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Advanced Economic Modelling & Analysis

Competition Benefits and the ACCC Regulatory Test

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Executive Summary

Drayton Analytics Pty Ltd is pleased to present this report to the Australian Competition and Consumer Commission (ACCC) on behalf of ElectraNet SA (ESA) in response to the ACCC's *Review of the Regulatory Test: Discussion Paper* (2003). Due to continuing criticism from some market participants that the test in its current form does not allow for the inclusion of benefits arising from the promotion of competition in the market, section 3.3 seeks public comment on 'competition benefits' and related issues. As a result, this report:

- discusses the concept of 'competition benefits' and their intended role in the Regulatory Test (the test);
- examines the appropriateness and practicality of the six proposals for measuring competition benefits (primarily addressed in section 3.3. of the ACCC discussion paper); and
- provides some recommendations to guide further work in this area.

Primary Issues

Competition Benefits and Their Role in the Regulatory Test

The ACCC discussion paper states that competition benefits "arise from increased competition between generators, and the reduction in market power, resulting from free flowing interconnectors."[1] Given this definition, the ACCC discussion paper then turns to proposed approaches from market participants for identifying and measuring market power. While Drayton Analytics agrees that benefits arising from reduction in market power are legitimate economic impacts that should be included in any transmission project benefit-cost assessment (if applicable), there are several concerns with the ACCC's current approach to the entire 'competition benefits' issue because:

[1] ACCC (2003), p. 38.

- the basic measures of benefits and costs under the test, by definition, account for all relevant economic impacts from changes in production and consumption due to a project, given they are applied correctly;
- benefits due to market power reductions, therefore, are implicitly included in the test's definition of *market benefit*, and as a result, are allowable under the current test (but this fact is not explicit); and
- attaching a connotation to 'competition benefits' that relates specifically to market power
  - implies (incorrectly) that such benefits must not be allowable under the current test,
  - may inadvertently lead to participants overlooking or disregarding other legitimate net benefits from consumption changes that have no relationship to market power reductions.

These observations warrant clarification of the current test. Specifically, the fact that the test (implicitly) allows for demand-side impacts, such as changes in the net value of consumption from interconnection, should be made explicit. At present, the only attempt to proxy such effects is through the 'VoLL provision'. This allowance is inadequate, however, because it completely ignores consumption impacts in non-VoLL periods. Although (short-run) demand for electricity is highly price inelastic, it is not zero, especially for commercial and industrial customers. As a result, such impacts, which are relatively 'small' on a trading period by trading period basis, may be significant, in aggregate, over the project benefit-cost horizon.

At present, the test places *disproportionate* emphasis on supply-side benefits and costs, particularly in the form of production 'cost savings' (such as fuel savings) and avoided or deferred capital costs.

Evaluation of Proposed Measures of 'Competition Benefits'

This report discusses the strengths and weaknesses of the six proposals for measuring reductions in market power. The primary conclusions from this evaluation are that:

- unless it is intended that the test becomes the new market power detector / regulator, it is entirely unnecessary to develop a test to specifically address benefits from market power reductions;

- the review should instead focus on improving the clarity of the current test with regard to allowable benefits and costs and how to correctly assess them, especially with respect to evaluating changes in the net value of consumption resulting from price changes, regardless of whether they arise from market power reduction or some other source; and

- all of the proposals ultimately require some assumption about the relative movement of regional prices post-interconnection relative to the *status quo*, and mathematically consistent and auditable optimisation-based simulation provides the most effective and robust tool for analysis.

Future Directions

Joint consideration of all of the issues covered to this point raises the overarching question of whether or not the test, in its current form possesses sufficient clarity and provides sufficient guidance to enable participants to understand it comprehensively and to apply it on a consistent basis.

It is recognised that the applicant is ultimately responsible for making a case for the inclusion of individual benefit and cost items in an assessment. The ACCC could enhance the clarity and understanding of the overall assessment process, however, by providing a more structured framework for project evaluation.

Some participants will claim that a more structured test will inevitably make it overly complex and unworkable. A more structured test is not mutually exclusive with a more practical test. In fact, the opposite is true - the lack of clarity that characterises the current test is one of the primary sources of confusion, misapplication of the test, and manipulation of the test by some market participants. In summary, the test should provide a transparent, consistent, and economically correct path for proponents to follow when making an assessment.

Recommendations

Recommendation 1: The definitions of producer and consumer surplus should be explicitly stated, and the test should clarify that if these measures are calculated correctly, they include all relevant economic benefits and costs.

Recommendation 2: If it is decided to include an explicit definition for 'competition benefits', it should *not* be in specific reference to market power reductions but more generally, to any real benefits (or costs) that accrue from interconnection creating changes in the value of consumption (positive or negative) in both regions. A more appropriate descriptor is 'consumption benefits', as opposed to 'competition benefits', because it aligns itself more clearly with the benefit-cost concepts of producer and consumer surplus that are the actual basis of the test.

*Recommendation 3***:** The test should clarify that the current framework already allows for the inclusion of 'competition benefits' *and* for the inclusion of other consumption benefits not associated with market power reductions - in short, all relevant changes in the value of consumption in both interconnected regions. These effects are real economic impacts; simply because they occur on the demand-side of the market, as opposed to the supply-side, does not give them any less importance than supply-side effects, such as benefits from fuel savings, in the final benefit-cost analysis.

Recommendation 4: In order to ensure that changes in the value of consumption are properly accounted for in the test, it is incumbent on the ACCC to develop some general guidelines for participants, addressing both data and methodology issues in this area. In particular, such guidelines should recognise that i) electricity demand (even short-run) is not completely insensitive to price changes and that modelling can estimate such relationships and the resulting price impacts on consumption and that ii) modelling anticompetitive, *i.e.* strategic, behaviour by generators under a range of plausible scenarios is an integral component of assessing 'competition benefits'.

1 Introduction

1.1 Purpose and Objectives

Drayton Analytics (DA) is pleased to submit this report to the Australian Competition and Consumer Commission (ACCC) on behalf of ElectraNet SA (ESA). This report is presented in response to the ACCC's request for public comment on *Review of the Regulatory Test: Discussion Paper* (*2003*). Although the discussion paper raises a variety of issues associated with the current Regulatory Test (the test), ESA has retained DA to address specifically i) the concept of 'competition benefits', ii) its role in the current test, and the iii) appropriateness and practicality of the six proposals for measuring competition benefits. As a result, this report primarily focuses on the contents of section 3.3 of the ACCC paper.

