make higher contributions).

78. The authors use instrumental variables to confirm the direction of causality from campaign contributions to regulatory price outcomes, and establish the extreme unlikelihood that omitted variable bias could explain away the entire estimated effect of campaign contributions on prices.

79. Edwards and Waverman (2006)²² regress local telecommunications interconnect rates for a sample of 15 EU member states that includes all of the countries in the Analysys report's sample apart from Norway against a number of explanatory variables. Apart from cost-related differences, the authors found that public ownership of the incumbent telecommunications carrier had a large positive impact on prices that was statistically significant at the 1% level. The degree of independence of the national regulatory authority from the executive government of the State exerted a downward influence on prices that was statistically significant at the 5% level.

80. In my opinion, the European regulated prices cannot validly be used to benchmark an Australian TSLRIC+ cost model. The prices represent an inhomogeneous mixture of values derived from inconsistent methodologies. Further, the relationship between EU regulated telecommunications access prices and the underlying costs is likely to vary between countries, depending on such issues as whether the form of regulation is price cap or rate of return, the extent of state ownership of the incumbent, and the degree of regulatory independence from

²² Edwards, G. and L. Waverman, "The Effects of Public Ownership and Regulatory Independence on Regulatory Outcomes: A Study of Interconnect Rates in EU Telecommunications," *Journal of Regulatory Economics*; 29:1 23-67, 2006.

executive government. No adjustment has been made in the Analysys report for any of these factors.

7 Treatment of common costs

81. A final, and fundamental difficulty in matching prices with costs arises when several different services are provided by the same asset base. The costs of that asset base are common to the services. Different regulators allocate these common costs differently among the services. Usually there is no single “correct” allocation. Instead an allocation decision must be made that is inherently arbitrary. These arbitrary cost allocation decisions impede the comparison of prices between jurisdictions in which the allocations have been done differently.
82. Fixed network services provide a case in point. The Analysys report compares the prices charged for each of the following services:
- a) Wholesale line rental;
 - b) Line sharing service;
 - c) Local carriage service involving only local switching;
 - d) Local carriage service involving single tandem switching;
 - e) Originating/Terminating access involving local switching; and
 - f) Originating/Terminating access involving single tandem switching.
83. Each of these services makes use of the local loop between an end-user’s premises to a potential point of interconnection on the end-user side of the customer access module. The cost of this local loop is common to all of these services as well as others, including ULLS.
84. With the exception of wholesale line rental and the line sharing service, each of these services makes use of the remote switching stage and/or the local access switch closest to the end-user’s premises. The cost of the RSS and/or LAS is common to services c), d), e), f) and others.

85. Services d) and f) make use of tandem switching within the Inter-Exchange Network. The cost of tandem switching is common to these services and others.
86. These facts mean that the cost of none of these six fixed network services is separable from the costs of the others. A cost-reflective price for any of these services necessarily involves an allocation of common costs (local loop, local switching, tandem switching) across some or all of these services. As a rule, such common cost allocations are arbitrary.
87. The individual service price comparisons made by Analysys will be affected by the common cost allocation decisions made by each regulator. There is evidence that different regulators do in fact allocate the common costs differently among these services. For example, the Analysys report notes that the LSS prices in some jurisdictions include an allocation of line rental costs, whereas in other jurisdictions they do not. Figure 6.1 shows that the average basic monthly LSS rental prices among countries that do not include an allocation of line rental costs are lower than the overall average.
88. More generally, two countries with identical costs but different rules for allocating common costs will have different prices for each of the services. One country will have lower prices for some services and the other country will have lower prices for the other services. Comparing the countries at the level of individual services will reveal nothing useful about the relative cost levels. A meaningful comparison would need to take account of prices for a bundle of services grouped around the common cost elements.
89. Analysys has failed to consider this common cost issue. Its single-service price benchmarking reveals more about each regulator's cost allocation rules, which are essentially arbitrary administrative decisions, than it does about cost relativities between jurisdictions. The difficulty is evident from the fact that the national price rankings are different for each of the six services considered.
90. Expressing the prices in AUD units, LCS prices in the Netherlands were equal to the median value, but WLR and OTA prices were above the

median. WLR and locally-switched OTA prices for Greece were equal to the median value, but LCS and single tandem switched OTA prices were above the median. In France, LSS prices were equal to the median, but LCS and OTA prices were below the median, and WLR prices were above the median.

