Comparing TSLRIC and TELRIC

A Report on behalf of AAPT Ltd

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Executive Summary

The Australian Competition and Consumer Commission (ACCC) has, on many occasions, stated that it favours a total service long-run incremental cost (or TSLRIC) approach to access pricing in telecommunications. In contrast, Telstra's latest undertakings are explicitly based on a total element long-run incremental cost (or TELRIC) approach (as in its PIE II model). This is an approach that has been employed in the US.

While many consider the two approaches to be practically the same, this report demonstrates that this is not the case on both a conceptual and practical level. We consider both the conceptual and the practical differences between TSLRIC and TELRIC. At a conceptual level, the two measures will differ whenever there are shared network elements and part of the cost of these elements is a common cost and part is an incremental cost of the services that use the shared element. There are likely to be many such elements in a fixed line telecommunications network. For example, most switches that are engineered to cope with total service flows have both common and incremental cost aspects.

In such situations, TELRIC modelling can potentially lead to inappropriate service pricing. We show that TELRIC pricing, when applied to services, cannot guarantee that service prices do not fall below the economically appropriate price floor set by long run incremental cost, and TELRIC pricing cannot guarantee that service prices do not rise above the economically appropriate ceiling set by stand alone cost. If TELRIC prices for services violate relevant price floors or price ceilings, then this implies that there are inappropriate economic service prices and that some services may be artificially cross subsidising other services.

At a practical level we show that the TELRIC modelling incorporated in PIE II will differ significantly from appropriate TSLRIC pricing. In particular, because PIE II does not include all the services that use some or all of the PSTN, it almost certainly excludes some services that share common costs with PSTN originating and terminating services and the other UT Services. This means that the costs determined by PIE II will tend to be systematically biased upwards.

We conclude that TELRIC pricing, and in particular the PIE II model, is inconsistent with TSLRIC pricing and can lead to economically inappropriate and biased prices when erroneously applied to services such as PSTN originating and terminating access.

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1 Introduction

In February 2003, Telstra submitted its proposed undertaking for PSTN interconnection pricing to be evaluated by the Australian Competition and Consumer Commission (ACCC). Telstra's proposed interconnection prices are based on estimates of an 'efficient network' and associated costs using the PIE II model.[1] As Telstra notes, the PIE II model is a total service long run incremental cost (TELRIC) model.[2] Telstra argues that "[t]he network Efficient Costs of a UT Service are best approximated by using a total element long run incremental cost ("TELRIC") model."[3]

At the same time, Telstra "accepts that the prices for the UT Services will be set on the basis of their TSLRIC plus an allocation of common costs, most importantly the PSTN CAN costs and any service specific costs."[4]

The ACCC noted this apparent discrepancy between Telstra's claimed approach and the methodology embedded in PIE II in its Discussion Paper.[5] In that Paper, the Commission invited views on the differences between TSLRIC and TELRIC, including the importance of any differences and the appropriateness of these alternatives "for the purpose of calculating the efficient costs of supplying the PSTN O/T and ULLS access services." (p.20)

AAPT has asked us to prepare this paper as a response to the Commission's request. We proceed as follows. Section 2 reviews cost concepts in economics and why TSLRIC has become an appropriate pricing benchmark for the regulation of the telecommunications industry. Section 3 then introduces the concept of TELRIC while section 4 provides a comparison of the two concepts in the context of PSTN interconnection pricing. A final section concludes.

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[1] *Telstra's submission in relation to the methodology used for deriving prices in its proposed undertakings (Telstra's submission)*, 9 January 2003, Introduction, paragraph 6.

[2] *Telstra's submission*, Introduction, paragraph 7.

[3] *Telstra's submission in support of its undertakings*, 9 January 2003, p.6.

[4] *Telstra's submission in support of its undertakings*, 9 January 2003, p.5.

[5] Australian Competition and Consumer Commission, *Telstra's undertaking for domestic PSTN originating and terminating access, unconditioned local loop service and local carriage service: Discussion paper*, March 2003, p.18-19.

2 Total Service Long Run Incremental Cost (TSLRIC)

The concept of total service long run incremental cost (TSLRIC) developed out of the theory of costing for multi-product firms. Much of this theory was developed in the late 1970s and early 1980s and was developed to deal with inadequacies when common cost concepts were applied to multi-product firms.[6] To fully appreciate the concept of TSLRIC, it is important to briefly review these basic cost principles.

2.1 Cost concepts and TSLRIC

Economists describe an (efficient) firm's technology by the type of costs that the firm bears when it produces its output. Broadly speaking, economists break costs into fixed costs and variable costs. "Some costs, called fixed costs, do not vary with the quantity of output produced."[7] In other words, these are costs that the firm must bear when it produces a positive quantity of output but these costs do not change as the exact level of the firm's output changes. In contrast, "[s]ome of the firm's costs, called variable costs, change as the firm alters the quantity of output produced."[8] Total costs are simple the sum of all fixed and variable costs.

A cost that is of key importance to much economic analysis is marginal cost. "Marginal cost tells us the increase in total cost that arises from producing an extra unit of output."[9] Two important features should be noted about marginal cost. First, it only considers an increase in output by one unit. Second, the concept of marginal cost can be applied to a firm regardless of whether the firm produces only one product or the firm produces a variety of products. Of course, for a multi-product firm, the marginal cost of one of its

[6] A useful reference that summarises much of the literature on multi-product firms up to the end of the 1980s is Panzar (1989).

[7] Gans, King and Mankiw (2003, p.269). Similar definitions can be found in most introductory texts on microeconomics.