It is understood that 'competition benefits' is a primary focus of the ACCC review and that this focus, in large part, has been prompted by criticism that the test in its present form does not account for such benefits. As a starting point, it is vital to clearly define the market impacts that the concept of 'competition benefits' is intended to capture since by nature, such a concept is potentially broad in scope. The ACCC discussion paper states that competition benefits "arise from increased competition between generators, and the reduction in market power, resulting from free flowing interconnectors."[2] Based on this definition, it is clear that competition benefits is intended to refer specifically to 'benefits' accruing from reductions in market power that are attributable to interconnector construction/expansion.

Such market power mitigation benefits, as defined, are legitimate benefits for inclusion in the test calculus because they represent real economic impacts. First, it must be recognised that the current test already allows (at least implicitly) for inclusion of such benefits. Second, this report demonstrates that such a definition is not particularly useful and in fact, it may be misleading because it focuses attention on price reductions that result from market power mitigation *only*, and not on price reductions in general.

Competition benefits, as defined in the ACCC paper, are benefits that result from the reduction or elimination of market power, measured by the value of output expansion relative to the market power situation. For example, the construction of a new inter-regional interconnector may reduce a (pre-interconnection) monopoly price in the importing region such that consumers in that region receive a 'competitive benefit' equal to the difference between the pre- and post-interconnection prices over their entire pre-interconnection

[2] ACCC (2003), p. 38.

consumption volume.[3] At the same time, however, consumers in the importing region will also receive an additional 'competition benefit' from the lower, post-interconnection price increasing consumption above the pre-interconnection consumption level. These two effects have entirely different implications for social welfare. The first is a transfer of wealth between generators and consumers, while the second effect is a real increase in the value of consumption as a result of the price change. In this particular example, this change leads to an allocative efficiency improvement through the reduction of the deadweight loss from the exercise of monopoly power.

Interconnection, however, can also create a 'consumption benefit' through price changes that is independent from market power. For example, an interconnector that links two competitive regions – one with 'high' demand and one with 'low' demand, such that the high demand region imports additional spare capacity from the low demand region. In this case, the price decreases in the importing region and consumers in that region pay the lower price on all of their pre-interconnection consumption (a transfer), plus they also expand their consumption. Although the latter effect does not represent an allocative efficiency improvement, it nevertheless is a 'benefit' attributable to the project.

Given this simple example, the implication is that the real issue is not examining market power *per se* (after all, this task is the job of a regulator not a transmission project benefit-cost test) but the effects of changes in the value of consumption arising from interconnection. The test, in its current form, is largely silent on the valuation of demand-side impacts relating to changes in consumption, although it implicitly allows for their inclusion.[4] This lack of clarity in the test typically results in more emphasis being placed on supply-side benefits in the form of cost savings, such as benefits from fuel substitution, avoided or deferred capital costs, *etc*. A review that focuses exclusively on issues of market power will not only confuse the debate, but it will, by default, ignore other demand-side effects from lower (or higher) prices that have nothing to do with reductions (or increases) in market power.

Given this fundamental issue as a relevant starting point, the objectives of this report are to:

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[3] The analysis must neutralise this benefit to consumers in the importing region because it represents a transfer of equal value from the monopoly to consumers. Since the former is included in the calculation as a benefit and the latter as a cost, they exactly offset. The importance of this issue is discussed in section 2.

[4] The exception is the use of a 'VoLL provision' to capture such benefits. See the discussion in section 2.

- review the general framework of the test and the economic concepts that serve as its basis since confusion over some of these concepts are contributing to the current state of the debate;
- address the issue of competition benefits and provide some clarifications;
- discuss how the debate over the competition benefits issue has exposed some basic weaknesses of the current test, particularly in regard to its failure to address fully demand-side impacts;
- review the merits of the six proposals for identifying and measuring market power, although it must be stressed that an exclusive focus on benefits arising from market power reduction may be misleading; and to
- provide some recommendations for improvements to the test given the discussion of these issues.

1.2 Structure of the Report

Given the purpose and objectives identified in the previous section, section 2 reviews some basic benefit-cost concepts, examines the issue of competition benefits within the context of interconnection, and draws some conclusions for the test. Section 3 describes and discusses the six proposed approaches for the identification and measurement of market power. Section 4 develops some evaluation criteria in order to determine relative rankings for the six proposals. Section 5 gives the conclusions and recommendations of the report.

2 Competition Benefits and the Test

2.1 Economic Preliminaries

Before discussing the subject of 'competition benefits', it is helpful to review briefly the basis of the test and some fundamental concepts.

2.1.1 Quantitative Benefit-Cost Analysis and the Regulatory Test

In public policy, five basic approaches exist to policy analysis: i) standard benefit-cost analysis, ii) qualitative benefit-cost analysis, iii) modified benefit-cost analysis, iv) cost-effectiveness analysis, and v) multi-goal policy analysis. Selection of an approach depends on the number of relevant policy goals, *e.g.* efficiency only, efficiency and one additional goal, or efficiency and two or more additional goals.[5]

Standard benefit-cost analysis is the appropriate solution method for policy analysis if economic efficiency is the only relevant policy goal. The fundamental objective of standard benefit-analysis is to reduce all predicted impacts that would result from the implementation of a proposed project to a common unit of impact - dollars. Once this monetisation of impacts is completed, the evaluation rule is simply to choose the project associated with the largest net benefits, *i.e.* gross benefits less costs, properly adjusted for both time and risk.

The Regulatory Test for New Interconnectors and Network Augmentations (the test) is basically a standard (quantitative) benefit-cost analysis. In line with this methodology, the test calls for the analysis of the proposed project and a range of feasible, alternative projects. It requires that the proposed project maximises the net present value of the 'market benefit,' where market benefit is defined as the total net benefits of the proposed project to all participants in the electricity market, measured by "the increase in consumers' and producers' surplus or another measure that can be demonstrated to produce equivalent ranking of options in most (although not all) credible scenarios."[6]

The test departs from standard benefit-cost analysis in several respects. Although it addresses the timing of benefits and costs through the use of a properly selected discount rate, it does not explicitly address the issue of risk.[7] Further, it only crudely addresses the issue of project timing by requiring that the test's (favourable) determination in regard to a proposed project occurs within a certain timeframe of the start of project construction

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[5] See Weimer and Vining (1989), pp. 194-198 for a complete discussion.

[6] ACCC (1999), pp. 25-26.

