Submission by AAPT Limited

to the Australian Competition and Consumer Commission

Estimates of Ramsey-Boiteux Mark-Ups & Network Externality Effects

October 2005

1. Introduction

This is AAPT's third submission in response to *Vodafone's Undertaking in relation to the Domestic Digital Mobile Terminating Access Service — Discussion Paper*, April 2005 (the **Discussion Paper**). While AAPT's first submission, titled *Vodafone's Allocated Cost Model*, August 2005, answered questions posed by the Australian Competition and Consumer Commission (**ACCC**) on the cost modelling done by PricewaterhouseCoopers (**PwC**), this submission:

- Highlights problems with the academic integrity of the work done by Vodafone's economic consultant Frontier Economics on Ramsey-Boiteux Pricing and Network Externalities;[1] and

- Critically analyses arguments in the Vodafone submission[2] and the modelling of Ramsey-Boiteux Prices and Network Externalities undertaken by Frontier Economics. By doing this, the work addresses many of the questions posed by the ACCC on pp 25-31 of the Discussion Paper.

The analysis here should also be read in conjunction with the supporting submissions, *Appendix A*: *Production Cost Concepts* and *Appendix B*: *Ramsey-Boiteux Pricing*, which are attached. The appendices go into a greater level of detail about issues such as common cost recovery, the total service long-run average incremental cost, Ramsey-Boiteux pricing, and network externalities.

AAPT submits that, given the issues with the Frontier and Vodafone submissions and modelling, the ACCC should give limited weight to the analysis done by Frontier and Vodafone.

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[1] Frontier Economics, *Modelling Welfare Maximising Mobile Termination Rates*, A Report Prepared for Vodafone, March 2005, available at http://www.accc.gov.au/content/item.phtml?itemId=677496&nodeId=file425dff7f208ef&fn=Appendix%203%20to%20Vodafone%20submission%20in%20support%20of%20second%20MTAS%20undertaking.pdf

[2] Vodafone, *Submission to the Australian Competition and Consumer Commission Access Undertaking Mobile Termination Access Service*, 23 March 2005, available at http://www.accc.gov.au/content/item.phtml?itemId=677496&nodeId=file425dff7ee16e2&fn=Vodafone%20submission%20in%20support%20of%20second%20MTAS%20undertaking%E2%80%94March%202005.pdf

2. The Academic Integrity of the Frontier Economics Analysis

AAPT believes that there are a number of examples in the Frontier Economics submission that raises doubts over the academic integrity of their work. In particular, AAPT outline in the following two sub-sections that:

- The Frontier Economics summary and assessment of the work done in a seminal paper by Ramsey[3] is incorrect; and

- The Mathematical Annex of the Frontier Economics Submission on pp 23-9 contains a number of omissions and mistakes. Further, the structure and work on pp 23-9 appears similar to the analysis done by Brown and Sibley on pp 194-201,[4] yet Frontier Economics fail to acknowledge or attribute any of the work to these authors.

2.1   Frontier Economics Incorrect Assessment of the Ramsey Paper

In their introduction, Frontier Economics cite the work of Ramsey on p 6, and state that:

> In a classic paper, Ramsey showed that the rules for economically efficient prices would have to change to allow for the recovery of fixed or common costs if the setting of prices at marginal costs was inconsistent with the zero-profit constraint. In the last twenty or thirty years, it has been accepted among economists that the standard for economically-efficient prices in a multi-product firm is given by the Ramsey rules – and not by the rule that is suggested by the first fundamental theorem of welfare economics, that price should be equal to marginal cost.

This is an incorrect summary of the analysis done by Ramsey. Ramsey's classic paper does not address the issue of "fixed or common cost" recovery. As suggested by the title, "A Contribution to the Theory of Taxation", the paper examines socially optimal taxation rules. Specifically, it looks at how to minimise the loss in consumer surplus when raising a given amount of tax revenue using distortionary taxes. This is evident from the introduction, where Ramsey outlines on p 47 that:

> The problem I propose to tackle is this: a given revenue is to be raised by proportionate taxes on some or all uses of income, the taxes on different uses being possibly at different

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3   F.P. Ramsey, "A Contribution to the Theory of Taxation", *Economic Journal* 37, 1927, pp 47-61.

4   S.J. Brown and D.S. Sibley, *The Theory of Public Utility Pricing*, Cambridge University Press, 1986.

rates; how should these rates be adjusted in order that the decrement of utility may be a minimum?

The common cost or natural monopoly style problem that Frontier Economics claims Ramsey deals with, was actually first addressed in a paper by Boiteux.[5] Boiteux examined the Socially-optimal linear price for a public enterprise monopoly to charge when marginal-cost pricing fails to allow for cost recovery. As he notes in the introduction (p 219), his paper was

> ...*left with the problem of determining how to amend the marginal cost pricing rule when the firm is subjected to a budgetary condition incompatible with the decision rule.*[6]

Although analysing a different economic problem to that of Ramsey, Boiteux derived a very similar optimal pricing result to the efficient taxation rule. Hence, in referring to the economically efficient linear utility prices that allow for the recovery of common costs, the name "Ramsey-Boiteux" (R-B) pricing generally appears.[7] This acknowledges the work of Ramsey, who established the initial rule (i.e. the "Ramsey Rule" for taxation), and Boiteux, who independently derived the same result in the context of cost recovery for a public utility.

For a more detailed summary of the papers by Ramsey and Botieux, see Appendix B, Section B.1, pp 3-6.

2.2 Mistakes, Omissions and the Failure of Frontier Economics to Reference Brown and Sibley

In Annex 2 on pp 23-29, Frontier Economics provide the mathematical analysis that they claim underlies the formal modelling that they have used to derive the socially-optimal prices. AAPT wishes to note that

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[5] M. Boiteux, "Sur la Gestion des Monopoles Publics Astrient á L'Equilibre Budgetaire", *Econometrica* 24, 1956, pp 22-40. As the original article is in French, W. J. Baumol and D.F. Bradford had the paper translated into English, and the citation for this is: M. Boiteux "On the Management of Public Monopolies Subject to Budgetary Constraints", *Journal of Economic Theory* 3, 1971, pp 219-40.

[6] The emphasis in the above quote is in the original paper and the translated paper.

[7] While academics, such as William J. Baumol, still refer to this type of pricing simply as Ramsey pricing (e.g. see W.J. Baumol and J.G. Sidak, *Toward Competition in Local Telephony*, MIT Press, Cambridge, 1994), AAPT believes that this does not provide the appropriate recognition to the contribution made by Boiteux in independently applying the technique to evaluate optimal linear utility prices.

there appear to be the following omissions and mistakes in the analysis Frontier has provided in their submission:

- In Annex 2.2, p 26, the authors claim the first equation represents the total utility, which is given by the $U(q_1, q_2\ldots q_n) - C(q_1, q_2\ldots q_n)$. This is incorrect. The first term in the equation $U(q_1, \ldots q_n)$ is actually the total utility. The equation presented by Frontier Economics is total utility minus the total costs of production and is better described as the "net utility" from consumption.

- In Annex 2.2, p 26, the second equation purports to be the "break-even constraint". However, the expression $\sum_{k=1}^{n} p_k q_k - C(q_1, q_2, \ldots q_n)$ does not represent a break-even constraint. It is simply an equation that depicts total revenues earned on all services minus the total costs of production. To be a break-even constraint the term "=" must be substituted in for the minus sign, or the expression must be set equal to zero — i.e. $\sum_{k=1}^{n} p_k q_k = C(q_1, q_2, \ldots q_n)$ or

$$\sum_{k=1}^{n} p_k q_k - C(q_1, q_2, \ldots q_n) = 0.$$

- In Annex 2.3, p 28 there is reference to including externalities into the standard Ramsey formula. On p 29, Frontier Economics then present the equation:

$$\left(\frac{p_j - MC_j}{p_j}\right) S_j = \left(\frac{p_i - MC_i/e}{p_j}\right)\left(\frac{eS_i}{S_i(1-e)+1}\right)$$

In this equation the term e simply appears, without any explanation or reference to what it is meant to capture. AAPT believes from its own analysis in Appendix B — Section B.5 — and from the discussion in the main text of Frontier Economics' submission, that the term e is what is referred to as the "Rohlfs-Griffin (R-G) Factor".

The R-G factor represents the average ratio of the marginal social value to the marginal private value for subscribers and captures the social benefit of an additional subscriber to the network, as it increases the number of communications opportunities available to existing users of the

network. The method was formulated and employed by Rohlfs,[8] and used later in a paper by Griffin[9], to approximate the effects of network externalities that arise from subscribing to the fixed-line telephony service. It is important to recognise that the methodology employed by Rohlfs and Griffin is not a definitive method to use to capture the impact of network externalities. It simply represents one method for approximating the impact of a network externality. This appears to be outlined by Charles River Associates (B. Mitchell and P. Srinagesh),[10] who state on p 35 that:

> The Rohlfs-Griffin factor is one way of quantifying the social benefit of an individual's decision to subscribe to the network.

AAPT discusses the issue of the R-G factor at greater length in Section 4.2 of this Submission.

AAPT maintains that the mistakes and omissions in the Annex represent a failure by Frontier Economics to properly understand the theory underlying R-B pricing and the impact of network externalities. AAPT also notes that the mathematical annex on pp 23-9 of Frontier Economics' submission appears to be similar to the mathematical appendix done by Brown and Sibley on pp 194-201. Frontier Economics provide no citation of the authors' work, and AAPT believes that this unattributed reliance on Brown and Sibley partially explains some of the omissions and mistakes that have been outlined. In particular, AAPT notes that:

- Annex 2.2, pp 26-7, is similar to pp 194-7 of Brown and Sibley. On p 195 in the first publication of Brown and Sibley, the breakeven constraint has an equal sign that is quite badly blurred and

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[8]   J. Rohlfs, *Economically-Efficient Bell-System Pricing*, Bell Laboratory Discussion Papers No. 138, January 1979.

[9]   J.M. Griffin, "The Welfare Implications of Externalities and Price Elasticities for Telecommunications Pricing", *The Review of Economics and Statistics* 64, 1982, pp 59-66.

[10]   Charles River Associates (CRA) (B. Mitchell and P. Srinagesh), *Economic Analysis Of Fixed-to-Mobile Call Termination Charges*, A Report prepared for BellSouth International, 28 March 2003. Available at http://www.ustr.gov/assets/Trade_Sectors/Telecom-E-commerce/Section_1377/2004_Reply_Comments_on_Review_of_Compliance_with_Telecom_Trade_Agreements/asset_upload_file925_6906.pdf

looks like a minus sign, which as outlined earlier, is the sign that Frontier Economics incorrectly placed on the term.

- Annex 2.3, pp 28-9, is similar to pp 197-9 of Brown and Sibley. The final equations on p 29 are almost identical, although Frontier Economics have put the equation in terms of "super-elasticities", rather than own-price elasticities, and Frontier Economics have not gone into any of the detail presented by Brown and Sibley about the meaning of the term e.

- Annex 2.1, pp 23-5, is similar to the work done on pp 200-1 of Brown and Sibley on optimal two-part tariffs. In the Annex, Frontier Economics tailor the optimal two-part tariff analysis to their own framework where there is a mobile and fixed line network. While Frontier Economics explicitly recognise that their actual model uses separate demand functions for subscription and mobile outbound services, they justify their analysis on the basis that the optimal two-part tariff is theoretically equivalent to the analysis with linear demands. AAPT questions whether the analysis has simply been included because Brown and Sibley — who Frontier Economics appear to use to guide their mathematical Annex — include it.