[8] Gans, King and Mankiw (2003, p.270).

[9] Gans, King and Mankiw (2003, p.272).

products will generally differ from the marginal cost of another of its products.

Marginal cost can be contrasted with average cost. For a firm that produces only a single well-defined product, average total cost is simple the total cost of production divided by the total quantity of output. It is similarly possible to define average fixed cost and average variable cost. Average cost cannot usually be uniquely defined for a multi-product firm. This is because, for a multi-product firm, there is no unique 'quantity of output' that can be divided into total costs. For example, suppose a shop sells 100 cups of coffee and 50 newspapers and that its total costs are $1000. To calculate average total cost it is necessary to divide total cost by a quantity. But should the quantity be just the number of cups of coffee, just the number of newspapers, or some 'combination' of the coffee and the newspapers? If a 'combination' of cups of coffee and newspapers are used, then how should these different goods be combined? For these reasons, additional cost concepts have been developed by economists in order to deal with multi-product firms.

For a multi-product firm, total production costs depend on the total amount of each product produced. Broadly speaking, total costs for a multi-product firm may be broken down into costs that are specific to an individual product and costs that are not specific for a single product. The latter are called 'common costs.' "Costs that are not attributable to any particular good or service are called *common costs*. Common costs can be fixed costs but they need not be."[10] Costs that are product specific or are attributable to a single product are referred to as the incremental cost of that product. The long run incremental cost (LRIC) of an individual product refers to the product-specific costs associated with the total volume of output of the relevant product. More formally, the LRIC of an individual product is the difference between the total costs incurred by the firm when producing all products, including the individual product under analysis, and the total costs of the firm when the output of the individual product is set equal to zero, holding the output of all other products fixed.[11]

[10]Sidak and Spulber, 1997, p.23, emphasis in original. Further, Sidak and Spulber, p.312-313 (emphasis in original) note that "A firm's *common* costs are costs incurred in the provision of some or all of the firm's services that are not incremental to any individual service. Hence, common costs can only be avoided by shutting down the entire firm or by not producing a particular group of services under study." Sidak and Spulber (p.312-313) also note that the term 'joint costs' is sometimes used.

[11] It is possible to also talk about the incremental cost of a group of products. This refers to the costs of the relevant firm that are specific to either an individual

A simple example might help clarify the concept of LRIC. Consider a firm that supplies specific volumes of two separate products, *A* and *B*. The firm produces these products using a common infrastructure facility that has a cost of *F*. All of this facility is required to produce either product by itself. In addition to this common cost, the product specific cost of supplying the relevant volume of each product is given by C_i where *i* refers to a specific product with $i = A$ or *B*. The long run incremental cost of supplying product *A* is simply given by C_A. To see this note that total production costs are given by $F + C_A + C_B$. If the firm decided to produce none of product *A* but to retain its current volume of product *B*, then its total production costs would be $F + C_B$. The total cost saving by ceasing to produce product *A*, holding the volume of product *B* fixed, is given by the product specific cost C_A.

The concept of incremental cost needs to be distinguished from the concept of marginal cost. The marginal cost of product is the increase to total costs faced by a firm when it raises the output of the relevant product by one (and only one) unit. In contrast, the incremental cost of a product refers to the total current output of that product.[12] To avoid confusion between these two concepts the word 'total' is sometimes added to LRIC. Thus, the term 'total service long run incremental cost' (TSLRIC) is sometimes used to make it clear that the relevant increment in the product under discussion is the total output of that product.[13]

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product in the group, a combination of products in the group, or are specific to the group of products as a whole.

[12] As Panzar (1989, p.13) notes "the incremental cost of a product [is] the change in the firm's total cost caused by its introduction at the level y_i, or, equivalently, the firm's total cost of producing *y* minus what that cost would be if the production of good *i* were discontinued, leaving all other output levels unchanged." Note that in Panzar's terminology, *y* refers to the total output of all products by a multi-product firm (formally called the 'vector' of outputs) while y_i refers to the total output of a single product, denoted as product *i*.

[13] "The term 'total service,' in the context of TSLRIC, indicates that the relevant increment is the entire quantity of the service that a firm produces, rather than just a marginal increment over and above a given level of production. Depending on what services are the subject of a study, TSLRIC may be for a single service or a class of similar services. TSLRIC includes the incremental costs of dedicated facilities and operations that are used by only the service in question. TSLRIC also includes the incremental costs of shared facilities and operations that are used by that service as well as other services," Federal Communications Commission (FCC), *The first report and order re local competition*, Common Carrier Docket 96-98, 1996, paragraph 677.

Economists distinguish between a 'long run' and 'short run' on the basis of a firm's ability to unwind its fixed costs.[14] In particular, for any firm, in the short run, certain costs will be fixed in the sense that these costs could not be avoided even if the firm was to cease production. In contrast, the long run is the period of time such that all costs, including those costs that are fixed in the short run, can be treated as variable costs. The use of the term 'long run' in TSLRIC means that the costs to be included in the analysis of incremental cost include both fixed costs and variable costs related to the relevant product.[15]

The concept of incremental cost also needs to be distinguished from the concept of stand-alone cost. The stand-alone cost of any particular product is the total cost that a firm would incur if that firm produced the relevant volume of the particular product without producing any output of any other product. In the example presented above, the stand-alone cost of producing the relevant volume of product *A* is given by $F + C_A$.