91. In my opinion, one consequence of these facts is that sample averages or medians are not reliable benchmarks with which to test a cost model. Each median value is taken from a different country. It is not valid to infer that a single country could charge prices equal to (or near) the median value for each service and still recover its costs overall.
92. Unless a cost model is tested with reference to an internally consistent bundle of service prices, such as the prices offered simultaneously in a single jurisdiction, the testing procedure is invalid.

Annexure 1: List of documents reviewed

- Analysys Mason, Report for the Australian Competition and Consumer Commission, “*International benchmarking analysis: analysis of WLR, LCS, LSS and PSTN OTA*,” 18 August 2009.
- Analysys Mason spreadsheet containing background data
<http://www.accc.gov.au/content/index.phtml/itemId/894157>
- ACCC, “*Draft pricing principles and indicative prices for LCS, WLR, PSTN OTA, ULLS, LSS*,” August 2009.
- De Figueiredo, R.J.P. and G.A. Edwards, “*Does Private Money Buy Public Policy? Campaign Contributions and Regulatory Outcomes in Telecommunications*,” *Journal of Economics & Management Strategy*, Vol. 16, No. 3, pp. 547-576, Fall 2007.
- Demographia World Urban Areas (World Agglomerations) Population & Density, August 2008. <http://www.demographia.com/db-worldua2015.pdf>
- Edwards, G. and L. Waverman, “*The Effects of Public Ownership and Regulatory Independence on Regulatory Outcomes: A Study of Interconnect Rates in EU Telecommunications*,” *Journal of Regulatory Economics*; 29:1 23-67, 2006.
- Ingenious consulting network, “*Commentary on the use of international benchmarking in setting interconnection rates*”, December 2008.
- Re Optus Mobile Pty Limited & Optus Networks Pty Limited [2006] ACompT 8 (22 November 2006).
- Review of Eircom’s Cost of Capital, ComReg 07/88, November 2007.
- Telstra, “*Telstra’s Ordinary Access Undertaking for the Unconditioned Local Loop Service: Response to Ovum Advisory Notes—public version*”, 8 April 2009.

Annexure 2: Instructions

I have been asked to undertake the following:

1. Review and critically evaluate the international benchmarking analysis undertaken by Analysys Mason (Ref 14806-203) for the ACCC and used by the ACCC to validate outputs from its cost model as well as to support the ACCC's indicative pricing for the following declared services: LCS, WLR, LSS and PSTN OTA.
2. Comment on the appropriateness and validity of the methodology adopted by Analysys Mason in undertaking their benchmarking, including the extent to which cost factors have been adequately addressed or reflected by Analysys Mason in their results.
3. Given 1. and 2., comment on the reliability and appropriateness of the Analysys Mason results for validating outputs from the Analysys cost model and/or for providing a price range in support of the ACCC's draft indicative prices.

Annexure 3: Curriculum Vitae

Mike Smart, Consulting Director, LECG

LECG Ltd
Level 14, 68 Pitt Street
GPO Box 220
Sydney NSW 2001
Australia
Phone: +61 (0) 2 9234 0210
Mobile: +61 (0) 4 0724 6646
Email: msmart@lecg.com

BIO/SUMMARY

Mike Smart, based in Sydney, works primarily in the fields of competition, pricing and business strategy, focusing on infrastructure and other networked businesses. He applies empirical economics to valuation, costing, corporate strategy, regulatory and competition policy issues. He has advised the Australian industry leaders in rail, telecommunications, logistics, gas, mining, electricity and aviation, among other private and public sector organisations. Mike's advice includes the preparation of reports, submissions, board papers, financial models, and testimony. Mike has given expert evidence in the Federal Court of Australia and the Australian Competition Tribunal.