[7] The typical approach for addressing risk is the concept of expected value. See Varian (1992), pp.172-197.

and *vice versa*.[8] Finally, the calculation of the market benefit is only based on a partial, not a full, equilibrium, analysis; therefore, it excludes effects in secondary markets.[9] Detailed discussion of these deviations from standard benefit-cost analysis is beyond the scope of this report.

2.1.2 A Framework for Identifying Benefits and Costs

With respect to the assessment of the benefits and costs of a proposed project, it is first necessary to characterise two worlds: i) pre-project and ii) post-project. In general, this process requires accurately characterising the relevant market and institutional features in the pre-project, *i.e. status quo*, world and in the post-project world. Market characteristics include, for example, the number of firms in the relevant industry and their cost structures, the degree of product differentiation, and the nature of interaction among these firms. Institutional features include, for example, the legal and regulatory frameworks that determine the organisation and operation of the market.

Characterising the pre-project state of the world is, at least in principle, relatively straightforward, in that characterising that world involves characterising the *status quo*. Consequently, this description relies on the use of observations of current market conditions and currently available data. Modelling the state of the world *with* the project, however, is more problematic, in that describing this world requires a set of assumptions that characterise the post-project world for each year following project implementation, up to the project asset life. The possible forms that this world may take will vary, depending on a number of factors, including expected market and institutional features and the behaviour of participants given these features.[10]

Since such factors are essential to detailing a proper market setting, it is obviously critical to use an analytical approach that can model such assumptions and predict market outcomes based on those assumptions for each year following the implementation of the project.[11] Given the predicted

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[8] ACCC (1999), pp. 28-29. One possible approach for addressing the project timing issue is the real options theory of finance. A firm with an investment project that can be delayed holds a real option, *i.e.* the right to implement the project in one of several time periods. The basic idea is that a project should be delayed if that delay increases its expected value. Let NPV_t be the net present value of the project at time t, and V^d_{t+1} be the net present value of delaying the project one period *assessed at time t*. If $\alpha = V^d_{t+1} - NPV_t$ then the value of the option to delay the project one period is $\varsigma_t = f(\alpha)$, where $f(\alpha) = \alpha$ if $\alpha > 0$ and 0 otherwise and all estimates occur in period t. The project should be undertaken immediately if two conditions are satisfied: i) $NPV_t \geq 0$ and ii) $\varsigma_t = 0$. Transmission projects are excellent candidates for this treatment since they are highly likely to have a non-zero delay optionality due to the sunk nature of transmission assets following construction, the possibility of delaying such projects (perhaps at a non-zero cost), and the uncertain stream of expected benefits associated with them.

[9] See ACCC(1999), pp. 27-28. Standard benefit-cost analysis includes such effects, unless i) price does not change in the secondary market *and* ii) the secondary market is undistorted.

[10] Characterising the post-project world, of course, raises the spectre of dispute because it requires assumptions about changes in market and institutional features. Nonetheless, making some assumptions about these changes is inescapable in any assessment. All that is possible is the use of robust research and analysis to guide their formulation and to develop different sets of assumptions to test, such that each set describes a different, but plausible post-project world.

[11] The term, 'model,' is used in a generic sense in this context.

outcomes, *e.g*. prices and quantities, it is possible to calculate the net present value of the total net benefit to the market or equivalently, the net present value of the social surplus. The concept of social surplus is discussed in the next section.

2.1.3 Measuring Benefits and Costs: Consumer and Producer Surplus

The basic measurement tools of benefit-cost analysis are consumer and producer surplus:

- consumer surplus – the difference between the amount that a consumer is willing to pay for a good and the amount that the consumer actually pays when purchasing it; in other terms, the total benefit from consumption less total cost; and[12]

- producer surplus – the sum over all units produced of the difference between the market price of the good and the marginal cost of production; in other terms, total revenue less total variable costs.[13]

The sum of consumer and producer surplus is *social surplus*. Social surplus measures the net benefits that consumers and producers receive from their participation in markets. Changes in social surplus are used to measure changes in the welfare of society.

The test requires that a transmission project maximises the net present value of the market benefit, where the market benefit is the total net benefits of the project to all consumers and producers in the market. Consequently, the test requires a proposal to maximise the net present value of the total net benefit to the market or equivalently, the net present value of the social surplus.

Appendix A contains a basic but useful review of consumer and producer surplus.

2.2 Understanding 'Competition Benefits'

2.2.1 The ACCC Definition

The ACCC discussion paper states that competition benefits "arise from increased competition between generators, and the reduction in market power, resulting from free flowing interconnectors."[14] Before discussing this definition in the specific context of interconnection, it is important to understand the issue of market power and as a result, to consider the economic nature of the benefits that the ACCC definition implicitly captures.

Market power, in general, has been defined in a variety of ways and is a topic of considerable debate. For purposes of this report, an acceptable definition

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[12] For an insightful and intuitive explanation of the use of consumer surplus, see Harberger (1971).

[13] Since fixed costs, by definition, do not vary with output, the sum of marginal costs over the entire output range must equal the sum of the firm's variable costs. In the short-run, producer surplus exceeds profit if fixed costs are positive since PS = TR – VC and Π = TR – VC – FC, where PS is producer surplus, TR is total revenue, VC is variable costs, FC is fixed costs, and Π is profit.

[14] ACCC (2003), p. 38.

is the ability of a firm (or firms) to alter price away from the competitive level in a profitable manner.[15] The exercise of market power can occur on both the supply- and demand-sides of a market, but the usual context is the supply-side.[16] In this case, 'market power' is often used interchangeably with the term, 'monopoly power,' where the latter refers to the exercise of market power by the only firm serving the market, the monopolist. Given this definition, the following stylised example of a competitive market and a monopoly market illustrate the basic concept and implications of market power, as intended by the ACCC definition.

Consider the competitive market in Figure 1. By assumption, a producer in a competitive market is unable to influence the market price; therefore, its price is equal to its marginal revenue. A profit-maximising producer adjusts output to equate marginal revenue to marginal cost. The competitive price, therefore, is equal to marginal cost at an output of Q_C at price P_C. For the consumer, total benefit is equal to area A+B+C, but the cost of producing Q_C is B+C; therefore, consumer surplus is area A. For the producer, total revenue is B+C, total (variable) cost is C, and producer surplus is B, the firm's competitive rent.[17] The sum of consumer and producer surplus, or social surplus, in this market is A+B.