A profit-maximising firm would not want to produce a particular product if the revenue it earned from that product fell below the TSLRIC. If the revenue were less than TSLRIC then the firm would be able to increase its profit by ceasing production of the relevant product (in the long run) while holding its output of all other products fixed. If the revenue that a firm earned from a particular product exceeded the stand-alone cost of that product then in theory another firm not currently producing the product would be able to profitably enter production in competition with the existing firm. This is because the revenue associated with the particular product exceeds the costs of just producing that product alone. If the revenue associated with a particular product falls between the TSLRIC and the stand-alone cost of that product then (a) it is profit maximising for the firm to continue producing the relevant product and (b) no other firm would wish to enter into the industry and compete by producing the particular product alone. As a result, it is sometimes claimed that incremental cost forms a relevant price-floor for an individual

[14] "The term 'long run,' in the context of 'long run incremental cost,' refers to a period long enough so that all of a firm's costs become variable or avoidable", Federal Communications Commission (FCC), *The first report and order re local competition*, Common Carrier Docket 96-98, 1996, paragraph 677.

[15] The ACCC (1997) *Access pricing principles – Telecommunications, a guide* (July, p.28) states that "TSLRIC is the incremental or additional costs the firm incurs in the long term in providing the service, assuming all of its other production activities remain unchanged. It is the cost the firm would avoid in the long term if it ceased to provide the service".

product or service while stand-alone cost forms a relevant price ceiling for that product or service.[16]

2.2 Technology and TSLRIC

TSLRIC is technology-dependent. Because TSLRIC analyses costs, if there are alternative technologies that involve different costs, then the TSLRIC value for a particular product will differ depending on the technology being costed. For example, there might be two alternative technologies. The first might involve a high degree of common costs but few product specific costs. The second might involve few common costs but high product specific costs. The TSLRIC for a particular product will be higher under the second technology than under the first technology, because TSLRIC focuses only on the product specific costs.

For regulatory purposes, TSLRIC estimates are usually based on 'forward looking' technology. This refers to the best technology currently available to produce the relevant set of outputs under analysis. For example, suppose that the first technology was an older technology that is used by an incumbent firm, but that the second technology is the current best technology available in the sense that the total production costs under the second technology are less than the total costs under the first technology. Then the forward-looking TSLRIC of an individual product would be calculated on the basis of the second technology – the best technology currently available.

TSLRIC estimates need not be based on forward-looking technology but could be based on actual or historic costs rather than on forward-looking costs.[17] Other cost-based approaches to telecommunications regulation also involve a choice between historic costs and forward-looking costs. There has been significant debate, particularly in the United States, on the use of forward-looking technology when establishing the access prices for various elements in a telecommunications network. When first implementing the 1996 Telecommunications Act in the U.S. the Federal Communications

[16] See for example Baumol and Sidak, 1994, p.66 and p77-78.

[17] "Because the practice is so widespread, it is often implicitly assumed that TSLRIC pricing must always be based on an optimised model of the network, and valued at replacement cost of modern equivalent assets. This is not correct, however. It would, for example, be possible to construct TSLRIC prices for a real rather than a notional network valued at historic rather than replacement cost," (CRNEC, 2001, paragraph 7).

Commission (FCC) considered the arguments both for and against the use of forward looking costs for regulatory purposes and decided to proceed with an approach based on forward looking costs.[18] This decision has been challenged in the courts and the ability of the FCC to use forward looking costs for telecommunications regulation was recently upheld by the U.S. Supreme Court.[19]

The use of forward-looking costs to estimate TSLRIC-based interconnection prices and other cost-based pricing in telecommunications has become relatively standard worldwide. "[T]oday most regulators and experts generally agree that the ideal approach for calculating the level of interconnection charges would be one based on forward-looking costs of supplying the relevant facilities and services."[20]

We do not consider the arguments in favour and against the use of forward-looking costs when determining telecommunications pricing. Rather, the emphasis here is on the difference between TSLRIC and TELRIC. Both of these can be measured using forward looking costs.

2.3 TSLRIC and common costs

As noted above, TSLRIC might be viewed as a relevant lower bound on the revenue earned by a multi-product firm from a particular product. However, if a firm only received revenue equal to TSLRIC for all of its products then, in general, it would make an economic loss. This is because TSLRIC only considers product specific costs but makes no allowance for common costs associated with multiple products. A firm that only received revenue equal to TSLRIC on all its products would make a loss equal to its common costs.

For this reason, when TSLRIC is used for regulatory purposes, it is usual to allocate some of the common costs associated with a regulated product to the revenue that can be earned from that product. For example, Intven notes that "TSLRIC measures the difference in cost between producing a service and not producing it. TSLRIC is LRIC in which the increment is the total service. Hence,

[18] See paragraphs 635 and 639 of Federal Communications Commission (FCC), *The first report and order re local competition*, Common Carrier Docket 96-98, 1996

[19] *Verizon v FCC*, May 2002.

[20] Intven (2000, p.3-25).

mark-ups are required to recoup a portion of joint and common costs, which are not included in TSLRIC."[21]

The cost measure that includes both the TSLRIC of a service and an allocation of relevant common costs has been referred to by the ACCC as TSLRIC+.[22] We adopt this terminology here.