3. Ramsey-Boiteux Pricing: Vodafone's Arguments & Frontier Economics' Modelling

In order to evaluate the R-B pricing arguments of Vodafone and the modelling of Frontier Economics, the analysis in this Section:

- Summarises the theory underlying R-B pricing and assesses the arguments made by Vodafone in relation to R-B prices being consistent with competitive and contestable market outcomes. Much of the theoretical work is taken from *Appendix B*, and the analysis can be viewed in greater detail there;

- Examines how R-B principles are used in practice by regulators. This highlights the practical difficulties associated with calculating a R-B price, and illustrates why the total service long-run

(average) incremental cost-based price (TSLR(A)IC or TSLRIC)[11] that includes some mark up to account for the common costs of the network (i.e. TSLRIC+),[12] is consistent with R-B pricing principles; and

- Assesses the methodology of Frontier Economics and the data used by Frontier Economics to derive the optimal prices.

In the course of this analysis AAPT deals with many of the questions posed by the ACCC on R-B pricing on p 30 of the Discussion Paper.

3.1   The Theory of Ramsey-Botieux Pricing

3.1.1   The Theory of R-B Pricing — A Simple Case with No Cross-Price Effects

In the absence of the regulator allowing a utility to perfectly price discriminate or charge multi-part tariffs on services, economics has established that the most efficient way to recover the common costs arising from the provision of multiple services is through allowing prices to be set in accordance with Ramsey-Boiteux (R-B) pricing principles.   This ensures that the common costs can be recovered, while minimising the overall efficiency loss associated with distorting the linear price away from the long-run marginal cost of production. Although the rule appears in a number of different guises, in its simplest and most commonly stated form — i.e. where there are no cross-price effects, there are constant costs of production and two services — it involves setting the price of a service i so that the lower (higher) the own-price elasticity of demand ε_i is, where $\varepsilon_i = -\dfrac{\partial P_i}{\partial Q_i}\dfrac{Q_i}{P_i} > 0,$[13] the greater (lower) the proportionate

mark-up that is required in price P_i from the marginal cost of production MC_i. Where superscript R

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[11]   Although technically the per-unit price should be denoted TSLR(A)IC, the term TSLRIC is often used by regulators to describe this methodology. For a more detailed discussion see *Appendix A*, Section A.2.

[12]   In determining the headline rate for the public switched telephone network originating and terminating access (PSTN OTA) charge, the ACCC uses the terminology TSLRIC+ to describe the TSLRIC estimated price which includes a mark up to account for the common costs associated with the customer access network (CAN).

[13]   The negative sign on the own-price elasticity term means that it will be a positive number throughout the analysis here.

denotes the outcomes under the R-B price and the term λ represents what is sometimes referred to as the "Ramsey Number", the textbook R-B (or inverse-elasticity) price is often formally written as satisfying the condition:

$$\frac{P_i^R - MC_i}{P_i^R} = \frac{\lambda}{\varepsilon_i^R} \, , \quad i = 1, 2 \ldots n \text{ and } 0 < \lambda < 1 \qquad (1)^{14}$$

The intuition for why the value of the Ramsey number λ tends to be represented as being bounded between 0 and 1 in equation (1) is as follows:

(i) If λ were equal to zero then the price in each market would just be equal to the long-run marginal cost of production (i.e. $P_i = MC_i$). However, this outcome cannot arise because it requires that no common costs of production are being recovered in the first place; and

(ii) If λ were equal to one, then the utility would be charging the unregulated monopoly price for each service i (i.e. $(P_i^m - MC_i)/P_i^m = 1/\varepsilon_i^m$). Generally though, as outlined in *Appendix B*, Section B.2 and B.3, such pricing is ruled out by combining the assumptions that:
- the regulated monopoly is subject to a zero profit constraint; and
- the regulated firm engaging in monopoly pricing will over-recover its common costs.

Note that if instead of a zero profit constraint some positive level of positive profits is allowed to be earned, then as outlined by Braeutigam,[15] the same pricing structure emerges across the services as outlined in equation (1). The resulting prices, however, will be higher than is the case for the zero profit constraint, as they are required to not only efficiently allocate the common costs of production, but also the allowed rents across each service. The charges are now effectively the welfare-maximising prices for

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[14] In the instance where there are cross-price effects, then as outlined in *Appendix B*, Section B.3.2, the R-B prices will still have to satisfy a version of the inverse-elasticity formula. However, instead of having the own-price elasticity term in equation (1), there will now be what is known as a "superelasticity" term for good i; and compared to the case where there are no cross-price effects and a given common cost; with substitutes (complements) the R-B prices will be lower (higher).

[15] R.R. Braeutigam, "An Analysis of Fully Distributed Cost Pricing in Regulated Industries", *Bell Journal of Economics* 11, 1980, pp 182-96. See p 189, footnote 14, and p 193, footnote 17.

the given level of common cost and profit that the firm is allowed to earn. Importantly, the higher mark-up in price above marginal cost means that there is also a lower level of welfare or efficiency compared to the instance when zero economic profits are allowed. Further, although in equation (1), and the example used in *Appendix B*, the R-B price for each service is always below the unregulated monopoly price, the structure of pricing across markets is identical to that which would arise under third-degree price discrimination of consumers by the monopoly. Joskow[16] makes this point, stating (at p 80) that,

> …the structure, though not the level, of the Ramsey-Boiteux prices is the same as the prices that would be charged by an unregulated monopoly with an opportunity to engage in third-degree price discrimination.

This highlights that R-B price is a form of price discrimination, and if any firm were to voluntarily set R-B prices it must have some form of existing market power to do so.

3.1.2 Vodafone's Arguments on R-B Pricing and Market Power

Vodafone outline on pp 17-9 of their submission that:

- The Commission is incorrect to assert that R-B prices requires the existence of market power; and

- The data limitations required to calculate R-B prices are neither insurmountable nor sufficient to rule out consideration of R-B pricing concepts in determining the MTAS in an undertaking.

As the practicality of setting R-B prices is addressed in Section 3.2, only the first point is addressed by AAPT in this sub-section.

Vodafone challenge the ACCC's claim that a precondition of R-B pricing is the existence of market power in the retail mobile market, on the basis that:

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[16] P. Joskow, "Regulation of Natural Monopolies", forthcoming in *Handbook of Law and Economics*, A.M. Polinsky and S. Shavell (eds.), Elsevier Science B.V, 2005. Draft available at: http://econ-www.mit.edu/faculty/download_pdf.php?id=1086.

- The ACCC definition of market power, which simply requires the deviation of price from marginal cost, is not a useful definition in the context of trade practices litigation or regulation. Vodafone instead proposes (on p 18) that market power "is more usefully defined as the ability to sustain the earning of supernormal profit"; and

- R-B pricing is consistent with outcomes under Contestable Market theory. Citing a paper by Baumol,[17] Vodafone note that in a contestable market setting, where there is free entry and exit, a firm would price in order to just recover its long-run costs of supply, thereby earning zero supernormal profit.

In response to this, AAPT notes that:

- The ACCC definition of market power is consistent with that outlined by Laffont and Tirole.[18] In the Glossary on p 285, the authors define market power as:

    Market power The ability for a firm to charge a price above marginal cost. Market power is not inconsistent with the absence of profit or free entry into the market, because the profit generated by the markup may be offset by the fixed cost of producing and marketing the good or service

- Even if Vodafone's definition of market power was accepted — as outlined in Section 3.1 and Appendix B, Section B.3.1 — R-B prices can still be derived for the case where the firm earns supernormal profits. This outcome has been formally shown by Braeutigam.[19] The only difference between the R-B prices satisfying a greater than zero profit constraint, and the R-B

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[17] W.J. Baumol, "Contestable Markets: An Uprising in the Theory of Industry Structure", *American Economic Review* 72, 1982, pp 1-15.

[18] J-J. Laffont and J.Tirole, *Competition in Telecommunications*, MIT Press, Cambridge, 2000.

[19] R.R. Braeutigam, "An Analysis of Fully Distributed Cost Pricing in Regulated Industries", *Bell Journal of Economics* 11, 1980, pp 182-96, shows on p 189 in footnote 14, and on p 193 in footnote 17 that R-B prices can be derived for an allowed profit constraint that is greater than zero.

prices for a zero profit constraint, is that the level of welfare achieved by the R-B prices with the zero profit constraint will be higher.[20]

- Appealing to contestable market theory to justify why R-B pricing may arise voluntarily is problematic. As a theory of Industrial Organisation, Contestable Market Theory was widely discredited over two decades ago. Based upon this it is somewhat surprising that Vodafone has chosen to rely upon it to sustain its arguments about how R-B prices can be voluntarily set in an industry.[21] At best, Contestable Market Theory highlights how the threat of entry can internally discipline the behaviour of participants in a market; but more generally it is theory that Shepherd[22] outlines (on p 585) relies upon, "a specialized, extreme set of conditions, which are probably found in no real markets which have significant internal market power", and "offers little so far to industrial organization research and teaching".

In his critique of Contestable Market Theory Shepherd points out that in order for the desirable results of zero profit, Ramsey optimal pricing, and efficient market structure to be achieved, there must be "ultra-free entry" by potential competitors to the industry. As Shepherd points out (on p 573) in order for ultra-free entry to arise, the industry must satisfy each of the following three conditions:

1. *Entry is free and without limit*;

2. *Entry is absolute*; and

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[20] AAPT notes that if Vodafone is referring to the R-B prices associated with a zero profit constraint when using the terminology "Ramsey optimal pricing" on p 18, then it is correct in its assertion that the regulated monopoly will only earn a normal rate of return.

[21] For two immediate examples, see the following critiques of Baumol's paper; M.L. Weitzman, "Contestable Markets: An Uprising in the Theory of Industry Structure: Comment", *American Economic Review* 73, 1983, pp 486-7; and M. Schwartz and R.J. Reynolds, "Contestable Markets: An Uprising in the Theory of Industry Structure: Comment", *American Economic Review* 73, 1983, pp 488-90.

[22] W.G. Shepherd, ""Contestability" vs. Competition", *American Economic Review* 74, 1984, pp 572-87.

3. *Entry is perfectly reversible*.

AAPT suggests that none of the above conditions would currently be met in the mobile industry, (e.g. there are clearly large sunk costs associated with building a new mobile network). Therefore, Vodafone cannot reasonably rely upon contestable market theory, in order to argue that the R-B prices associated with zero profit will voluntarily be charged by mobile providers.

3.2 Ramsey-Boiteux Pricing in Practice

3.2.1 Problems of Accurately Estimating R-B Prices

The informational difficulties associated with accurately estimating R-B prices are well-established, and there is very little support amongst economists for regulators actually implementing R-B prices in regulated industries. This is highlighted in each of the following statements.[23]

- n/e/r/a (N. Attenborough, R. Foster, J. Sandbach)[24] on p 8:

  One difficulty in applying this theory to present day telecommunications markets is that the traditional Ramsey pricing analysis assumes one monopoly producer. In competitive markets (where company specific elasticities differ from total market elastciticies), Ramsey pricing as described above may not be sustainable….

  Ramsey prices are difficult to estimate with accuracy, as they require assumptions about marginal costs, price elasticities and externality factors.