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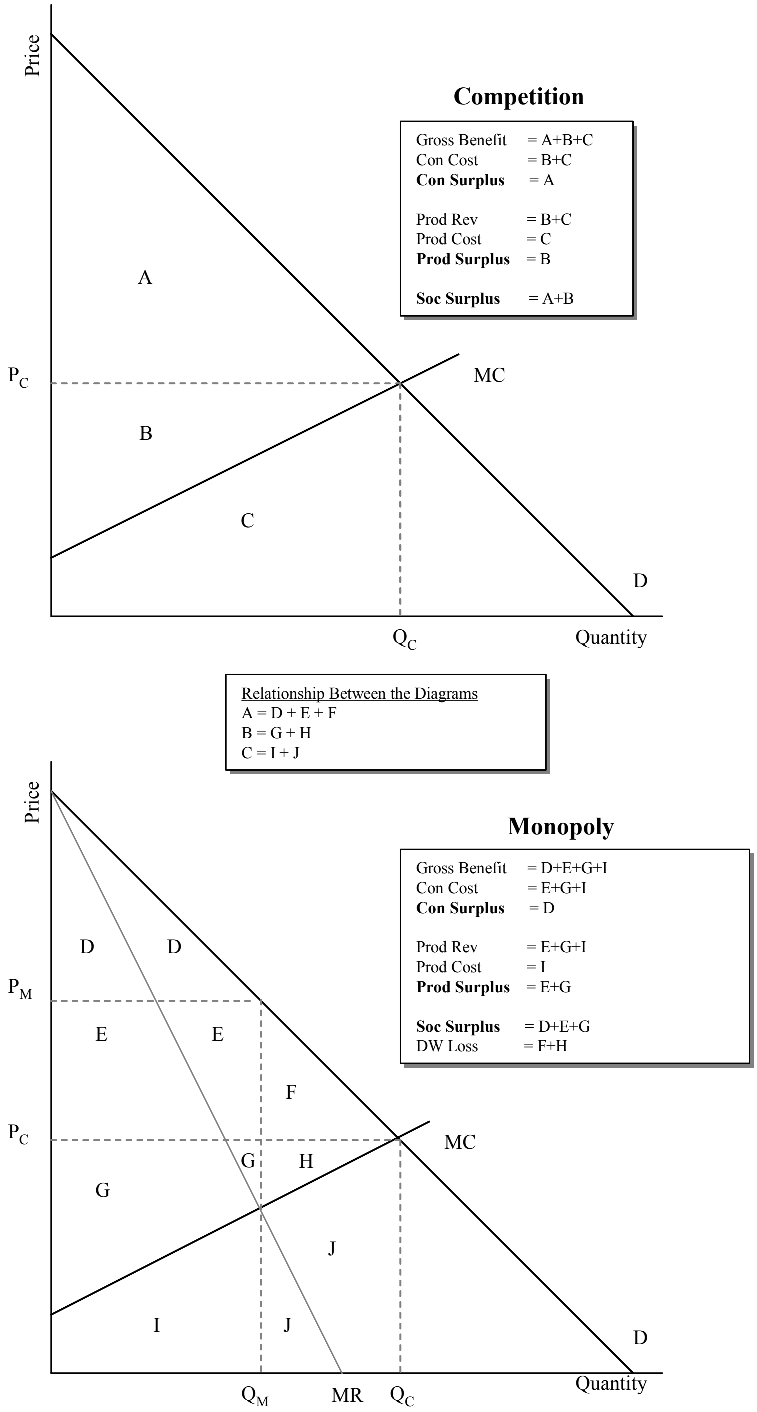
[15] Regulatory, as opposed to economic, definitions of market power typically qualify the definition with a phrase such as '…for a significant period of time.' This qualification is generally problematic because it raises all types of issues and is not particularly helpful.

[16] On the demand-side, a buyer with market power attempts to lower the price in a profitable manner.

[17] Rents are any payments in excess of the minimum amount required to cover the cost of supply.

Figure 1: Competition vs. Monopoly



Consider now the monopoly market in the bottom half of the figure. The producer, for whatever reason, is able to affect the price to its advantage. Specifically, for a monopolist, the marginal revenue is less than the price it receives (except at an output of zero, where they are equal for a linear demand function). The profit-maximising monopolist adjusts output until marginal revenue equals marginal cost, producing Q_M and charging price, $P_{M.}$ This price maximises the monopolist's profit, but in order to charge it, the monopolist must withhold (Q_C - Q_M) units from the market. With this behaviour, consumer surplus is now only equal to area D, while producer surplus has increased from B to E+G. Area E is simply a transfer from consumers to the monopolist and is a monopoly rent. The producer gains this surplus relative to the competitive outcome, but at the same time, it loses the surplus equal to area H, the competitive rent (P_C – MC) over (Q_C - Q_M) units.

The change in social surplus as a result of the monopoly is $(D+E+G)_M$ – $(A+B)_C$, which, using the relationships between the diagrams, is equal to $(D+E+G)_M – (D+E+F+G+H)_C = - (F+H)$. The result is that welfare, *i.e.* social surplus, is less under the monopoly by this area. The area, F+H, is known as the deadweight loss of monopoly power because it represents a loss in net value to society. [18] Specifically, for (Q_C - Q_M), the marginal willingness to pay by consumers exceeds the marginal cost; as a result, the producer should produce these units but does not because it withholds this output in order to increase the price. This loss in value is known as an *allocative inefficiency* because the forgone consumption to consumers has a value that is greater than the cost to the supplier.[19]

With respect to interconnection, if the current state of the world is the monopoly situation and interconnection makes the monopoly region a (net) importing region with the price falling to the competitive level, then the net benefit of the interconnection – ignoring project capital costs and all other benefits and costs – is area F+H, the change in the social surplus between the two states of the world. The deadweight loss under monopoly results in under-production, and the elimination of market power in this example yields a benefit that follows from the net value of increased consumption relative to the monopoly situation. This benefit is the benefit that the ACCC is attempting to capture with its definition.

2.2.2 Are There Other Types of 'Competition Benefits'?

'Competition benefits' is a potentially broad economic phrase that is being used in a particular context in the review of the test. Specifically, it is intended to refer to benefits that accrue from the reduction of market power, as described in the previous section. While Drayton Analytics agrees, in principle, that reductions in the impacts of market power are real economic benefits, there are several concerns with the proposed definition.

'Competition benefits' carries a significantly broader connotation than benefits from market power mitigation. Interconnection can bring 'competition' to the market, in particular to the importing region, in several

[18] This efficiency loss, or loss in value to society, is one of the major concerns of economics. Even if the government completely taxed away the monopoly profits and redistributed them to consumers, the outcome is still inefficient because the monopoly output is less relative to the competitive level. Further, although the wealth transfer is not necessarily unimportant, it is not possible for microeconomics to evaluate it in any meaningful sense.