Two points need to be noted with regards to increasing TSLRIC cost values to allow for common costs. First, economic principles state that fixed costs (including common fixed costs) should be allocated in a way that creates the least distortion to prices for the relevant product. In general, fixed costs should be recovered from fixed charges. More formally, the economically efficient recovery of fixed costs depends on the responsiveness of demand for the relevant product. If demand for a relevant product is relatively unresponsive then allocating more of the common fixed costs to that product will have little effect on the quantity of that product purchased and will lead to little economic distortion. In contrast, if demand for a relevant product is highly responsive to changes in price then an increase in the allocation of common fixed costs to that product, which leads to a rise in the product price, will lead to a large change in the quantity of the product consumed and a large economic distortion. The use of information about demand responsiveness (both own and cross price elasticities of demand) is a key element in efficiently allocating common costs.[23] If demand information is not used to efficiently allocate common costs then any allocation is unlikely to satisfy economic principles of maximum efficiency.

Second, care must be taken when determining true common costs of production from product specific costs that relate to facilities or

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[21] Intven, 2000, p.B15. See also Federal Communications Commission (FCC), *The first report and order re local competition*, Common Carrier Docket 96-98, 1996 at paragraph 643.

[22] "The existence of common (unallocable) costs means that pricing at TSLRIC fails to achieve overall cost recovery. … a practical 'solution' to the cost recovery problem has been found by including a contribution to common costs in TSLRIC (sometimes called TSLRIC+), but this involves an efficiency-in-use cost because the higher price means that some units are not supplied even though they have a value in use above their cost of provision to the economy", ACCC (2000) *Submission to the Productivity Commission Telecommunications Competition regulation Inquiry*, Attachment 3, p.2-3.

[23] See Laffont and Tirole (2000) particularly section 2.2.1. If the relevant product is a wholesale product such as PSTN access then the elasticity for the product is derived from the elasticity of demand for the retail product(s) produced using that input. As the input price rises this leads to a rise in retail prices and a reduction in consumers' purchases. The elasticity is a measure of this consumer response.

production processes that are used to produce more than one product. For example, suppose that a particular telecommunications product involves the use of a switch that is also used to produce a range of other telecommunications products. Further, if the relevant product was not produced at all, then a smaller (and less costly) switch could be used to provide the other products. Then, the increase in the cost of the switch that is required when the relevant product is produced is a cost that is specific to the product and is included in TSLRIC.

A simple extension to the algebraic example presented above may help to illustrate this point. Again, suppose that there are two relevant telecommunications products, *A* and *B*. The first product *A* might refer to local calls while the second, *B* might refer to PSTN interconnection services. As above, suppose that the variable, product specific costs associated with these services are C_A and C_B respectively, and that the cost of commonly used production elements is *F*. However, if only product *B* were produced then a smaller common element could be used with a cost F_B. Then the TSLRIC of product *A* is the total cost of producing both products at their current volumes, $F + C_A + C_B$ less the cost of production with current levels of product *B* and no product *A*, $F_B + C_B$. Thus, the TSLRIC of product *A* is $C_A + (F - F_B)$.

In our analysis comparing TSLRIC and TELRIC in section 4, we will use this extended algebraic example to highlight differences between these two cost approaches.

3 Total Element Long Run Incremental Cost (TELRIC)

While approaches to regulatory telecommunications pricing used in North America and Europe are based on notions of incremental cost, different countries use different approaches and the differences between these approaches have important practical implications.

Intven notes that "[t]he European Commission has adopted a TSLRIC-type approach, called, Long Run Average Incremental Cost (LRAIC) as its preferred costing methodology. The term 'average' is intended to capture the policy decision that defines the increment as the total service. LRAIC, hence, includes the fixed costs specific to the service concerned: 'service-specific fixed costs'."[24]

In contrast, the U.S. uses TELRIC. The term TELRIC was first used by the FCC when interpreting its roll under the U.S. 1996 *Telecommunications Act*. This Act was predicated on a high degree of unbundling by the Incumbent Local Exchange Carriers (ILECs). Thus, the Act was based on the idea that incumbent local exchange carriers (ILECs) would lease elements of the local telephone network to potential competitors. These competitors would then combine these elements together (possibly with their own elements) to provide relevant services for end users.[25]

In order to facilitate element-by-element unbundling of the local telecommunications network, the FCC modified TSLRIC to apply it to each individual element in the local telephone network rather than applying it to services that flow across the network. In other words, the starting point for the FCC in applying the 1996 *Telecommunications Act* was to consider an element-by-element break-down of the network and then to price individual elements on the basis of the cost of the individual element and the traffic flow across that element.

"TELRIC is the incremental or additional cost a firm incurs in the long run to provide a network *element*, assuming all of its other production activities remain unchanged.… TELRIC prices discrete

[24] Intven, 2000, p.B15

[25] See Rosston and Noll, 2002

network elements or facilities like the local loop and switching …" (Productivity Commission, 2001, p.622, note 1, emphasis in original)

The application of TELRIC in the U.S. has been controversial and, as already noted, has led to a number of disputes before the courts. When referring to the recent decision in *Verizon v FCC*, Kaserman and Mayo (2002, p.123) note that "[t]he Supreme Court Opinion unequivocally provides authority to the FCC to implement TELRIC pricing for unbundled network elements." But they also note the ambiguity in determining what is and what is not an 'element' under the 1996 *Telecommunications Act*. For example, "access to the local exchange network when the transmission involves a long distance call … may not be an 'element' under the Act" even though local call termination service is an 'element'. (p.123-4).

4 Does TELRIC differ from TSLRIC?

Some industry commentators have suggested that there is little if any difference between TELRIC and TSLRIC when setting interconnection prices. For example, the Productivity Commission (2001, p.622, note 1) argues that the distinction between TELRIC and TSLRIC is "somewhat arbitrary."