- n/e/r/a (N. Attenborough)[25] on p 6:

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[23] AAPT wishes to note that two of the authors associated with the n/e/r/a quotes highlighting the problems with implementing Ramsey-Boiteux prices are Nigel Attenborough and Jonathon Sandbach. Nigel Attenborough was the expert that Vodafone called upon to provide economic evidence in the ADJR challenge to the ACCC in the Federal Court in 2005, while Jonathon Sandbach is now the Vodafone Group Ltd Head of Regulatory Economics.

[24] n/e/r/a (N. Attenborough, R. Foster, J. Sandbach), *Economic Effects of Telephony Price Changes in the UK*, NERA Topics No. 8, 1 September 1992, available at http://www.nera.com/image/3963.pdf.

…Ramsey prices are unlikely to be appropriate or sustainable once there is significant competition.

- CRA (B. Mitchell and P. Srinagesh) on p 41:

  …the computation of Ramsey prices requires a great deal of information on both demand and costs, including demand elasticities, cross-elasticities and cost functions for all the services in questions….The calculation of Ramsey prices is likely to be difficult and costly, and the results of the exercise will be only as reliable as the data on which they are based.

  Even if Ramsey prices can be accurately calculated, they may not be appropriate in a dynamic and competitive environment.

- Baumol and Sidak[26] on pp 38-9:

  This data requirement is one reason why most regulators and consulting economists have rejected the use of the Ramsey formulas even to provide approximations for the prices that the regulated firm should be permitted to charge for its products. Marginal-cost figures are difficult enough to come by, although reasonably defensible approximations have been provided by firms to regulatory bodies. But up-to-date estimates of the full set of pertinent elastcities and cross-elastcities are virtually impossible to calculate, particularly in markets where demand conditions change frequently and substantially. As a result, an attempt to provide the regulator with an extensive set of Ramsey prices is likely to be beset by inaccuracies, by obsolete demand data, and by delays that will prevent the firm from responding promptly and appropriately to evolving market conditions.

The above problems with estimating R-B prices, led Baumol and Sidak to state (on p 39) that:

> …regulators have accepted the usefulness of Ramsey theory as a source of general qualitative guidance rather than as a generator of precise and definitive prescriptions for pricing….Ramsey analysis is unlikely to determine the actual magnitudes of regulated prices.

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[25] n/e/r/a (N. Attenborough), *Regulation of Competitive Telecommunications Markets*, NERA Topics No. 12, 1 April 1993, available at http://www.nera.com/image/3958.pdf.

[26] W.J. Baumol and J.G. Sidak, *Toward Competition in Local Telephony*, MIT Press, Cambridge, 1994

3.2.2 The Use of Ramsey-Boiteux Principles by Regulators

Regulators in the US and Australia appear to use R-B principles when assessing the reasonableness of rail access charges on bottleneck lines. For example, the US regulator, the Surface Transportation Board (STB) — formerly the Interstate Commerce Commission (ICC) — allows rail track providers with bottleneck facilities to charge discriminatory prices to carriers on the basis that these rates could potentially recover the common network costs with a minimum efficiency distortion, and may be consistent with the type of outcomes that would emerge under R-B pricing. As Baumol and Sidak note (on p 39)

> Ramsey theory has, for example, been used to defend the legitimacy of the general welfare of what in the regulatory arena is called "differential pricing" — that is, the use of discriminatory prices, in the economic, rather than legal sense.[27]

In 1985, the ICC, recognising the impractical nature of actually setting regulated R-B prices, and wanting to ensure that discriminatory rates were not being set at the monopoly levels; adopted what they refer to as constrained market pricing (CMP) principles.[28] This procedure — which amongst other things, involves using a stand alone cost (SAC) price ceiling test, and implicitly, a total service average long-run incremental cost (TSLR(A)IC) price floor[29] — is considered to represent a cost-based proxy for R-B pricing.[30] A similar method has since been adopted by state-based regulators in Australia to regulate rail access charges.[31]

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[27] Baumol and Sidak though, do recognise the problems with using R-B pricing principles to justify the differential pricing of services. The authors note on p 55 that such rules may be "no more than a rationalization for the practices of price-discriminating monopolists."

[28] See *Coal Rate Guidelines*, 1 I.C.C. 2d, 1985.

[29] For more information about the concepts of stand-alone cost, total service long run (average) incremental cost, common cost and TSLRIC+-based prices, see *Appendix A*, Sections A.3-A.5.

[30] n/e/r/a (J. Dodgson, S. Holder, S. Jones and L. Besancon), *Regulatory Approaches to Cost Allocation*, A Report Prepared for Office of the Rail Regulator UK, April 2001, available at http://www.rail-reg.gov.uk/upload/pdf/nera_costalloc.pdf

[31] For example, the Independent Pricing and Regulatory Tribunal (IPART) in New South Wales has adopted what has been referred to as a Baumol price ceiling and price floor test and a combinatorial cost test, to assess the reasonableness of the differential rates charged to captive shippers accessing the Hunter rail network.

AAPT notes that as a TSLRIC+ calculation for services — i.e. a TSLR(A)IC-based price with a proportionate mark up to recover the common cost — lies within the bounds of the SAC price ceiling and the TSLR(A)IC price floor, the TSLRIC+ methodology can be considered to be broadly consistent with R-B principles. Further, AAPT believes that it is likely to be a better indicator of the appropriate price to charge than an estimated R-B price, as it will not be subject to the same type of uncertainty. That is, the TSLRIC+ method does not require up-to-date estimates of the own-price, cross-price, and volume elasticities to determine the regulate rate. On this basis AAPT maintains that a properly formulated TSLRIC+-based price, is likely to be more appropriate for determining the MTAS, than the R-B price estimated using the Frontier model.

3.3 Assessing the Frontier Economics Model Estimating R-B Prices

3.3.1 The Failure to Include Services in the Frontier Economics Model

In addition to the various problems that have already been highlighted with estimating R-B prices, Frontier Economics R-B pricing model fails to attribute the common network costs estimated by PwC over a number of services using the network — e.g. GPRS and SMS[32]. The failure to include these additional services means that the common costs are being recovered across too few services in the R-B model employed by Frontier Economics, which leads to R-B prices for mobile termination that are artificially inflated, and fail to achieve a second-best efficient outcome for the industry. This result is illustrated in the two-good example in Appendix B, Section B.2 (see Figures B.2, B.3 and B.4), which shows that regardless of the demand elasticity or the marginal cost of providing the additional service, it is always welfare improving for an extra service to make some contribution to the recovery of the common cost. Further, the increase in price above marginal cost on the additional service, leads to a decrease in the amount of common cost that must be recovered from existing services, which decreases the existing services' price level.

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[32] In particular, the failure to include the SMS and data services in the Frontier Economics model is likely to be of increasing significance in the future, as these services become a more important source of revenue. IDC (J. Yau and W. Chaisatien), *Australian Cellular 2005-2009 Forecast and Analysis: No Strings Attached*, April 2005, notes on pp 17-19, that in 2004, non-voice services, such as SMS, MMS and other data, made up just under 15 per cent of total industry revenue. Based upon the higher growth rates anticipated for non-voice services, IDC forecasts that by 2009, non-voice services will comprise approximately 29 per cent of total mobile industry revenues (see Table 8).

3.3.2 Elasticity Data

The Frontier Economics model uses own-price, cross-price, and volume elasticity estimates to derive the R-B prices. Similar to AAPT's earlier submission in response to the Optus' Undertaking,[33] AAPT here asks the following questions about the elasticity estimates:[34]

- What makes the demand elasticity estimates appropriate in an Australian context?

- Given the sensitivity of the outcomes for the R-B prices to the elasticity estimates, why does there appear to be a disagreement between the elasticity numbers used by the consultants of Vodafone, Frontier Economics and those used by the consultants of Optus, CRA?

- Are these estimates appropriate to use when moving from a lightly to more heavily regulated market? That is, does the introduction of cost-based regulation for the MTAS itself have an impact upon the estimated demand elasticities that should be used? and

- Most significantly, is it appropriate to use the estimated elasticities in the modelling process, in light of the fact that different demand curves appear to have been used in the elasiticity estimation and the optimal price calculation in the Frontier Economics model? That is, elasticities tend to be estimated econometrically using assumptions about constant own-price and constant cross-price elasticity, and some form of log-linear demand. In contrast, the Frontier model uses linear demand. As outlined in Section B.6.1, at different points on a linear demand curve the price elasticity of demand will vary. Therefore, unlike the econometrically estimated constant

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[33] AAPT, *An Economic Critique of the Submission by Charles River Associates*, June 2005, available at http://www.accc.gov.au/content/item.phtml?itemId=694508&nodeId=file42c4a48c76e2b&fn=AAPT%20submission%20(2)%20%E2%80%94%20June%202005.pdf

[34] AAPT notes there is a slight difference between the Frontier Economics model and Rohlfs model used to estimate R-B prices by CRA on behalf of Optus. The Frontier Economics model includes three services — subscription, mobile origination/outbound calls, and fixed-to-mobile calls — while the Rohlfs model distinguishes between four services — subscription, mobile origination usage other than off-net calls, fixed-to-mobile calls, and mobile originated off-net usage. Consequently, the Rohlfs model requires more own-price and cross-price elasticity estimates than is necessary in the Frontier Economics model.

elasticities of demand, the elasticities in the Frontier Economic model will be changing as the prices move away from the initial level to the socially-optimal linear prices that recover the common cost.

Based upon the complications associated with setting R-B prices, and the questions that have been outlined above, AAPT believes that the prices provided by Frontier Economics will not reflect the second-best prices that would actually maximise welfare in the mobile services market.

3.3.3 The Cost and Demand Input Data

In the modelling done by PwC and Frontier Economics, the data used is generally from 2002 and 2003. While it unclear why data from these years has been employed, AAPT believes that this older data is likely to lead to over-inflated incremental and common costs of the network than is the case if more recent data were used.

4. Network Externalities

In order to evaluate the approach to network externalities and the use of the R-G factor by Vodafone and Frontier Economics, the work in this Section summarises:

- What network externalities are, the potential impact that they have on the efficient pricing of mobile services, and the potential inefficiencies that may arise from subsidising handsets in the mobile market;

- The theory underlying the R-G factor and how it accounts for network externalities, R-B pricing in the presence of an R-G factor, and problems with using the R-G factor;

- The other types of externalities that may be relevant in evaluating mobile termination — e.g. the call externality and the fixed-line network externality; and

- Some issues with measuring welfare in the presence of complementary relationships and network externalities.

In the course of this analysis AAPT deals with some of the questions posed by the ACCC on network externality mark ups on p 32 of the Discussion Paper. Much of the theoretical work that is drawn upon here is taken from *Appendix B*, Section B.5, and the analysis can be viewed in greater detail there

4.1 Network Externalities and the Mobile Market

4.1.1 Network Externalities and Subsidies

Liebowitz and Margolis[35] outline on p 76 that network externalities — or what the authors suggest are more appropriately described as *network effects*[36] — arise because:

> As the number of users of a product or network increases, the value of the product or network to the other users changes.

In the context of telecommunications it means that each new subscriber to a telephone service increases the number of communication opportunities that are available to existing users of the network.

As network effects have an impact upon all existing subscribers to the network, it is often argued that network effects are very difficult to internalise without some form of corrective pricing of the subscription service (i.e. the access service). This is highlighted by Rohlfs, who notes on p 5 that because a network effect involves many people, it "probably cannot be fully internalised without corrective pricing", and that the "effect of such externalities is that the economically efficient price of access to the network is below marginal cost of access". The impact of a network effect that cannot be internalised i.e. a (positive) network externality, is illustrated in Figure 4.1.