[19] The allocative inefficiency may not be the only source of inefficiency from a monopoly. In an environment with limited competition, firms may be able to operate above minimum cost, *i.e.* produce profitably without achieving the minimum costs that are technically feasible. This possibility, known as 'X-inefficiency', is beyond the scope of this study. See Leibenstein (1976) for a complete discussion of this issue.

ways – other than through market power mitigation. Two additional types of 'competition benefits' are:

- fuel cost savings, through the substitution of cheaper imports for more expensive local generation in the importing region; and
- consumption benefits that arise from the lower price in the importing region (as a result of interconnection) stimulating additional demand, relative to pre-interconnection levels.

First, suppose that an interconnector joins a 'high' cost region (A) with a 'low' cost region (B), and the generators in each region behave competitively. The interconnector capacity is expanded. Sufficient spare capacity exists in region B such that the augmentation results in flow from region B to A, and the interconnector is binding some periods during the year.[20] With price separation between the regions, price decreases in the importing region. A benefit occurs in the form of production cost savings because some of the more expensive local generation is replaced by the cheaper imported generation. This effect in a real sense is a 'competition benefit' because the interconnection expansion has enabled the cheaper generation to 'compete' with expensive, local generation.

Consider the same example again. The impact of interconnection lowers the price of output to consumers in the importing region over their pre-interconnection consumption volume – this effect is simply a transfer from local generators to consumers. The lower price, however, facilitates the expansion of output in the importing region *relative to pre-interconnection levels* since it stimulates additional consumption.[21] As a result, this additional consumption has a net positive value that is also a real economic benefit as well and could appropriately be referred to as a 'competition benefit.'

Note that in these examples the opposite effects will typically occur in the exporting region, but the effects will not be offsetting (unless very special conditions are satisfied).

These cases are two important examples in which 'competition benefits' are realised, but these net benefits have no relationship to market power reductions, *i.e.* allocative efficiency improvements. Appendix B provides more complete and detailed examples in the context of interconnection.

2.3 Implications for the Current Regulatory Test

This section presents important conclusions and implications for the test that follow directly from the previous discussion and analysis.

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[20] Throughout this report, transmission losses are ignored, without any loss of generality.

[21] The only case in which a lower price would not stimulate some additional consumption relative to pre-interconnection levels is if the demand in the importing region is perfectly inelastic. Although electricity demand is significantly inelastic, it is not perfectly inelastic, and further, it is more elastic for commercial and industrial customer classes. This issue is discussed later.

2.3.1 Are 'Competition Benefits' Included in the Current Test?

As a starting point, section 3.3 asserts that "one of the biggest criticisms of the regulatory test is that it does not recognise competition benefits."[22] This assertion is *not* correct. In fact, the test *implicitly* recognises such benefits because it states that the test is satisfied if an augmentation maximises the net present value of the market benefit, where market benefit is defined as the total net benefits of the proposed augmentation or the change in consumers' and producers' surplus.[23] If the changes in consumer and producer surplus are both identified and measured correctly then these changes, by definition, fully account for all benefits and costs attributable to the proposed investment. This concept is the foundation of quantitative benefit-cost analysis and is not affected by the precise definition of 'competition benefits'.

The test is not explicit about this issue; therefore, given its definition of market benefit, the only inference to be drawn is that such benefits are allowable under the current test. As discussed in the previous sections in this chapter, regardless of the current *intent* of the test, such benefits should be included as a natural component of a correctly applied net benefit calculation.

Given these observations, it is completely unnecessary to create a separate 'competition benefit test'. Consequently, the focus of the present review should not be on developing a new test but on clarifying and specifying the components of the current test with greater accuracy. This task may likely require the ACCC to take an active role in educating the market on these fundamental concepts.

2.3.2 Defining 'Competition Benefits'

The ACCC discussion paper defines competition benefits as those benefits that accrue from the reduction of market power. These benefits arise through the expansion of output above the level that prevails under market power. Although appealing, this definition is misleading because it uses broad-sweeping terminology, *i.e.* 'competition', to label what is a specific source of potential benefits. Such a definition may likely create the possibility that other benefits – not related to market power reductions – are disregarded.

In order to avoid confusion and misapplication, the test should clarify and make explicit that i) producer and consumer surplus, by definition, account for all benefits and costs associated with changes in production and consumption due to a project, ii) benefits due to market power limitations are covered by such a definition and as a result are already an allowable component of the test – whether participants realise this fact is another issue, and iii) a more accurate descriptor is '*consumption benefits* (and costs)' since it captures the intended meaning of the ACCC definition, *and* it also encompasses all other legitimate benefits and costs from consumption changes. Also, the terminology, 'production' and 'consumption' benefits, is more clearly and obviously aligned with producer and consumer surplus than 'production' and 'competition' benefits.

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[22] ACCC (2003), p. 38.

[23] ACCC (2003), p. 45.

This issue brings to the forefront a significant deficiency in the current test – there is a highly *disproportionate* emphasis in the test on supply-side benefits, specifically in the form of 'cost savings' in production, such as fuel savings, *e.g*. the substitution of cheaper generation for more expensive generation in the importing region, avoided or deferred capital investment, *etc*. While it is recognised that these benefits (and costs) are legitimate, the test implicitly gives them more 'weight', through the omission of almost all consideration of demand-side benefits (excluding transfers) that affect consumption.

The only attempt to specifically address this issue is that the test allows for consideration of the value of electricity consumers as captured by VoLL. This provision appears to be an attempt to value consumption changes, analogous to the following example. An interconnector expansion lowers price in the importing region (assume the interconnector is constrained after expansion). Production of generators in the importing (exporting) region decreases (increases) relative to pre-interconnection, and consumption in the importing (exporting) region increases (decreases) relative to pre-interconnection.

The VoLL provision attempts to ensure that the test properly values consumption changes in this situation, but it only does so if the price reaches VoLL and ignores it otherwise. Changes in the value of consumption do not occur only at VoLL prices, but only allowing for them in this situation greatly simplifies their calculation. This approach implies that the value of consumption changes are underestimated in both regions since consumption effects are ignored in non-VoLL price periods (The result will be underestimation of a consumption *benefit* in the importing region and a consumption *cost* in the exporting region; importantly, these two effects do not exactly offset each other except under very special and improbable conditions.)