The FCC, when devising TELRIC, clearly saw it as a distinct approach to TSLRIC, albeit based on the same underlying ideas when applied to network elements. The FCC also noted TELRIC values will tend to differ from TSLRIC values. For example the element-by-element approach of TELRIC means that there are few common costs.[26] This avoids many of the cost-allocation issues associated with TSLRIC+.

The differences between TELRIC and TSLRIC fall into two categories – theoretical differences and practical differences. The main theoretical differences relate to the allocation of common costs. The practical differences, however, raise greater concerns. In practice, TELRIC based models, such as PIE II, cannot calculate TSLRIC because they do not include all relevant services. In other words, their element-by-element approach almost always fails to include the full range of services necessary for a TSLRIC analysis and effectively creates a stand-alone cost model. We discuss each of these differences in more detail below.

4.1 Theoretical differences

As noted above, the main theoretical differences between TELRIC and TSLRIC relate to the treatment of common costs. To see this, return to the extended algebraic example presented in section 2.3. Remember that there were two services, *A* and *B*. Production of these telecommunications services involved the use of some common infrastructure and some service specific costs. The product specific

[26] Federal Communications Commission (FCC), *The first report and order re local competition*, Common Carrier Docket 96-98, 1996, paragraph 678.

costs were denoted C_A and C_B for products A and B respectively. The costs associated with common network elements were denoted by F.

Let us detail this example further by considering the network elements that are needed to produce these two products. Suppose that there are three elements, X, Y and Z with forward looking costs of C_X, C_Y and C_Z respectively. For example X might be a link and Y and Z might be switches. Further, suppose that all of the cost of X is common in the sense that X is needed for both services and all of X is needed for either service. There is no cost saving for this element even in the long run if one service ceases. In contrast, Y is a common switch but the capacity of Y depends on the volume of traffic. If either service ceased in the long run then the capacity of Y could be reduced with a one-third saving in costs. Finally, Z is only used for product B.

We can move between service and element costs. Thus, in this example and given our assumptions, $F = C_X + C_Y$, $C_A = 0$, and $C_B = C_Z$. Remembering that the incremental cost of a service is the additional cost associated with that service then the incremental cost of A is given by:

$$LRIC_A = C_X + C_Y + C_Z - \left[C_X + \tfrac{2}{3}C_Y + C_Z\right] = \tfrac{1}{3}C_Y$$

while the incremental cost of service B is:

$$LRIC_B = C_X + C_Y + C_Z - \left[C_X + \tfrac{2}{3}C_Y\right] = \tfrac{1}{3}C_Y + C_Z .$$

Now suppose that the relevant service that requires regulatory price setting is service B. A TSLRIC approach begins with the Total Service LRIC for B, which is given by $LRIC_B$. The analysis then considers the common costs that need to be allocated. These common costs are the amounts not covered by the TSLRICs of the two services. Thus, the common costs are given by:

$$CC = C_X + C_Y + C_Z - \left[LRIC_A + LRIC_B\right] = C_X + \tfrac{1}{3}C_Y$$

Under a TSLRIC+ approach, some portion of these common costs would be allocated to the service that is being priced. Preferably, this allocation would be on the basis of demand sensitivity for the two products. However, in practice, common costs are often allocated on minutes of use (MOU) or 'call ends'. For example, suppose that the common costs were allocated on the basis of minutes of use, and the share of traffic through both X and Y that relate to service B is given by s. Then the TSLIRC+ associated with service B is:

$$TSLRIC+_B = LRIC_B + s.CC$$
$$= s.C_X + (1+s)\tfrac{1}{3}C_Y + C_Z$$

On this same basis, and noting that the share of traffic through both X and Y that relate to service A is given by $(1 - s)$, the TSLRIC+ for service A is given by:

$$TSLRIC+_A = (1-s)C_X + (2-s)\tfrac{1}{3}C_Y$$

These TSLRIC+ values would then be allocated over the relevant services to determine the prices of the services.

Alternatively, suppose that we were engaged in a TELRIC pricing proposal that was required to determine a price for the service B. A TELRIC approach considers each element individually and allocates the cost of that element over the services that use that element. In general, the allocation is on the basis of some measure of traffic through the element. Thus, element X is used by both services and if the cost of this element is allocated on the basis of traffic shares, then the share of C_X allocated to service A is $(1 - s).C_X$ while the cost $s.C_X$ is allocated to service B. Similarly, element Y is used by both services and given the volume of both services the optimally sized element Y will have a cost of C_Y. Again it will be allocated according to the traffic shares. Element Z, however, is only used by service B and so this service bears all the cost of the element.

From this, we can easily calculate the TELRIC values for the two services, just by adding up the allocated costs to each service over all elements. Thus, for service B:

$$TELRIC_B = s.C_X + s.C_Y + C_Z$$

while for service A:

$$TELRIC_A = (1-s)C_X + (1-s)C_Y .$$

Comparing the two alternative approaches, we can see that the TSLRIC+ values and the TELRIC values differ in the way that they treat the network element that is partially a common cost between the two services and partially an incremental cost. In general, the cost of element Y will be allocated differently depending on the traffic flows. In fact, in this simple example, the cost of element Y will only be allocated in the same way under TELRIC and TSLRIC+ if the traffic flows of the two services are exactly equal so that $s = 0.5$. But there is no reason why this needs to be the case and for any other traffic flows the TSLRIC+ and TELRIC measures will differ.