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[35] S.J. Liebowitz and S.E. Margolis, "Network Effects", *Handbook of Telecommunications Economics*, Volume 1, M.E. Cave, S.K. Majumdar and I. Vogelsang (eds.), Elsevier Science B.V., Amsterdam, 2002.

[36] Liebowitz and Margolis maintain on pp 76-8, that the term network externality is often used to describe how an existing consumers' value is affected by a change in the size of the network. They argue however that this is a careless use of the term "network externality", because it is more appropriate to describe this as a *network effect*. The use of the term network externality should be reserved for those instances where there is a market failure, or a network effect that is not being internalised in the market. Further, Liebowitz and Margolis note that although network participants are unlikely to internalise the impact that their joining a network has on existing subscribers, network owners may well internalise such effects.

The diagram illustrates an instance where over the N subscribers there is a diminishing marginal external benefit (MEB) from the network externality, which is exhausted or equal to zero once the level of subscription $\overline{N}$ is reached. Therefore, the network externality is relatively more important the lower is the level of penetration or subscription in the access market, and for the $\overline{N}$ th subscriber, the marginal private benefit (MPB) will be equal to the marginal social benefit (MSB). Further, although there is a network externality in this example, whether or not it is necessary to actually subsidise subscription and price below cost — as prescribed by Rohlfs to achieve the Pareto efficient outcome — depends upon the level of the marginal cost of production to society (MC).[37]

FIGURE 4.1 THE NETWORK EXTERNALITY
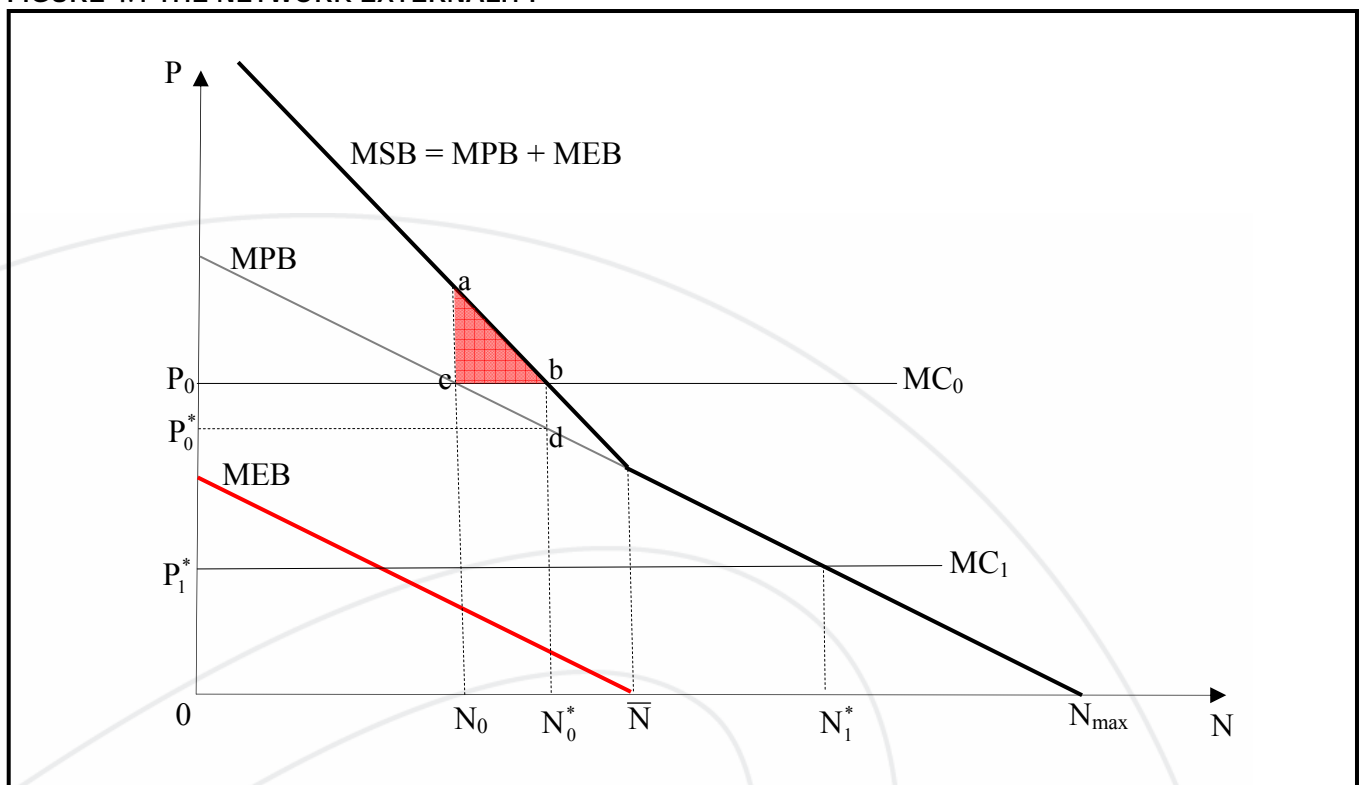
If the marginal cost is MC_0, then adopting the terminology of Buchanan and Stubblebine,[38] the positive network externality in Figure 4.1 is "Pareto-relevant". Here, in order to derive the welfare-maximising

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[37] ACCC, *Mobile Services Review: Mobile Terminating Access Service*, Final Decision, June 2004, p 165 uses a similar diagram in Figure 6.4.

[38] J.M. Buchanan and W.C. Stubblebine, "Externality", *Economica* 29, 1962, pp 371-84.

level of subscription N_0^*, the price must be set below marginal cost at P_0^*. A marginal cost-based price of P_0 generates inefficient under-subscription on the network, and an overall deadweight-loss of area abc. If it is assumed there are no marginal deadweight-losses associated with raising the relevant funds, then the efficient outcome is achieved through providing the network with a total subsidy payment equal to $P_0 bd P_0^*$. In contrast, if the marginal cost of production to society is MC_1, then the positive externality is in the words of Buchanan and Stubblebine "Pareto-irrelevant", and the welfare-maximising outcome is simply obtained by setting price equal to the marginal cost — i.e. $P_1^* = MC_1$.

In the example outlined above, if there is a common cost and a number of services over which this cost can be efficiently apportioned through R-B pricing, are there circumstances where it will still be efficient to subsidise subscription? In the case of marginal cost MC_1, where the externality is "Pareto-irrelevant", no subsidy payment is required. However, where the marginal cost is MC_0 and the externality is "Pareto-relevant", it is possible for the optimal R-B price to be below the marginal cost, and for a subsidy payment to still be required on subscription.[39] Whether or not the optimal linear price recovering the common costs P_0^R lies in the range so that $MC_0 > P_0^R > P_0^*$, rather than $P_0^R > MC_0$, will depend upon such things as:

- the elasticity of demand — i.e. the more elastic (inelastic) demand for subscription is relative to other services, the smaller (larger) is the mark up above P_0^* that is required, and the more (less) likely it is that subscription will need to be subsidised;

- the size of the network externality — i.e. the smaller (larger) the size of the marginal network externality, the less (more) likely it is that subscription will need to be subsidised; and

- the size of the common cost of production — i.e. the smaller (larger) the size of the common cost, the smaller (larger) is the magnitude of any mark up required above P_0^*, and the more (less) likely it is that subscription will need to be subsidised.

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[39] This outcome is shown in *Appendix B*, Section B.5, Figure B.13. However, unlike Figure 4.1, Figure B.13 assumed that the externality existed overall all levels of subscription where the MPB was greater than zero.

In the context of the mobile market, the existence of network externalities and the potential for below-cost optimal R-B prices for subscription, has formed the basis of the argument by mobile network operators (MNOs) that above-cost mobile termination rates — in particular above-cost fixed-to-mobile (FTM) termination rates — are an efficient mechanism for subsidising handsets. Armstrong[40] formally shows this result, and states on p 343 that:

> …a higher termination charge raises the equilibrium mobile subscriber utility via handset subsidies and the like, this in turn increases mobile subscription, which in turn raises the utility of fixed network subscribers because of the network externality effect.

He then goes on to emphasise that while the presence of network externalities provide a reason for pricing termination above cost and subsidising subscription, as the optimal price is still below the unregulated charge for termination, it "does not provide a good argument for deregulating mobile call termination charges."

4.1.2   Network Externalities in Telecommunications

As outlined in *Appendix B,* Section B.5, much of the initial literature on externalities in telecommunications emphasised the importance of the network externality due to its effect on all existing network subscribers. While at lower levels of subscription the number of other people connected to the network may be a crucial factor in the decision to subscribe, there is a general consensus amongst economists that in both the fixed-line and mobile market, once higher levels of penetration are reached, the significance of network externalities will diminish. This is recognised in each of the following papers and statements:

- Mitchell[41] outlines in his modelling of optimal US fixed-line telephony rates that he has chosen not to take into account the impact of network externalities due to the high level of saturation that exists in the market. He notes on p 518 that:

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[40]   M. Armstrong, "The Theory of Access Pricing and Interconnection", *Handbook of Telecommunications Economics*, Volume 1, M.E. Cave, S.K. Majumdar and I. Vogelsang (eds.), Elsevier Science B.V, 2002.

[41]   B.M. Mitchell, "Optimal Pricing of Local Telephone Service", *American Economic Review* 68, 1978, pp 517-37.

Also ignored are the dynamic effects of the number of subscribers in the telephone network on the value of service to any one subscriber. Although such externalities may be important in other countries, they should have only a limited marginal effect on demand in a system with a high saturation of subscribers.

- Kahn and Shew[42] state in relation to fixed-line telephony on p 242 that:

    …it could be that, as subscription has exceeded 90%, marginal subscribers have come to consist disproportionately of people relatively isolated from society generally, to whose hypothetical addition to the network existing subscribers would impute progressively smaller values.

- Sidak and Spulber[43] on p 548 notes that:

    Network externalities become less important as more and more subscribers are connected to the network. With respect to the narrowband network for voice telephony, once subscription rises to more than 95 percent of all households, the remaining positive externalities that may be achieved on the margin surely become quite small.

- CRA (Mitchell and Srinagesh) emphasise on p 35 in relation to telephone networks that:

    …in economies with relatively low penetration rates (especially amongst businesses) telephone service will have relatively high network externalities compared with economies with high penetration rates. The network externality is therefore likely to be more important in less developed countries with low penetration rates than in developed countries, such as the UK and the US.

- Iimi[44] conducts an econometric study of demand for services in the Japanese mobile phone market. Using data from 1996-1999, he finds that in contrast to Okada and Hatta[45] — who used data from 1992-1996 — the network effect no longer plays a significant role in the demand for cellular phone services in Japan. Iimi outlines on p 18 that:

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[42]   A. E. Kahn and W. B. Shew, "Current Issues in Telecommunications Regulation: Pricing", *Yale Journal on Regulation* 4, 1987, pp 191-256.

[43]   J.G. Sidak and D.F. Spulber, *Deregulatory Takings and the Regulatory Contract*, Cambridge University Press, Cambridge, 1997.

[44]   A. Iimi, "Estimating Demand for Cellular Phone Services in Japan", *Telecommunications Policy* 29, 2005, pp 3-23.

[45]   Y. Okada and K. Hatta, "The Interdependency of Telecommunications Demand and Efficient Price Structure", *Journal of the Japanese and International Economies* 13, 1999, pp 311-35.