2.3.3 Are Identifying and Measuring Market Power Relevant?

Market power reduction is relevant to the extent that it is another potential source of net consumption benefits that may arise from interconnection. The identification and measurement of market power, however, should not be an end itself unless the test is to assume a new role of both market power detector and regulator.

If a detailed and correct methodology is developed for assessing changes in the value of consumption, such a methodology will automatically include any real benefits arising from market power reduction – since such benefits will be captured by pool price and output changes. All that is necessary is for a methodology to capture demand-side consumption effects accurately – regardless of whether the source of those impacts stems from market power reduction or otherwise.

A screening test is a measure, typically based on historical data, which regulators use to assess whether or not changes in market structure may result in potentially anticompetitive behaviour. As a result, screening tests themselves do not measure market power effects; they only *identify* the potential for them. Further, screening tests are often inaccurate predictors of market power because they do not explicitly account for changes in the behaviour of market participants, which is subject to the influence of a number of factors for which the screening test does not account.

Some of the approaches discussed in section 3 either propose the use of a screening test for detection of market power, *e.g*. Powerlink Public Benefits Competition Test, or they are screening tests themselves, *e.g*. HHI. Drayton Analytics does not recommend a screening test for the detection of market power. Instead, the focus should be on clarifying and designing the present test to account more accurately for changes in the value of consumption.

2.3.4 Measuring Benefits and Costs

General Comments

By its nature, transmission expansion cannot simply be judged strictly by the 'benefits' or the 'costs' alone that it brings generators and consumers because a standard transmission investment, whether inter- or intra-regional will yield:

- benefits to generators upstream of the constraint and to consumers downstream of the constraint;
- dis-benefits to generators downstream of the constraint and to consumers upstream of the constraint; and
- changes in the values of inter-regional settlements residues.

Consequently, changes in regional market prices are essential output from any analytical process because they are the main determinants of the pattern of benefits and costs from interconnection. A transmission expansion, for example, may create a $20M benefit by the provision of an increment of power transfer at a lower price, but it may also result in a $120M 'second order' effect by reducing the market-clearing price to consumers in the importing region over their pre-interconnection purchases. This 'second order' impact, however, is not a real net benefit – it is a benefit to consumers but a loss to generators in the region. The implications from this example are that the:

- test must ensure that all such 'second order' effects are effectively neutralised in any assessment since they do not represent real net benefits;
- design of the test must be accurate and comprehensive because in such situations regional price changes will yield gross benefits from expansion that are likely to far outweigh the net benefits; and
- it is impossible to make any realistic assessment of potential benefits from transmission expansion without an assumption, at least implicit, regarding the relative movement of regional prices.

Comments on Production

Most proposals to date examine benefits from several major sources: i) fuel cost savings, ii) avoided or deferred capital costs, and iii) reliability improvements. Simulation studies are used to predict market outcomes with and without the project. Important issues for assessment of these benefits and costs relate to the private nature of generator cost data and predictions about how the market dynamics, *i.e.* participant behaviour will change, post-expansion.

Comments on Consumption

This simplification of the valuation of demand-side, or consumption, benefits in the current test for interconnection projects is problematic because the gross benefits associated with such projects will likely swamp the net benefits. If net benefits of consumption changes attributable to interconnection across both regions are positive (negative) then the current approach may make a marginal project that is economic (uneconomic) fail (pass) the test.

Some participants will argue that these changes can safely be ignored (other than in VoLL periods) since the short-run demand for electricity is highly inelastic (price insensitive). While it is acknowledged that short-run demand is highly inelastic, it is not zero, especially across different classes of consumers. Even residential demand is not perfectly inelastic, and commercial and industrial demands are likely to be relatively more elastic, given the existence of dispatchable loads in these classes. Over time, the value of such consumption changes in aggregate is likely to be significant. If, for example, a transmission augmentation in year 1 results in lower pool prices by mitigating market power in the importing region, then generators may be forced to renegotiate contracts with retailers in year 2, and these benefits will flow through to end-use consumers in year 3. Given the benefit-yielding asset life of an augmentation is likely to exceed several years, consideration of such consumption effects should not be neglected by the present test.

Some participants will argue that modifying the current approach to address this deficiency is too complex because it will involve pool modelling and the estimation of annual demand functions. This argument is not accepted. First, pool modelling is already an integral part of applying the test because assessing net production benefits and costs from interconnection requires a prediction of how interconnection will change generator dispatch in a region. Second, an abundance of data exists for the estimation of demand functions, and in fact, NIEIR already estimates such functions to a certain extent.

3 Proposed Measures of Competition Benefits

3.1 Market Simulation Studies (MSS)

Given that this proposal is general, this section first provides an overview of market simulation and then attempts to highlight the aspects of market simulation particularly relevant to modelling competition benefits.

3.1.1 Description

Market simulation is a commonly accepted analytical tool for backcasting, benchmarking, and/or forecasting outcomes in electricity markets. At a basic level, market simulation consists of four interrelated components:

- analytical engine / solution method;
- network model;
- behavioural model; and
- input data.

Analytical Engine

The analytical engine refers to the method that uses the network model, input data, and behavioural model to obtain a solution. Two common solution methods are heuristics and optimisation. A heuristic market simulation is comprised of a collection of rules-of-thumb and other relationships derived from human experience with power system and market operations, *e.g*. rules related to unit commitment or price discovery. Computer programs that implement these rules as a way of simulating market outcomes are inherently 'black boxes' with little or no ability to audit or confirm the optimality or otherwise of their results.[24]

Solution developers and practioners have moved away from heuristics models because they:

[24] Henwood PROSYM is an example of a heuristics 'black-box' model.

- are inflexible and algorithmically fragile, *i.e.* what may appear to be a small change in data or market rules can cause the simulation output to change in an inconsistent manner;
- are not open to audit, *i.e.* it is extremely difficult to draw out the logic or set of rules that resulted in any particular output; and they
- do not make use of mathematical programming techniques used to clear 'real world' markets.

Optimization has emerged as the preferred and dominant solution method for both real-time market clearing and market simulation. Optimisation involves the application of mathematical programming techniques, such as linear programming, with known and verifiable properties, to obtain a solution. Simulation using optimisation permits the modelling of all relevant details of the market due the development of specific optimisation techniques to network industry problems and to accelerating improvements in computational speed and power. Further, since market and institutional features impact and interact with participant behaviour, it is critical that the solution method allows for full flexibility in modelling the level of detail. Importantly, if input data and assumptions are known to the analyst, then the existence and uniqueness properties that characterise these mathematical programs make the solutions to these problems fully and comprehensively auditable, disposing of the frequent criticism that modelling is simply a 'black box.'