It could be argued that such differences are likely to be small in practice. After all, so long as the relevant cost 'breakdowns' for individual elements and the relative traffic flows are not 'too different' then the gap between TELRIC and TSLRIC+ is likely to be small.[27] But this is an empirical issue about which we have no useful information. Because Telstra has carried out a TELRIC modelling exercise rather than using a TSLRIC model, we do not know whether the difference between the two approaches is large or small for Telstra's network. All we know is that the TELRIC value provided by Telstra from its PIE II model is almost certainly *not* the same as a correctly evaluated TSLRIC+ value.

Further, the implications of the difference between TELRIC and TSLRIC+ can have important implications for interconnection pricing. Remember that the LRIC represents an appropriate floor on service pricing. If a service were priced below the long run incremental cost of that service then the producer would find it more profitable to stop supplying that service in the long run, even though the service may be socially desirable. But even in our simple example above, TELRIC pricing *cannot* guarantee that all service prices will exceed the service LRIC. To see this, suppose that the cost of element X is relatively small compared to the cost of element Y and that s exceeds two thirds. In that situation, the TELRIC of service A may fall below the LRIC of service A.[28] Of course, in a two service example, and remembering that total cost is just the sum of the stand-alone cost of one service and the incremental cost of the other service when there are only two services, if the TELRIC of service A falls below the LRIC of that service, then the TELRIC of service B will exceed the stand-alone cost of that service. Thus, even in the (trivially simple) example presented in this section, TELRIC pricing, when applied to services, cannot guarantee that service prices do not fall below the economically appropriate price floor set by long run incremental cost, and TELRIC pricing cannot guarantee that service prices do not rise above the economically appropriate ceiling set by stand alone cost.

The theoretical differences between TELRIC and TSLRIC+ pricing arise for a very simple reason. TELRIC is designed to apply on an

[27] To see this for our simple example, note that the 'breakdown' of C_Y into incremental costs is symmetric between the services, so that one-third of the cost of Y is part of the LRIC for service B and the same amount is part of the LRIC for service A. In this situation, symmetric traffic flows (i.e. $s = 0.5$) eliminate the difference between TELRIC and TSLRIC+.

[28] Formally, substitution shows that the TELRIC of service A will fall below the LRIC of service A if $s > \frac{1}{C_X + C_Y}\left(C_X + \frac{2}{3}C_Y\right)$.

element-by-element basis over telecommunications networks. It is not designed to apply on a service-by-service basis. In contrast, TSLRIC+ is a service-based measure of costs and is designed to determine the cost basis for regulated service pricing.

4.2 Practical differences

While the theoretical differences between TSLRIC+ and TELRIC discussed above are a cause for concern, they are relatively minor problems compared to the differences that arise in practical application of TELRIC pricing.

Before we consider these practical differences, however, we must consider how TSLRIC+ analysis should be implemented. We can then contrast this with the practical application of TELRIC under the PIE II model to highlight the significant differences between the approaches.

4.2.1 Implementing TSLRIC+

In order to calculate the TSLRIC+ of any service or group of services, network modelling must follow a set of steps. The first step in any TSLRIC calculation is the determination of the relevant service to be analysed. For example, the relevant service may be PSTN originating and terminating interconnection services.

The second step in a TSLRIC analysis is to consider the complete set of products the relevant firm provides and that should be included in the costing model. When considering the TSLRIC of a particular product it is necessary not only to identify the product directly under analysis but also to identify the other products that might share common costs with the particular product. The output of all these other products must be held fixed during the TSLRIC analysis in order to determine the true incremental cost of the specific product under analysis.

For example, if the relevant service under analysis is PSTN originating and terminating access, then all other services that share some common costs with this service need to be included in the costing model. Some of these services are obvious, such as local call services, and are included in Annexure C of Telstra's submission. Other services may be less obvious. For example, ISDN data services, ADSL services and leased lines use parts of the PSTN and share common costs with PSTN originating and terminating access

services. As such, these services need to be included in the relevant network model for a TSLRIC analysis.

If relevant products are omitted from the analysis then there is a danger that the evaluated incremental cost will not be the true incremental cost but will include common costs associated with excluded products. Again, we can see this by the simple example above. Suppose that the regulator wished to determine the LRIC of service *B* in order to calculate a TSLRIC+ price but that service *A* was omitted from the network modelling. Then there would only appear to be one relevant service (service *B*) and the LRIC of this service would (erroneously) be calculated using an efficient network model as $C_X + \frac{2}{3}C_Y + C_Z$. This exceeds the true incremental cost of service *B* and, in fact, is the stand-alone cost of service *B*. Similarly, if the regulator wished to find the LRIC of service *A* but excluded service *B* from the modelling exercise, then the LRIC of service *A* would be falsely estimated as $C_X + \frac{2}{3}C_Y$. Again, this exceeds the true LRIC and is, in fact, the stand alone cost of service *A*.

After the LRIC of the specific service is calculated, it is necessary to determine the relevant common costs and to allocate these common costs across all relevant services. This step transforms TSLRIC into TSLRIC+. An aggregate measure of common costs can be determined from the computer model by estimating the incremental cost of each service in turn, and then subtracting the sum of these incremental costs from the total cost of all services. The remainder represents costs that are shared by at least two services that use the PSTN.[29] Once the total common costs are determined, part of these costs needs to be allocated to the relevant service to create the value of TSLRIC+.

A simple schematic diagram representing the process for TSLRIC+ pricing is presented in Figure 1.

[29] This step can involve varying degrees of complexity. For example, Baumol and Sidak (1994) propose a combinatorial test to allocate common costs more finely. Such an approach determines common costs by working outward from the specific product under analysis. The combinatorial approach, however, is limited by its relative complexity compared to a simple aggregate measure of common costs. The combinatorial approach also includes an allocation rule that might not lead to an outcome that is as efficient, from an economic perspective, as an allocation of common costs that is fully-based on the sensitivity of demand.