These diminishing network externalities can be interpreted as follows: the product differentiation effect tends to overwhelm the network externality effect. A fundamental reason is that the market is becoming more saturated and the installed-base is growing at a relatively moderate rate.

Further he notes that once market saturation occurs:

…subscribers pay closer attention to carrier-specific product attributes, not merely seeking the original benefit of mobile telephone services, which is that they can make a phone call anywhere at any moment. Correspondingly, mobile carriers are predetermined to rush into development [of] competition for new services; cellular phone services are becoming more and more differentiated.

In Australia, a recent study by market analysts IDC (W. Chaisatien and J. Yau),[46] notes that the mobile market surpassed "natural saturation" for the first time in 2004, when there were approximately 17.87 million mobile phone services in operation in Australia, which is equivalent to 89 per cent of the population. IDC outlines that natural saturation is reached when around 85 per cent of the population are mobile phone subscribers, and according to IDC on p 2, "statistically it means that every Australian from the age of 12 onwards is invariably a subscriber to a cellular service." As every Australian who could be using a mobile phone is already using one, IDC notes that the Australian mobile market is now reaching a new phase of competition where carriers must reposition and further differentiate themselves. The level of saturation and the increased product differentiation means that it is arguable that — as outlined by Iimi in relation to the Japanese mobile market — any network externality associated with subscription may no longer be relevant to the Australian mobile market. As there is also likely to be a low marginal cost of production of handsets now due to technological advancement, it is arguable that the Australian mobile market is currently at the outcome depicted in Figure 4.1, where the marginal cost is MC_1 and the network externality is "Pareto irrelevant". If this was the case, then it would be harder to justify the need for above-cost mobile termination access charges on fixed-to-mobile (FTM) calls to subsidise handsets.

4.1.3   The Inefficiency of Handset Subsidies

MNOs in Australia have claimed that handset subsidises serve to internalise the positive network externalities that exist in the mobile market. This not only ignores that due to natural saturation there may

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[46]   IDC (W. Chaisatien and J. Yau), *Australian Cellular 2005-2009 Forecast and Analysis: No Strings Attached*, April 2005.

no longer be any network externality that requires subsidising, but that handset subsidies also to appear serve a significant commercial function for providers, such as the prevention of churn. Bomsel, Cave, Le Blanc and Neumann (BCLN) highlight this point on p 21, stating that,[47]

> Handset subsidisation as applied by MNOs is not only a means of getting marginal (non-) subscribers to the network, it is also used to keep customers tied to a particular mobile network; in this capacity, handset subsidisation is a competitive instrument which has nothing to do with getting welfare optimal levels of penetration.

If handset subsidies are being used primarily as a competitive instrument, they may actually be generating inefficiencies. For instance, in assessing handset subsidies, BCLN note on p 21 that:

> There are even indications of an economic waste of resources associated with this type of excessive subsidisation of equipment.

This idea that the handset subsidy induces inefficient handset investment rather than the internalisation of any network externality is also borne out in the recent theoretical and empirical research done by Malmberg.[48] To assess the appropriateness of regulating the MTAS, he compared Swedish mobile regulation — where handset subsidies are not banned — with Finnish mobile regulation — where a ban on handset subsidies was introduced. This led him to conclude that there was a strong case for the regulation of the MTAS, and that:

> The Swedish handset subsidies seem to have stimulated subscriber growth during the period 1994-1995. In the subsequent period, the subsidies seem to have stimulated handset replacement rather than subscriber growth.

Finally, instead of an attempt to internalise externalities, the existence of below-cost or free handsets may only serve to illustrate the market power MNOs have over customers subscribing to their network. A

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[47] O. Bomsel, M. Cave, G. Le Blanc and K-H. Neumann, "How Mobile Termination Charges Shape the Dynamics of the Telecom Sector", Final Report, CERNA, wik Consult, University of Warwick, 9 July 2003, available at: http://www.cerna.ensmp.fr/Documents/OB-GLB-F2M-FinalReport.pdf.

[48] C. Malmberg, "Regulation and Welfare in the Mobile Market: Welfare Effects of Regulating Termination Charges in Mobile Networks", Department of Economics, Stockholm University, 2004, available at: http://www.kkv.se/forskare-student/pdf/uppsats2004_malmberg.pdf

similar point was raised by Kahn and Shew, who in the context of the fixed-line telephony service responded to a claim that access for the local service should be set equal to zero in a competitive market, by stating on p 204 that:

> …the assertion that competitive markets would never charge for access is not merely wrong; it is in some ways the opposite of the truth. The greater a firm's monopoly power — its ability to charge above marginal cost for usage — the greater its ability to offer access at less than cost, in confident expectation of recovering the deficiency through usage charges.

4.2 The Rohlfs-Griffin (R-G) Factor to Approximate the Impact of Network Externalities

4.2.1 The R-G Factor and R-B Pricing

As outlined in Section 2.2, the R-G factor was originally designed by Rohlfs to approximate the impact of network externalities that arise from subscribing to the fixed-line telephony service. Usually denoted by the term "e", the R-G factor represents the average ratio of the marginal social value to the marginal private value for subscribers, and Rohlfs prescribed that it should take a constant value between 1 and 2.[49] By employing a constant value, the term accounts for the diminishing importance of the marginal network externality as subscription increases, (an outcome discussed in Section 4.1.2); and as e = 1 captures an outcome when there is no externality, a greater level of internalisation of the network externality is simply captured by setting e further below 2. While it was initially used to assess optimal pricing in the fixed-line telephony system, the R-G factor has also recently been employed to assess optimal pricing in the mobile network in the UK.[50] The impact of using the R-G factor is illustrated in Figure 4.2 and a more detailed analysis of the R-G factor can be found in *Appendix B*, Sections B.5.2-B.5.4.

Figure 4.2 illustrates three different values for the R-G factor — e = 1, 1.5 and 2 — in a diagram where it is assumed that there is no longer any MPB from subscription when the level of subscription N_{max} is reached. In the diagram:

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[49] The contribution by Griffin is that his was the first academic publication to adopt this constant value established by Rohlfs to capture the network externality.

[50] The UK regulator used a value for the R-G factor of between 1.3 and 1.7, in order to estimate the efficient price for the mobile termination access service. See Oftel, *Review of the Charge Control on Calls to Mobiles*, 26 September 2001, p 72, paragraph A4.45, available at: http://www.ofcom.org.uk/static/archive/oftel/publications/mobile/ctm0901.pdf.

- where there is no network externality, i.e. $e = 1$, the marginal private benefit is equal to the marginal social benefit over all levels of subscription, and with N_0 subscribers, the marginal private and social value of subscription will be P_0;

- where according to Rohlfs the network externality is being partially internalised, i.e. $e = 1.5$, for the level of subscription N_0, the marginal private benefit of subscription will now be P_0, while the marginal social benefit is $1.5P_0$; and

- where according to Rohlfs the network externality is not being internalised, i.e. $e = 2$, at the level of subscription N_0, the marginal private benefit of subscription is again P_0, but the marginal social benefit is now $2P_0$.

FIGURE 4.2 ILLUSTRATING THE ROHLFS-GRIFFIN FACTOR "e"
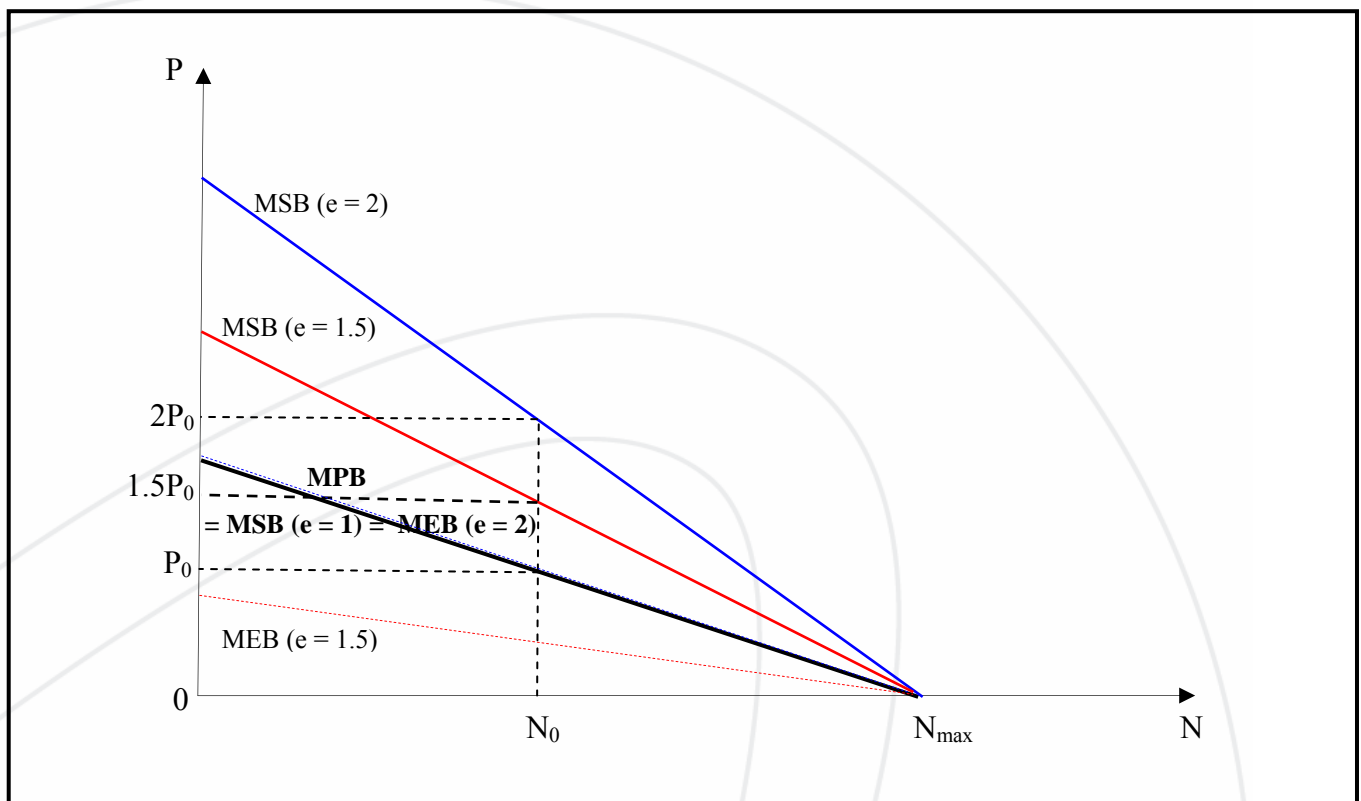
Further, it is apparent that unlike the outcome depicted in Figure 4.1, which assumes the MEB = 0 at some level of subscription where the marginal private benefit is still positive, while Rohlfs' approach assumes that the MEB > 0 over all levels of subscription where there is some positive marginal private benefit from subscription. Alternatively, using the term e to denote the network externality factor more generally, Figure 4.1 uses an externality factor that varies depending upon the level of subscription — i.e. $1 < e \leq 2$ when $N \leq \overline{N}$, but $e = 1$ when $N > \overline{N}$ — while the R-G factor outlined by Rohlfs remains constant as long as there is a positive marginal private benefit from subscription. CRA (B. Mitchell and P. Srinagesh) do appear to provide support for the use of the type of variable externality factor or R-G factor employed in Figure 4.1, rather than the simple constant term, as they state on p 35 that:

> In the context of business subscribers, it is likely that the Rohlfs-Griffin factor will decline as penetration increases....To the extent that some subscribers (especially business subscribers) are substitutes for other subscribers, one might expect that the Rohlfs-Griffin factor will decline as penetration of telephone service increases....Consequently, the Rohlfs-Griffin factor is likely to be higher in any Latin American country than it is in the UK.