Prior to joining LECG in March 2008, Mike was a Vice President of CRA International and an executive director of the Network Economics Consulting Group (NECG). Before joining NECG, Mike was the Manager of Corporate Strategy for the Rail Access Corporation of NSW during its corporatisation and first three years of operation. That role encompassed commercial and regulatory challenges including development of an access pricing strategy and negotiating access contracts, as well as a significant contribution to the development of the NSW Rail Access Regime.

Prior to that role, Mike advised the Public Accounts Committee of the NSW Parliament, worked as engineering manager in a data acquisition and machine vision firm, and consulted, in California, to the airline and electric power industries.

Mike is a member of the Trade Practices Committee of the Business Law Section of the Law Council of Australia.

EDUCATION

BA Magna Cum Laude (Astrophysics), Harvard University 1979

PRESENT POSITION

LECG Limited, Consulting Director, 2008

PROFESSIONAL EXPERIENCE

Litigation

- Briefed counsel for the Australian Pipeline Trust in a High Court challenge to the ACCC's Final Decision on the access arrangements for the Moomba – Sydney Pipeline. Decision handed down Sept. 2007.
- Authored an expert report in the matter of an application by East Australian Pipeline Limited [2005] ACompT 1, heard by the Australian Competition Tribunal, Sydney.
- Conducted a series of imputation tests used in expert testimony in the s46 case brought against Baxter by the ACCC in the Federal Court in Sydney (2005).
- Assisted in the preparation of expert testimony called by Pacific National in a Federal Court case concerning disputed management and occupancy of the Acacia Ridge rail terminal in Brisbane (decision 2005).
- Testified before the Australian Competition Tribunal in the matter of an Application by Virgin Blue Airlines Pty Limited, No 1 of 2004, Sydney.
- Testified before the Federal Court of Australia in the matter of Australian Gas Light Company v. Australian Competition & Consumer Commission (No 3) [2003] FCA 1525, Melbourne.
- Assisted in the preparation of expert testimony on behalf of the Coal Compensation Board with respect to a disputed compensation claim in the Coal Compensation Tribunal (2002).
- Assisted in the preparation of expert testimony on behalf of Duke Energy with respect to their successful action before the Australian Competition Tribunal to have the Eastern Gas Pipeline unregulated (2001).

Consulting

- Undertook a quantitative assessment of the external benefits generated by Sydney bus services and the socially optimal level of Government subsidy (2008-09).
- Performed an empirical estimate of CityRail's marginal costs (Nov 2008) used in IPART's review of Sydney urban rail fares for 2009 – 2012.
- Prepared sections of an application by the Australian Pipeline Trust to have light handed regulation applied to the Moomba-Sydney Pipeline. Approved in Nov. 2008, this application was the first of its kind under the new National Gas Law.

- Authored a series of expert reports concerning Telstra's applications for exemption from declaration of various Domestic Transmission Capacity Services (December 2007 – October 2008). The sought exemptions were partially granted.
- Prepared a quantitative assessment of the external benefits generated by urban rail transport in Sydney and the socially optimal level of Government subsidy (June 2008).
- Assisted NSW competition regulator IPART in its inquiry into the Port Botany land transport interface (Final report published March 2008).
- Co-authored, with Professor George Hay, an expert report concerning competition impacts of a merger in the plastic bottle industry (2007).
- Assisted FOXTEL in obtaining ACCC approval (granted March 2007) for its special access undertaking for its digital set top units.
- Advised IPART on its ongoing review process for actual coal rail access revenues against the statutory ceiling.
- Led a team analysing the regulatory test hurdles for a proposed reinforcement investment in the electricity transmission network for WesternPower (2007).
- Provided economic reports in support of the asset valuation for the Roma-Brisbane Pipeline in the 2006-2007 Access Arrangement round.
- Assisted AGL to obtain regulatory approval for the acquisition of certain Queensland retail energy business assets (2006-07).
- Advised a New Zealand firm on potential damages arising from alleged collusive pricing (2006-07).
- Worked in a team modelling the competition impacts of the (now approved) merger between Toll Limited and Patrick Corporation (2006).
- Prepared reports submitted to the National Competition Council on behalf of BHP Billiton Iron Ore concerning the Part IIIA application by Fortescue Metals Group to have the Mt Newman railway line declared (2005).
- Worked closely with the Australian Stock Exchange to develop and test options for the strategic review of trading, clearing and settlement prices, culminating in the December 2005 announcement of significant restructuring of prices.
- Prepared a pricing strategy for Airservices Australia concerning the intellectual property embedded in its published aeronautical data (2004-05).
- Assisted the Australian Pipeline Trust by preparing numerous submissions in regard to its campaign to have regulatory coverage of the Moomba-Sydney Pipeline revoked (2000 – 2003). Regulation was eventually revoked for the Western portion of the pipeline.