4.2.2 PIE II and TSLRIC+

In practice, the approach adopted by PIE II differs significantly from the approach suggested here for TSLRIC+ modelling. PIE II considers the total cost of constructing an Inter-Exchange Network and a customer access network (CAN) using forward-looking technology where this network is designed to produce only some of the services that Telstra actually produces and that are likely to share common costs with the UT services. Thus, PIE II differs from a TSLRIC+ model in four significant ways:

1. It does not calculate the TSLRIC of PSTN originating and terminating interconnection services. As such a calculation is a necessary precursor to calculating the TSLRIC+ of these services, it is clear that PIE II does not provide a measure of TSLRIC+.

2. What PIE II does calculate is the total cost of providing a bundle of PSTN services or equivalently the stand-alone cost of these particular services. It then uses this total cost to determine an average cost to be allocated over the relevant modelled services. In this sense, PIE II represents an average total cost model or a fully distributed cost model of a *particular incomplete* version of the Telstra network.

3. Because PIE II does not include all the services that use some or all of the PSTN, it almost certainly excludes some services that share common costs with PSTN originating and terminating services and the other UT Services. This means that the costs determined by PIE II will tend to be systematically biased upwards.

4. Because PIE II is based on TELRIC analysis it 'automatically' allocates common costs and this allocation may be economically inefficient. In this sense, PIE II removes discretion from the regulator compared to a true TSLRIC+ model and will not be as efficient in allocating common costs as a true TSLRIC+ model where the regulator could use additional economic information to carry out this allocation.

The third point is clearly of critical importance when determining the relevance of the PIE II estimates for TSLRIC+ pricing. It means that the PIE II estimates will systematically overestimate the true TSLRIC for the UT Services.

To see this, we can return to the simple algebraic example. Again consider the two services A and B and the three elements X, Y and Z.

Suppose that the relevant service for access is *B* and that *A* is a service that, while it shares common costs with service *B*, is not included in the TELRIC model. For example, *B* might be PSTN O/T interconnection services and *A* might be relevant data services.

Under the approach adopted by PIE II, the network will be constructed using the forward looking costs of providing service *B* alone. Because service *A* is not considered in the model, the network will be optimally configured for the provision of service *B* alone. The total cost of the network will be given by the full cost of elements *X* and *Z* and two-thirds of the cost of element *Y*. Thus, the PIE II equivalent measure of TELRIC for service *B* is given by:

$$PIE_B = C_X + \tfrac{2}{3}C_Y + C_Z$$

Note, of course, that this is just the stand-alone cost of service *B*. By leaving out some services that share common costs, PIE II does not calculate the LRIC of *any* service but rather calculates the stand-alone cost of the included PSTN services. This leads immediately to the first and second of the key differences between TSLRIC+ and PIE II noted above.

Under a model such as PIE II, the stand alone cost of the relevant services will be allocated on the basis of some measure of traffic. No demand-side information is taken into account (although PIE II does take the local call price cap into account).

To see the problems with the PIE II approach, we can compare the cost estimate generated by the model to both the true TELRIC and the true TSLRIC+ (with common costs allocated on the basis of traffic flows). Note that the PIE II cost allocated to service *B* will *always* exceed the TSLRIC+ of *B*. It will also exceed the true TELRIC of *B* except under the conditions noted in footnote 26. In particular:

$$PIE_B - TSLRIC+_B = (1-s)C_X + (1-s)\tfrac{1}{3}C_Y$$

Clearly, whenever there is *any* traffic flow associated with the erroneously omitted service *A*, this number is positive. In other words, PIE II will systematically over estimate the costs associated with UT Services. The PIE II model, as noted in the third point above, is systematically biased upwards.

What is the source of this bias? By erroneously omitting some services that share common costs with the UT services, PIE II starts from a stand-alone cost rather than a LRIC. It effectively chooses a subset of PSTN services, calculates the stand-alone cost of those

services and then allocates the entire stand alone cost to those services.

Clearly this has serious implications if the PIE II estimates are used to set interconnection prices. But it also has important implications for the omitted services. The PIE II approach effectively allocates all shared and common costs to the included services alone. The excluded services do not have to bear any of the common costs.

This is clear from our simple example. If service *B* is required to meet the stand alone cost incorporated in PIE_B then the only costs 'allocated' to the omitted service *A* are the incremental costs of that service. So long as *A* generates revenues that more than cover its incremental cost then the carrier will make profit over its entire operations.

The omission of services in the PIE II model has important competitive consequences. For example, suppose that the regulated network was competing against another network provider in the provision of service *A*. The regulated network would be able to price service *A* down to just the incremental cost of that service without operating at a loss over its entire network. This is because the regulated price of service *B* under PIE II recovers *all* the common costs associated with *both* service *A* and *B* for this carrier. In contrast, any competitive carrier would normally need to recover the common costs of its network from all of its services including the competitive service *A*. This would make it difficult (if not impossible) for competitors to successfully and fairly compete with the regulated carrier for the omitted services. This raises clear concerns about the long-term interests of end-users, particularly if the omitted services are fast growing products such as data services. But it is our understanding that these are exactly the services that are omitted from PIE II.