One implication of employing a constant R-G factor is that the network externality will always be "Pareto-relevant". Consequently, a below-cost price is required to achieve the Pareto-optimal outcome. That is, using subscript 1 to denote the outcome for the subscription service, the marginal condition for an unconstrained Pareto optimum is,

$$e \times P_1 = MC_1$$

$$\text{or} \tag{2}[51]$$

$$P_1 = MC_1/e < MC_1$$

As outlined in Section 4.1.1, the need for a below-cost price in order to maximise welfare in equation (2), means that it is possible when there are common network costs to be recovered, for the resulting R-B

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[51] This outcome is outlined in *Appendix B*, equation (B.31), and shown diagrammatically in Figure B.12.

price for subscription — which satisfies the outcome in equation (3) when there are cross-price effects with a product denoted by subscript 2 — to be below marginal cost.

$$\frac{\left(P_1^R - \dfrac{MC_1}{e}\right)}{P_1^R} = \frac{\theta}{\left[\dfrac{e\hat{\eta}_1^R}{1-(1-e)\hat{\eta}_1^R}\right]}, \quad \hat{\eta}_1^R = \varepsilon_1 \frac{\varepsilon_1\varepsilon_2 - \varepsilon_{12}\varepsilon_{21}}{\varepsilon_1\varepsilon_2 - \varepsilon_1\varepsilon_{12}} \qquad (3)^{52}$$

An illustration that a second-best efficient outcome of subsidising subscription is not guaranteed when the network externality is Pareto relevant is highlighted by both Rohlfs and Griffin. Employing what is now referred to as the R-G factor, both derived efficient R-B prices for local subscription in US Bell's fixed-line telephony service that were still above cost.[53]

4.2.2 Problems with the R-G Factor

In examining the issue of whether network externalities are measurable and whether they should be taken into account, BCLN note on p 21 that:

> The answer to this question is important, because any regulatory approach to take care of externalities in the pricing system requires appropriate and reliable quantification. If for instance, the effects of network externalities are small and the method of quantifying them is arbitrary, then it would be preferable for the regulator to ignore the effect to avoid distorting pricing structures.

While the R-G factor can be used to approximate the impact of network externalities, it was outlined earlier in Section 2.2 that it should not be considered a definitive method for capturing network externalities. Further, there is a degree of arbitrariness in choosing the appropriate value for the R-G factor. This seems to be acknowledged by Rohlfs, when he states on p 6 that it is "extraordinarily

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[52] A derivation of the outcome with no cross-price effects can be found in *Appendix B*, Section B.5.4.

[53] See Brown and Sibley on p 199.

difficult" to measure externalities,[54] and the term e must subsequently be formulated "by judgement".[55] Given the arbitrary nature of the value used for the R-G factor; the inability to accurately quantify the level of the network externality; and the fact that the Australian mobile market has reached a point of natural saturation; it is arguable that the network externality may now be ignored. Inappropriately modelling the network externality, such as using a constant R-G factor when the network externality is more appropriately captured by a variable externality or variable R-G factor that becomes smaller as the level of subscription increases, can lead to inefficiency.

FIGURE 4.3 THE INEFFIENCY OF INCORRECTLY ESTIMATING NETWORK EXTERNALITY SIZE: EXAMPLE 1
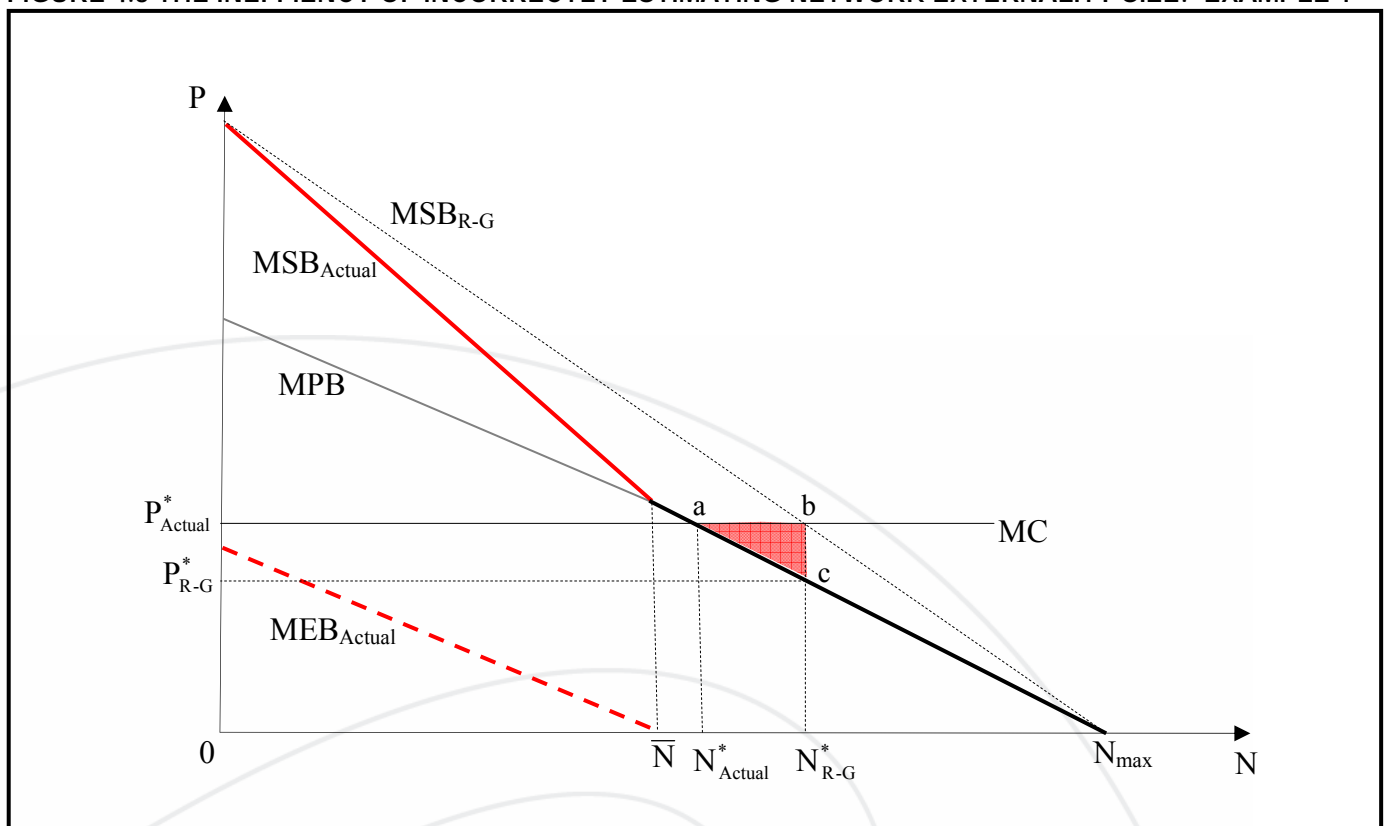
For example, if a constant externality factor is used, such as in Figure 4.2 to estimate the impact of the network externality, but the actual network externality is more accurately depicted by the outcome in

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[54] R.W. Crandall and J.G. Sidak, "Should Regulators Set Rates to Terminate Calls on Mobile Networks", *Yale Journal on Regulation* 21, 2004, pp 264-319, makes a similar point on p 299, stating that: "The difficult question is how to value the network externality".

[55] The arbitrariness associated with the R-G factor also appears to be recognised by Brown and Sibley who state on p 198 that: "Clearly, it is difficult to measure e".

Figure 4.1 where the network externality is no longer Pareto-relevant; then there will be a resulting deadweight-loss to society. This outcome is shown in Figure 4.3.

In the diagram, the actual outcomes are denoted by the subscript "Actual", while the outcomes derived through using the R-G factor are denoted using subscript "R-G". Here, employing the R-G factor suggests that a below-cost price of $P^*_{R\text{-}G}$ must be charged in order to achieve the socially-optimal level of subscription $N^*_{R\text{-}G}$. However, because the market has reached a point of natural saturation and there is no longer an external benefit associated with subscription, the welfare-maximising outcome is actually achieved by charging the competitive market price of $P^*_{R\text{-}G}$, which induces the lower level of subscription N^*_{Actual}. Therefore, in this instance, use of a constant R-G factor to approximate the impact of the network externality, leads to inefficient over-subscription and a deadweight-loss equal to the red-shaded area abc.

FIGURE 4.4 THE INEFFIENCY OF INCORRECTLY ESTIMATING NETWORK EXTERNALITY SIZE: EXAMPLE 2
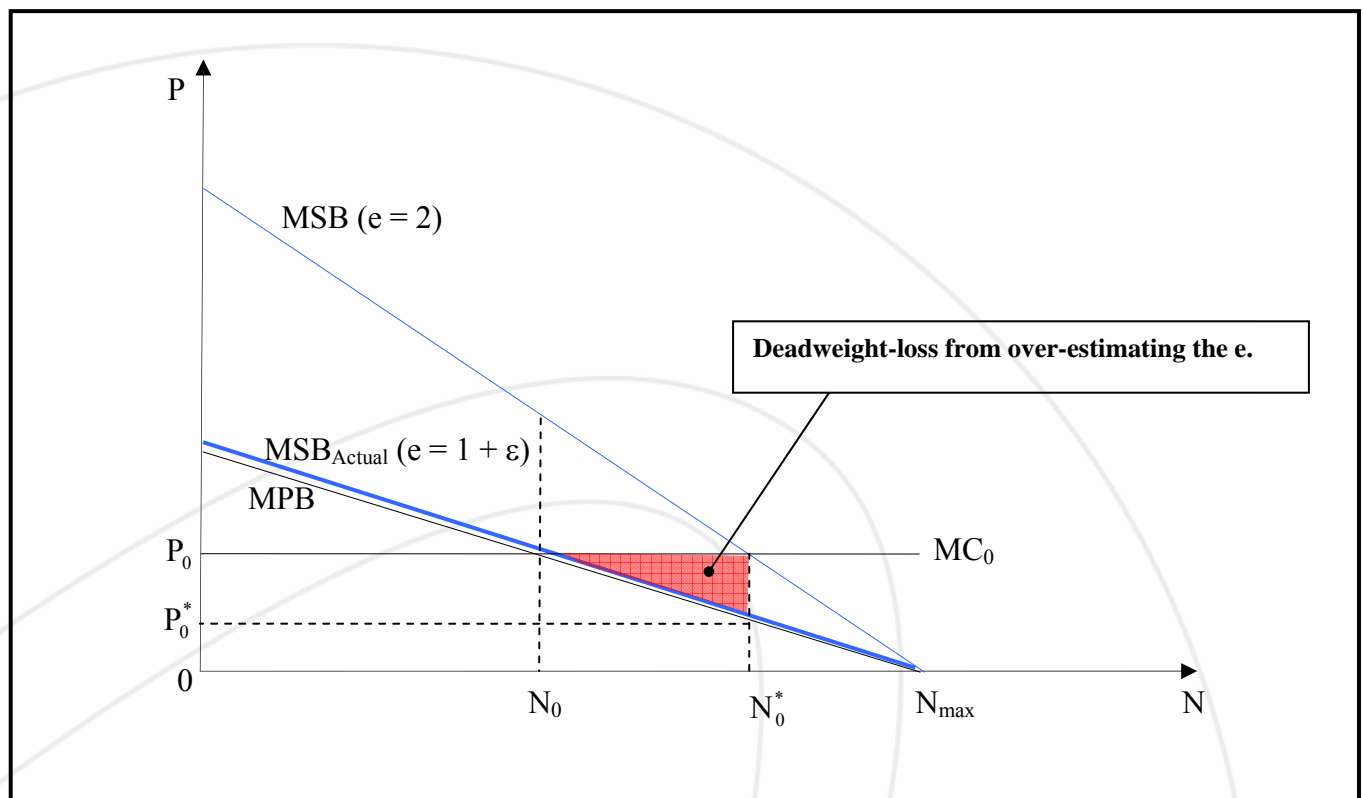
Even if it were appropriate to use the R-G factor to capture the network externality, where there was a very small marginal network externality, but it was "guessed" to be very large, the use of the wrong R-G

factor would lead to a recommended price that is likely to generate a greater inefficiency than would arise from simply ignoring the network externality. To illustrate this point the diagram in Figure 4.4 is used.