A second important aspect of optimisation-based techniques is that the mathematical programming solutions provide additional information that possesses an economic interpretation. As a result, the entire set of simulation outputs can be inferred directly from the 'primal' (physical) and 'dual' (financial) components of the programming solution. This advantage, along with the mathematical consistency and robustness of the technique, are major reasons that the Australian NEM market-clearing process (SPD) uses a linear programming formulation.

Network Model

The network model refers to the relevant features of the transmission/pricing model:

- regions / nodes;
- intra- and inter-regional transmission losses and constraints;
- network security and reliability; and
- settlements.

All of these features are modelled with various input data to the simulation.

Behavioural Model

Participant behaviour refers to a set of assumptions that characterise output and pricing decisions by various participants in a market. Given the typical structure of electricity markets, the behavioural model usually is most relevant to capturing the behaviour of producers, specifically generators. This report focuses primarily on producer, *i.e.* generator, behaviour, although it is recognised that retailers clearly 'behave' in certain ways as well that are consistent with the discussion in this section. For discussion purposes, models of participant behaviour can be classified into one of two groups, based on: i) cost recovery, or ii) strategic interaction.

Cost recovery behaviour typically does not focus specifically on the participant's method of interaction with other market participants. An assumption of cost recovery as a behavioural model may appear naïve initially. It may, however, be a perfectly realistic assumption, depending on the nature of the market, *i.e.* the market and institutional features, and on the participant's position within that market. For example, a producer may account for such a 'small' part of capacity that it does not attempt to manipulate the market-clearing price.

Cost recovery models involve the application of relatively straightforward algorithms to ensure that the participant recovers certain costs over a given period of time. The two primary cost recovery models are short-run marginal cost and long-run marginal cost. With short-run marginal cost, the producer simply constructs its offers to the market in order to recover variable fuel and operation and maintenance costs. With long-run marginal cost, the participant constructs its offers to recover short-run marginal costs plus charges for debt, equity, and fixed operations and maintenance expenses.

Strategic models focus on how market participants interact with each other in making their output and pricing decisions. In the economics literature, this strategic interaction among firms is the primary determinant of oligopoly market competition. Oligopoly markets are characterised by a limited number of producers, homogeneous or differentiated products, barriers to entry, and strategic interdependence among firms. An oligopoly market structure tends to characterise most electricity markets since production tends to possess scale economies, which leads to barriers to entry and a limited number of competing firms.

A central feature of oligopoly is that a few large firms in the market dominate production and are able to exercise market power by altering their output and/or pricing decisions to their advantage. Due to barriers to entry, some or all of these firms may earn substantial, positive economic profits over a sustained period of time. Since the number of firms is limited, each individual firm must consider its own set of market actions, *e.g.* output and pricing decisions, and the impact of these actions on its rivals. Further, each individual firm must account for possible reactions of rivals to its actions and the fact that its rivals will make a similar assessment of their own.

A prominent issue in the industrial organisation literature, therefore, is how an individual firm accounts for, and responds to, its rivals' actions in an imperfectly competitive market. In examining this issue, a complementary question that naturally arises is given a theory about an individual firm's behaviour toward its rivals and their possible reactions, how should such behaviour be modelled from an analytical perspective. One plausible answer to this question begins with the assumption that a 'rational' firm acts to maximise its profit. This assumption is known as the profit maximisation hypothesis and serves as a central postulate for economic theory.[25]

It follows from the profit maximisation hypothesis that an individual firm's profit maximisation decision should encapsulate some assumption regarding how its rivals will react to its output/pricing decisions. As a result, the primary component of models of imperfect competition is a specification of how a firm assumes that its rivals (possibly including potential entrants to the market) react to its decisions.

Computable equilibrium models of imperfect competition, based on standard optimisation techniques and game theory concepts, are the dominant approach in the economics literature for examining this strategic interaction among firms in an imperfectly competitive industry. Computable equilibrium models enable the analyst to build a model that includes these features to the required level of detail, such that deviations from a benchmark are captured by parameters in the model. At a basic level, this approach is consistent with the view of an equilibrium model of imperfect competition as a model of perfect competition distorted by quantity restrictions and price mark-ups above marginal cost.[26]

Input Data

Input data include all relevant demand- and supply-side data:

- demand – load forecasts, demand-side management, *etc*.; and
- supply – generator capacities and operating constraints, fuel costs and availability, energy constraints, maintenance requirements.

In applying simulation, a major issue is the accuracy and consistency of input data. First, accuracy of data is only as good as the quality and accuracy of the source. Robust and comprehensive research can typically ascertain data quality, and policy decisions that utilise simulation studies, typically use standard sources for certain types of data, *e.g*. load forecasts. The problem, however, arises if a simulation requires private data, *e.g*. generator costs. Since most electricity markets feature at least some private ownership, such private data requirements are unavoidable. In this case, the best course of action is to apply research and experience in order to develop possible estimates and to execute the simulation over a range of the input data. One benefit of approaching this data issue in such a manner is that this 'sensitivity analysis' gives the analyst an idea of how sensitive the simulation outcome is to variations in assumptions on private data. Such data issues are not unique to simulation but to any approach that attempts to predict market outcomes with any degree of accuracy.

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[25] Some theories of firm behaviour offer alternative hypotheses, but this subject is beyond the current scope of this article. See Tirole (1988) for a basic overview of the relevant literature.

[26] Greenberg and Murphy (1985).

3.1.2 Discussion

In attempting to predict the future market outcomes from the implementation of any project, it is always necessary to develop a simulation that attempts to characterise:

- network conditions, including
  - regional definitions,
  - transmission constraints,
  - transmission loss approximation, and
  - security of supply;
- supply-side market conditions/structure, specifically
  - generator asset ownership,
  - existing generation capacity, including generation unit expansions and mothballing,
  - new generator entry,
  - generation costs, *e.g.* fuel and other costs,
  - transmission capacity, and
  - generator contracting positions;
- demand-side market conditions/structure, specifically
  - load growth and regional load profiles, and
  - demand-side management options; and
- participant behaviour.

The current test recognises the basic importance of these components and the analytical process of accounting for them in an assessment. As discussed next, however, the test does not explicitly address participant behaviour issues, with the focus more on cost recovery models. This emphasis may be misplaced, given the potential for complex interactions between interconnector dynamics and generator behaviour.