Finally, note that under a model such as PIE II, common cost allocation is automatic. There is no regulatory discretion to allocate common costs because, at the element level, the common costs are just allocated across traffic flows. This is likely to be highly inefficient. Under a TSLRIC+ model, the regulator can use demand-side information to efficiently allocate common costs and to maximise the welfare and long-term interests of end-users. Under a model such as PIE II this discretion is taken away from the regulator. The model provides a potentially highly inefficient allocation of common costs.

5 Conclusion

In this report we have highlighted:

- The economic basis for TSLRIC and TSLRIC+, including providing a brief step-by-step method for TSLRIC+ modelling;
- The background to the development of TELRIC by the FCC in the specific context of the U.S. 1996 *Telecommunications Act*;
- The theoretical differences between TSLRIC+ and TELRIC, noting that TELRIC cannot guarantee that cost estimates either exceed relevant economic floors for pricing, or fall under relevant economic ceilings for pricing;
- The practical differences between TSLRIC+ and the approach to TELRIC incorporated in the PIE II model;
- The systematic upward bias that exists within PIE II; and
- The inability of PIE II to allocate common costs in an efficient manner consistent with the long-term interests of end-users.

6 References

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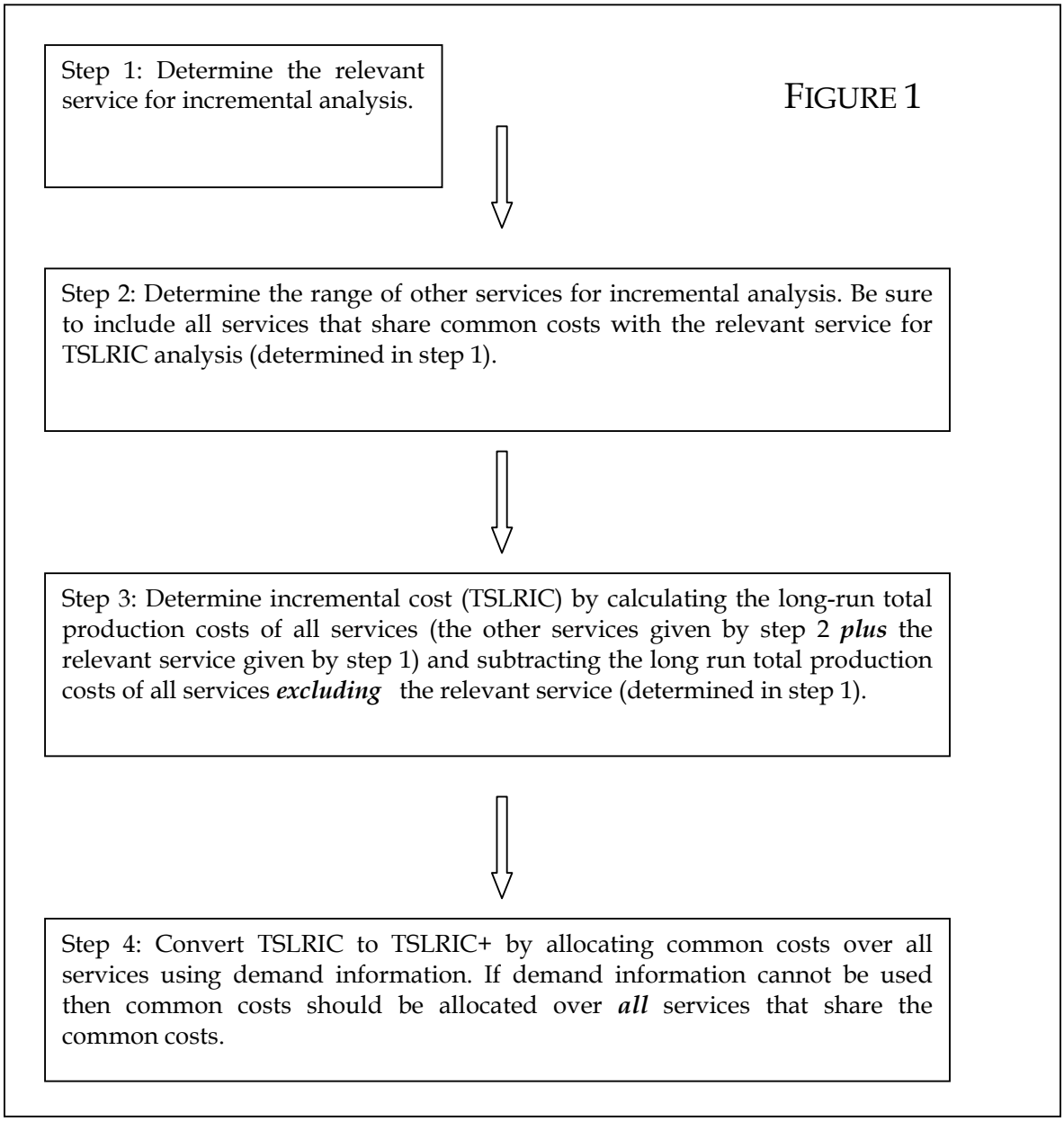
Step 1: Determine the relevant service for incremental analysis.
Step 2: Determine the range of other services for incremental analysis. Be sure to include all services that share common costs with the relevant service for TSLRIC analysis (determined in step 1).
Step 3: Determine incremental cost (TSLRIC) by calculating the long-run total production costs of all services (the other services given by step 2 plus the relevant service given by step 1) and subtracting the long run total production costs of all services excluding the relevant service (determined in step 1).
Step 4: Convert TSLRIC to TSLRIC+ by allocating common costs over all services using demand information. If demand information cannot be used then common costs should be allocated over all services that share the common costs.

FIGURE 1