- Provided a detailed avoidable cost analysis for an Australian firm responding to allegations of predatory pricing. The ACCC ultimately did not proceed with the case.
- Helped the Australian Stock Exchange to design and establish pricing for a new data service (2002).
- Prepared due diligence report on regulatory risk for one of the underbidders for Sydney Airport in 2002.
- Prepared revenue forecasts and other due diligence reports for Toll Holdings and Patrick Corporation on access prices in their successful bid to acquire Pacific National (2001-02).
- Advised the ACCC on a method for valuing the land under Sydney Airport. The recommendations were adopted by the ACCC in the 2000 Sydney Airport decision on aeronautical charges.
- Additionally, Mike has prepared a number of economic reports regarding merger authorisations, declarations under Part IIIA of the Trade Practices Act, matters involving misuse of market power, commercial pricing strategies, and regulatory pricing decisions.

OTHER POSITIONS HELD

2005 – 2008	Vice President, CRA International
2000 – 2005	Executive Director, NECG, Australia
1996 – 2000	Manager, Corporate Strategy and Manager of Systems, Rail Access Corporation of NSW, Australia
1993 – 1996	Director, Smart & Kay Pty Ltd, Australia
1989 – 1993	Independent Consultant, Australia
1986 – 1989	Engineering Manager, Science & Computing Applications P/L, Australia
1984 – 1985	Associate, Decision Focus Inc, Los Altos, CA (USA)
1980 – 1983	Professional Officer, University of NSW, Australia

PUBLICATIONS

“*Value of Sydney bus externalities and optimal Government subsidy*,” Mike Smart, Draft report commissioned by the Independent Pricing and Regulatory Tribunal of NSW, May 2009.

<http://www.ipart.nsw.gov.au/files/Consultancy%20Report%20-%20LECG%20Draft%20report%20on%20Value%20of%20Sydney%20bus%20externalities%20and%20optimal%20Government%20Subsidy%20-%2012%20May%202009.PDF>

“*Port Botany’s Landside: Market Pricing to Address Congestion*”, James Cox, Dennis Mahoney and Mike Smart, **Economic Papers, Volume 28, No. 1**, March 2009, 49-55.

“*An empirical estimate of CityRail’s marginal costs and externalities*”, Mike Smart, Report commissioned by the Independent Pricing and Regulatory Tribunal of NSW, November 2008.

<http://www.ipart.nsw.gov.au/files/Consultancy%20Report%20-%20LECG%20Report%20CityRail%20externalities%20and%20marginal%20costs%20final%20-%2020%20November%202008%20-%20WEBSITE%20DOCUMENT.PDF>

“*Value of CityRail externalities and optimal Government subsidy*”, Mike Smart, Report commissioned by the Independent Pricing and Regulatory Tribunal of NSW, June 2008.

<http://www.ipart.nsw.gov.au/files/CRAI%20report%20-%20CityRail%20Externalities%20-%2006%20June%202008.PDF>

“*Transport demand and spatial equilibria*”, Mike Smart, **Journal of Transport Economics and Policy, Volume 42, Part 2**, May 2008, pp. 323-343.

“*The Prime Minister’s Export Infrastructure Task Force: Two years on—has anything changed?*”, AusIntermodal conference, Sydney, 28 November 2007.