The diagram examines an extreme scenario where it is assumed that there is an actual value for e of $1 + \varepsilon$, where $\varepsilon \to 0$, but to set the optimal price the term e has been estimated to be 2. Now, assuming that a subsidy can be provided at zero cost, a price P_0^* is set, as it is believed that this will generate the optimal outcome for society. However, the result is a deadweight-loss to society from over-subscription equal to the red-shaded area. If instead, the network externality was just ignored and a price of P_0 set, then the resulting deadweight-loss would be negligible.

As the earlier quote from p 35 of the CRA (B. Mitchell and P. Srinagesh) document indicates that:

- a variable rather than constant R-G factor should be employed; and

- the value of the R-G factor is likely to be smaller in developed countries with higher penetration rates (eg Australia);

there is the potential for the type inefficiencies outlined in Figures 4.3 and 4.4 to arise in the Australian mobile market, by relying upon modelling that uses inappropriately large R-G factors that remain constant over subscription. While Frontier Economics derived various second-best efficient prices using different values for the R-G factor in their model,[56] AAPT believes that this is a rather arbitrary approach that fails to capture the type of variability of the externality factor over subscription that has been suggested will arise by CRA (B. Mitchell and P. Srinagesh). Further, the need to test prices for so many different values of the R-G factor should in itself highlight to the ACCC just how arbitrary this type of approach actually is in capturing the impact of network externalities.

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[56] CRA (C-W. Cheah, P. Muysert, P. Reynolds and A. Shelley) appear to only model the optimal price for an R-G factor equal to 1.5. See, CRA (C-W. Cheah, P. Muysert, P. Reynolds and A. Shelley), *Pricing Mobile Termination in Australia*, A Submission prepared on behalf of Singtel Optus, 22 December 2004, p 40, available at http://www.accc.gov.au/content/item.phtml?itemId=573237&nodeId=file425216ae7cd1d&fn=Appendix%20II%20to%20Optus%20MTAS%20undertaking%20submission.pdf

4.3 Other Types of Externalities

4.3.1 Call Externalities

The analysis in *Appendix B*, Section B.5 notes that in the provision of telecommunications services, aside from the network externality, there is also the potential for a call externality to arise. This is the benefit that a subscriber obtains from receiving a call that it does not have to pay for. In order to increase usage in a caller party pays system, and internalise any call externality that exits, there must be a lower price for calls.

Squire[57] was one of the first to formally analyse the impact of the call externality on efficient pricing. He established that in the presence of a call externality, marginal cost pricing was no longer efficient. Instead he states on p 524 that,

> In general, the price of calls should be less than their marginal costs by a margin representing the external benefit received by the "callee."

In the context of the mobile market, the existence of a call externality implies that there should be a lower price on FTM calls. Armstrong highlights this on p 344, stating that,

> …if mobile subscribers derive a benefit from incoming calls, then the regulator should set the termination charge *below* cost in order to encourage calls from the fixed sector.

While as outlined in *Appendix B*, Section B.5, economists have tended to emphasise the significance of network externalities, they appear to have downplayed the importance of call externalities. This is highlighted by Hahn,[58] who states on p 950 that:

> The call externality, however, has been given little attention in the literature, which is somewhat surprising considering roughly half of the benefits of using a telephone service is from receiving calls.

Hahn suggests that one reason for this is "probably because there has been no market mechanism by which consumers can express their preference for incoming calls". Further, Mitchell and Vogelsang note

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[57] L. Squire, "Some Aspects of Optimal Pricing for Telecommunications", *Bell Journal of Economics* 4, 1973, pp 515-25.

[58] J-H. Hahn, "Nonlinear Pricing of Telecommunications with Call and Network Externalities", *International Journal of Industrial Organization* 21, 2003, pp 949-67.

that a difficulty when assessing call externalities is that the demand for incoming calls is not readily observable, and cannot easily be related to other variables such as, outgoing calls, other purchases, or the number of subscribers.

A number of economists, such as Littlechild,[59] Rohlfs, and Willig,[60] have chosen to ignore call externalities in their analysis. They argue that call externalities can probably be easily internalised, as unlike the network externalities, which affect all existing subscribers, call externalities only involve two economic agents. For example, Willig states on p 133 that:

> The expression in equation (55) makes it clear that the marginal network externality effects that are relevant for pricing are potentially spread over all consumers with network access. In contrast, the effects of potential uninternalized values of incoming flows discussed earlier were concentrated on one consumer. For this reason, it was argued that such values were indeed likely to be privately internalized.

Further, Rohlfs notes at p 5 that two frequent callers could easily arrange to call each other half the time, thereby sharing the costs and roughly internalising any externality associated with the calls.

Mitchell and Vogelsang at p 60, and Hahn at p 950, however, both question the ease with which call externalities can actually be internalised by parties. Citing the work of Acton and Vogelsang,[61] they note that the Coase theorem is hard to apply in such situations, because the negotiations between a caller and a receiver that would lead to the internalisation of the call externalities, themselves, require costly telephone calls to be made. Both authors also summarise the results from Einhorn,[62] and Mitchell and Vogelsang states on p 61 that:

> The main result that can be derived in this context is that the importance of the call externality relative to the network externality increases with subscriber penetration.

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[59] S.C. Littlechild, "Two-part Tariffs and Consumption Externalities", *Bell Journal of Economics* 6, 1975, pp 661-70.

[60] R.D. Willig, "The Theory of Network Access Pricing", in H. Trebing (ed.), Issues in Public Utlilty Regulation, Michigan State University, East Lansing, 1979, pp 109-52.

[61] J.P. Acton and I. Vogelsang, "Telephone Demand Over the Atlantic — Evidence from Country-Pair Data", Technical Report R-3715-NSF/MF, RNAD, Santa Monica, 1990.

[62] M. A. Einhorn, "Regulatory Biases in Network Pricing with Access and Usage Externalities", mimeo, 1990.

Mitchell and Vogelsang subsequently conclude in relation to the optimal R-B prices that, "the price/marginal-cost markup for calls, relative to that for access, should decrease as penetration rate increases."

As it was highlighted earlier that the Australian mobiles market has reached a level of natural saturation, where according to IDC "every Australian who could be using a mobile phone is already using one", the result of Einhorn suggests that even in the unusual circumstance that network externalities were to matter in Australia, their relative importance compared to the call externality will have declined. Therefore, the optimal payment may require a decrease in the retail price for FTM services, and it is possible in the extreme case that subscription may be required to cross-subsidise FTM services.

4.3.2 Fixed-Line Network Externalities

While the analysis in Sections 4.1.2 and 4.1.3 examined network externalities in the context of mobile subscription, similar network externalities will exist for fixed-line subscription. As BCLN note on p 24,

> …taking into account network externalities for one type of network whilst ignoring it in another distorts competition between these two types of networks.

Although it is probably the case that the level of fixed-line penetration is currently such that fixed network externalities are not relevant, increasing fixed-to-mobile substitution by customers may eventually reach a point where the fixed-line externality may need to be taken into account once again. Consequently, rather than having fixed network operators (FNOs) in Australia subsidising MNOs, the efficient outcome may in fact eventually require MNOs to subsidise FNOs. A similar point is raised by BCLN, as they outline on p 24 that due to there being a higher penetration rate of mobile than for fixed network on the basis of personal communications, and an increasing trend for substitution in favour of mobile networks:

> …network externalities should be more of a policy concern for fixed networks than for mobile networks. If that is the case, regulators should have less rationale to tax fixed network users (via higher termination rates) in favour of increasing mobile penetration at levels which are already higher in mobile than in fixed networks.

This potential complication leads BCLN to conclude that in relation to network externalities that:

> …the best advice to regulators would appear to be to tax neither fixed network users for network externalities in mobile networks, nor to tax mobile users for network externalities in fixed networks, until the future trends in substitution between mobile and fixed networks become better understood.

The possible significance of fixed-line network externalities also has implications for optimal pricing in the Frontier Model, as it suggests that a truly welfare-maximising pricing model would solve for the socially-optimal prices across all services in the mobile and fixed-line networks.

4.3.3   Congestion Externalities

While both the network and call externalities are examples of positive externalities, it is also possible in telecommunications for there to be negative externalities arising from high levels of network usage. For example, Sidak and Spulber outline the negative congestion externalities that can arise in fixed-line local telecommunications network on p 548:

> Economists have given less attention to the negative externalities from higher levels of network usage. Nonetheless, negative network externalities relating to congestion plainly arise notwithstanding the conventional view that networks have such expansive economies of scale that capacity is seemingly unlimited. That cheerful view overlooks that the design of local telecommunications networks is predicated on probabilistic estimates of congestion in the use of familiar functions…that consumers may have come to assume are available at all times on an unlimited basis.

Sidak and Spulber note on p 549 that,

> Pricing access below cost is likely to lead to congestion externalities by failing to send correct pricing signals to consumers…

4.4   Network Welfare and Externalities (Inconsistent modelling by Frontier)

Reading the initial submission by Frontier Economics on *Modelling Welfare Maximising Termination Rates* in conjunction with its subsequent submission on the *Waterbed Effect* is problematic,[63] as:

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[63] Frontier Economics, *The Waterbed Effect*, A Report prepared for Vodafone, July 2005, available at http://www.accc.gov.au/content/item.phtml?itemId=700368&nodeId=file42eef83c48eef&fn=Frontier%20report%20on%20waterbed%20effect%20%E2%80%94%20July%202005.pdf

1. The waterbed effect arguments are sustained using a theoretical model that is inconsistent with the model adopted by Frontier Economics in deriving its welfare-maximising prices; and

2. The waterbed effect analysis appears to confuse the distinct concepts of network externalities and complements, and this can potentially lead to problems with measuring the overall welfare impact of price changes.

4.4.1 Inconsistent Modelling by Frontier Economics in their Submissions

In relation to the first point, Frontier Economics bases its analysis of the Waterbed Effect on a framework where:

- it combines the subscription and mobile originated services into a single demand curve for "retail services" for mobiles — see paragraph 17. In its actual modelling to derive the optimal price however, the subscription service is given its own unique demand curve;

- it claims that there is "complementary" relationship between demand for the combined retail mobile service and the mobile termination services. A complementary relationship implies that some type of cross-price effect exists between services. However, in the modelling done by Frontier Economics to derive its optimal R-B prices, no cross-price effects is assumed to exist between either the FTM and mobile subscription services, or the FTM and mobile originated call service. That is, these cross-prices effects in the actual model are simply set equal to zero; and

- the combined subscription and mobile originated services must have some effective retail price that is above cost in order for the analysis based upon total revenues to be consistent with analysis done using overall profit. It is questionable whether or not such an assumption can simply be made, as many of the arguments made by mobile network operators (MNOs) suggest that it is efficient for there to be some type of below-cost pricing for subscription, or a handset subsidy.

AAPT does not understand how Frontier Economics and Vodafone can legitimately use one theoretical model in its derivation of the R-B prices, yet rely on a completely different theoretical framework to

make their arguments about the waterbed effect. On this basis that AAPT believes that much of analysis in the Frontier Economics paper on the waterbed effect should be simply disregarded. Further, AAPT believes that there is a mistake in the way in which the complementary relationship is being modelled and possibly a mistake in the analysis on p 14. As the mistake in the way in which the complementary relationship is modelled is dealt with in greater detail in Section 4.4.2, only the problems with the analysis on p 14 are outlined for now.

Frontier Economics makes a claim that the level of any cost passthrough and resulting change in price will depend upon the elasticity of demand. In particular it states in paragraph 48 that:

> In general the more inelastic demand, the greater will be the change in prices resulting from a change in costs.

To prove this claim Frontier Economics uses a diagram in Figure 3, where there is a monopoly outcome, a constant marginal cost of production, and what appear to be linear demand curves. If it is the case that linear demand curves are being used then the Frontier Economics assertion is incorrect, as it is well known that with a linear demand curve and a constant marginal cost of production, the change in price will always be half the change in the marginal cost of production, regardless of how steep the demand curve is.

4.4.2 Network Externalities and Complementary Effects

To derive the socially-optimal prices Frontier Economics uses a model which assumes that:

- the relationship between subscription and FTM services is based upon a network externality effect;

- there is no cross-price effect between either subscription and FTM services, or mobile originated services and FTM services; and

- there is a network externality effect between subscription and mobile originated services, and there is a cross-price effect between subscription and mobile originated services.

The impact of the network externality on the FTM market when there is a change in the price of subscription is correctly illustrated in Frontier Economics' initial submission in Annex 1, Figure A1.2, p 21.

In its later analysis on the Waterbed Effect however, Frontier Economics appears to want to describe the relationship between the combined retail service and the mobile termination service, as complementary. The key difference between the two is as follows. A network externality involves a one-way effect — i.e. a decrease (increase) in the subscription price increases (decreases) the demand for FTM services, but a decrease (increase) in the FTM service price does not impact at all upon the demand for subscription. A complementary relationship meanwhile involves a two-way or reciprocal effect — i.e. a decrease (increase) in the subscription price increases (decreases) the demand for FTM services, and conversely, a decrease (increase) in the FTM price increases (decreases) the demand for subscription.

While Frontier Economics attempts to describe the relationship in its analysis of the waterbed effect as complementary, it has clearly not modelled a two-way effect in any of its diagrams. When decreasing the price for retail mobile services, the analysis in Figure 1 suggests that there must be a shift out in the demand for mobile termination services at the existing prices, as a higher level of total revenue is achieved. However, when Frontier Economics analyses the impact of a decrease in the price for termination services, it does not lead to any increase or shift out in the demand curve for the combined retail services in Figure 2. In terms of a shoe analogy — shoes being appropriate as they are an example of a perfect complement — the analysis of Frontier Economics amounts to saying that for a pair of shoes, an increase in the price of a left shoe will impact upon the demand for a right shoe, but a change in the price of right shoe will have no impact on a change in demand for a right.

Neglecting the impact of mobile termination services pricing on the demand for retail services suggests that Frontier Economics either, do not understand how a complementary relationship works, or that Frontier Economics is actually describing the impact of a network externality. Clearly, if Frontier Economics were to maintain that it is complementary relationship that they intended analyse, then this is likely to change the conclusions that they would be able to reach on the Waterbed Effect. The reason is that for a given price in retail mobiles services, a decrease in the price of FTM services would lead to an increase in demand for retail mobile services and a corresponding increase in overall revenues in that market.

The emphasis on distinguishing between network externalities and complementary effects has so far been isolated to examining the differences between the impact on demand, and potentially revenue. However, there is also a particularly important distinction to draw between measuring the overall welfare change.

FIGURE 4.5 WELFARE CHANGES WITH COMPLEMENTS AND NETWORK EXTERNALITIES
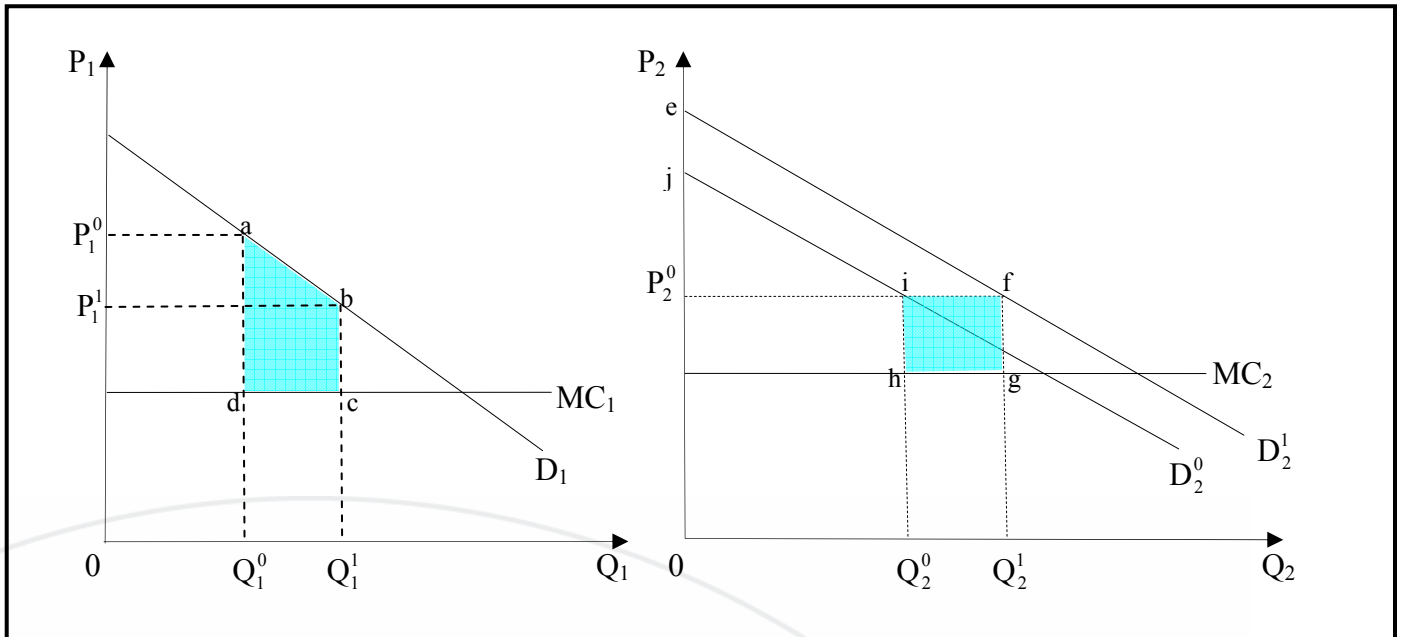
Where there are two goods — i.e. good 1 and 2 — in a complementary relationship, Figure 4.5 shows that a fall in the price in market 1 from P_1^0 to P_1^1, will lead to a shift out in the demand for good 2 from D_2^0 to D_2^1. If price is equal to marginal cost in market 2, then while there will be an increase in demand there will be no change in efficiency in market 2, then the overall welfare change will be equal to the welfare gain in market 1 — i.e. area abcd. If, however, the price in market 2 is distorted way from marginal cost, and set at P_2^0, then there will be a welfare gain equal to the Harberger[64] rectangle of area ifgh in market 2, and the overall welfare gain from the price decrease in market 1 will be equal to abcd + ifgh. Significantly, in this diagram, the area between the two curves and above the original price in market 2 — i.e. area efij — does not reflect an overall welfare gain. In contrast, if there was a network externality

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[64] A. Harberger, "Three Basic Postulates for Applied Welfare Economics: An Interpretative Essay", *Journal of Economic Literature* 9, 1971, pp 785-97.

resulting from an increase in demand in market 1, the analysis of Willig[65] on p 116 in Figure 2 suggests that the incremental consumer surplus captured by area efij is part of the overall welfare gain. Therefore, based upon the analysis of Willig, a price decrease in market 1 combined with an above-cost price in market 2 of P_2^0, will lead to an overall welfare gain of abcd + efghij.

The above results highlight that distinguishing between a network effect and complementary relationship is extremely important in terms of measuring or assessing the overall welfare effects. Further, if there is a combination of both effects occurring then treating the entire incremental consumer surplus as a welfare increase will lead to the overall welfare gain being overstated, while ignoring the entire incremental consumer surplus as a welfare loss may understate the overall increase in efficiency.

5. Conclusion

This submission highlights problems with the analysis done by Vodafone and Frontier Economics on Vodafones' behalf. It raises doubts about the understanding and academic integrity of the work done by Frontier Economics on R-B pricing, and highlights a number of inconsistencies in the theoretic modelling used by Frontier Economics to derive the socially-optimal price and the waterbed effect results. Further, the submission illustrates that:

- The R-B price derived by Frontier Economics are likely to be inappropriate for recovering the common network costs, as Frontier Economics has chosen to ignore a number of important services over which the costs should be allocated;

- R-B prices are consistent with the exercise of market power as defined by Laffont and Tirole, and results from contestable market theory do not provide a legitimate reason for why R-B prices are consistent with competitive outcomes;

- There is little if any support for the use of R-B prices in a practical regulatory context, due to the difficulties associated with obtaining accurate and up-to-date estimates of the relevant demand elasticities. An appropriately designed TSLRIC model and a TSLRIC+-based price is

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[65] R.D. Willig, "The Theory of Network Access Pricing", pp 109-52, pp 109-52.

subsequently likely to provide a better estimate of the appropriate price for the MTAS, and should be consistent with R-B pricing principles that it is suggested regulators should impose;

- The Australian Mobile Market has reached a level of natural saturation, so the marginal network externality in the mobile market is likely to have either diminished in importance, or simply have disappeared;

- The value of the R-G factor used to measure network externalities is arbitrarily set, and there is no empirical justification for its use. Further, even if it were appropriate to use the R-G factor to capture the network externality:

  - it may be more appropriate to use an R-G factor that varies over subscription, rather than the constant R-G factor generally employed by Frontier Economics in its modelling; and

  - the use of an incorrect value could lead to a greater inefficiency than would arise if the network externality were simply ignored;

- With increasing fixed-to-mobile substitution, it is possible that fixed network externality may soon be of greater significance than the mobile network externality;

- The call externality has the opposite impact on the FTM price to the network externality, and it is likely to become of increasingly important as higher levels of subscription are reached; and

- The call and network externality, may already be internalised without any need for corrective pricing.

Based upon the above, and the reasons presented by AAPT in other supporting submissions in response to Vodafone's undertaking, AAPT believes that the ACCC should reject Vodafone's Mobile Terminating Access Service Undertaking.