“*The role of economic regulation in reducing bottlenecks*”, conference on economic regulation in transport and logistics, Lloyds List DCN, Melbourne, 6 June 2007.

“*The economic value created by the emergence of a national gas pipeline network*”, paper presented at the Australian Pipeline Industry Association’s Annual Pipeline Convention 2006, Alice Springs, 16 October 2006.

“*Track access and regulation*”, presented to a course organised by the Australasian Railway Association in Melbourne, August 30-31, 2006.

“*The relative competitiveness of road and rail haulage*”, presentation to a conference at the National Library on challenges in achieving efficient pricing in freight infrastructure, Canberra, April 28, 2006.

"Two case studies on road vs rail freight costs", Mike Smart and Simon Game, submission to the Productivity Commission inquiry into freight infrastructure pricing, May 25, 2006.

"Safety fears could derail years of reform," Sydney Morning Herald, 23 April 2003, p. 13.

Sydney Airport Revised Draft Aeronautical Pricing Proposal. Final report prepared for the ACCC, December 2000.

"Land and Easement Valuation in Pricing for Networked Businesses – A Critical Appraisal." Henry Ergas and Mike Smart, Conference on Asset Valuation, ACCC, Melbourne, 16 June 2000.

"Practical Aspects of Rail Access Implementation." Published in the Proceedings: Current Issues in Access. Business Law Education Centre, Sydney, 29 October 1999.

"Solving the Riddle of Combinatorial Logic." Published in the Proceedings 23rd Australian Transport Research Forum, Perth, 30 September 1999. pp. 789-803.

"Understanding Life Cycle Costing and Applying Life Cycle Analysis." Published in the Proceedings: Advanced Asset Management. IIR Conference, Sydney, 28 September 1998.

"Application of Valuation Policies for Infrastructure Assets". Published in the Proceedings: Strategic Asset Management in the Public Sector. IIR Conference, Sydney, 24 November 1997.

(Consultant responsible for drafting Parliamentary committee report) Inquiry into Financing of Urban Infrastructure -- Report on European Inspection Tour. Public Accounts Committee, Parliament of New South Wales. Report No. 67. December, 1992. ISBN 0 7240 9554 3.

(Consultant responsible for drafting Parliamentary committee report) Report on the National Parks and Wildlife Service. Public Accounts Committee, Parliament of New South Wales. Report No. 59. December, 1991. ISBN 0 7240 8806 7.

(Consultant responsible for drafting Parliamentary committee report) Report on Payment Performance. Public Accounts Committee, Parliament of New South Wales. Report No. 55. April, 1991. ISBN 0 7240 8797 4.

(Consultant responsible for drafting Parliamentary committee report) Report on the Forestry Commission. Public Accounts Committee, Parliament of New South Wales. Report No. 52. December, 1990. ISBN 0 7240 8786 9.

"ASYST Applications." The First Australian Forth Symposium: University of Technology, Sydney, May 1988.

"*Measuring Solar and Electric Heating Contributions in Occupied Houses.*" Smart and Ballinger. **Energy and Buildings 9**. 213-219 (1986).

"*Fourier-synthesized Weather Data for Building Energy Use Estimation.*" Smart and Ballinger. **Building and Environment Vol.19 No.1**. 41-48 (1984).

"*An Economic View of Passive Solar Design in an Australian Context.*" Ballinger and Smart. Published in the Proceedings: Solar World Congress, Perth, August 1983.

"*Tracking Mirror Beam Sunlighting for Deep Interior Spaces.*" Smart and Ballinger. **Solar Energy Vol.30 No.6**. 527-536 (1983).

"*An Empirical Study of Problem Heat Flow Paths in Simulation Models.*" Smart and Ballinger. Chapter 6 in **Predictive Methods for the Energy-Conserving Design of Buildings**. H.J. Cowan Ed. Pergammon, Sydney (1983).

"*Propagation of Magnetically Guided Acoustic Shocks in the Solar Chromosphere.*" Foukal and Smart. **Solar Physics 69**. 15-25 (1981).