Specifically, with respect to transmission proposals, two of the most important factors that a simulation must take into account are the impact of the proposed project on the network model and the impact of the project on generator behaviour. Further, the simulation cannot take these factors into account in isolation since different states of the interconnector, *i.e.* constrained and unconstrained, are likely to create significantly different market dynamics. This task requires two sequential steps: i) developing a model of how generator behaviour (in both regions) will change as a result of the interconnection and how it may differ depending on the *state* of the interconnector, and ii) determining the impact of this change in behaviour on benefits and costs. Further, such behaviour will likely change over the life of the asset as participants 're-optimise' their strategies in response to changing market conditions.

The first step involves attempting to model generator behaviour in both regions pre-interconnection, and developing a range of plausible scenarios that describe how generators in each region might respond post-interconnection. There exists a rich and growing literature in advanced microeconomics that relies on game theory models of imperfect competition to model different types of strategic behaviour[27]. Further, due to the nature and complexity of electricity markets, as well as to the related potential for the exercise of market power, significant research has focused on market power issues in an electricity-specific context.

The key issue is that some expectation must be formed of how interconnection will affect behaviour in both regions. At present, the test only appears to explicitly allow for short-run marginal cost bidding and "simulations that approximate actual market bidding and prices…"[28]. It is, therefore, unclear to what extent the test at present also permits modelling of strategic behaviour, even though its representation is critical to assessing potential impacts on benefits and costs.

The second step – determining the impact of changes in participant behaviour on competition benefits – inescapably requires an assessment of how regional prices change. As described in section 2, prices are an integral part of the calculation of the net benefits from interconnection (transfers aside), and a methodology that predominantly utilises changes in costs to various parties will not, in general, result in a correct assessment.

3.2 Powerlink's Public Benefits Competition Test (PBT)

3.2.1 Description

Powerlink proposes that the test could be augmented to include an 'option' public benefits test, with the intention that this expansion of the test includes 'competition and other benefits' under certain special circumstances. Such a test could be constructed to provide a range of benefits to a proponent in its assessment based on, but not limited to, consideration of i) actual pool price outcomes, ii) strategic bidding scenarios, and iii) major load development scenarios.

Powerlink recommends that this test is only applied under certain circumstances, such as:

[27] The most relevant models for modelling market power in electricity markets are Cournot, Bertrand, Supply Function Equilibrium, and Conjectured Supply Function Equilibrium. For a technical overview of these models, see Day *et al*. (2001).

[28] ACCC (2003), p. 48

- historical evidence exists that wholesale prices have been significantly higher than marginal costs;
- market power occurs or will occur, necessitating a definition of when market power arises; and
- overcoming a particular network limitation is considered sufficiently important by one or more jurisdictions.

3.2.2 Discussion

The type of test that Powerlink proposes would include the consideration of factors – pool price outcomes, strategic bidding scenarios, and major load development scenarios – that are natural and critical components of the Market Simulation proposal. In this respect, the Powerlink proposal appears to advocate such simulation as a viable approach, with the caveat that it can only be applied given one or more of the three special circumstances listed previously are satisfied. In other terms, the Powerlink proposal is 'Conditional Market Simulation' since the special circumstances effectively qualify as a type of screening test for the possibility of significant competition benefits. This report's assessment of Market Simulation Studies, therefore, applies equally to the first element of the Powerlink proposal. The issue of using a screening test is addressed in section 2.3.3 and omitted in this discussion.

3.3 Hirschmann-Herfindahl Index (HHI)

3.3.1 Description

The ACCC (2003) discusses both the HHI and then a modified version of it. This section addresses both measures in turn, beginning with the more general HHI.

The HHI is a measure of market concentration and equals the sum, over all firms in the market, of the squares of their respective market shares, *i.e.*:

$$(1) \qquad HHI = \sum_{i=1}^{n} \alpha_i^2$$

where i = 1,…,n is the number of firms in the relevant market and $\alpha_i = q_i / Q$, firm i's market share (q_i) of total industry output (Q), expressed in percentage terms. The extreme of a pure monopoly market, therefore, would have an HHI = 10,000. A market with ten competing firms, each with a 10% market share, would have an index of 1,000, while a market with an extremely large number of firms with equivalent market shares would yield an index near zero.

The United States Department of Justice and other government agencies have historically utilised the HHI as one of their tools for the antitrust analysis of proposed (horizontal) mergers. Specifically, a post-merger HHI is forecast and compared to the pre-merger HHI, and changes in the HHI serve as a 'screening test' to indicate the potential for market power resulting from structural changes attributable to the merger. If the post-merger HHI is less than a threshold level then no further investigation of potential merger impacts is conducted.[29]

The 'Adjusted HHI' is:

$$(1) \qquad HHI^{adj} = \sum_{i=1}^{m} s_i (s_i + \bar{s}),$$

where there are $i = 1,\ldots,m$ unconstrained firms with market share s_i, and the aggregate market share of the unconstrained firms is $\bar{s}$.

3.3.2 Discussion

The Standard HHI

Since the HHI is simply a measure of market concentration, its use as an indicator for market power requires two implicit, but vital, assumptions: i) high market concentration is an accurate indicator of the potential for high price-cost margins and that ii) high price-cost margins are, in turn, accurate indicators of the presence of market power. Empirical evidence has demonstrated that this first assumption is correct for some markets[30]. The issue of whether price-cost margins are reasonable indicators of the existence of market power is a complex issue because it depends on the characteristics of the specific product and market.

A key issue in calculating the HHI is defining the relevant product market. Such a task must address both the geographical extent of the market and/or the range of products included in it. For example, does the market for petrol consist of Adelaide only, South Australia, or the entirety of Australia? (For certain markets, such as housing, it is reasonable to define significantly restrictive boundaries. Consequently, the residential housing markets in Adelaide and Melbourne are separate and distinct.) After establishing a geographical market, it is necessary to consider the product range, *e.g.* whether the market for petrol includes both leaded and premium? Since many consumer vehicles can use either fuel, a concentration analysis would likely include them in the same market. On the other hand, the same market would likely exclude diesel fuel since typically, consumer vehicles cannot use diesel fuel and *vice versa* for diesel-fuelled vehicles.[31]

A primary appeal of the HHI is that it is based on the oligopoly theory of microeconomics. Suppose that firms in a market produce a homogeneous product, possess constant marginal costs, and face no capacity constraints. Under an assumption of Cournot competition, it can be shown that the weighted average of the firms' price-cost margins from the equilibrium

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[29] The general guidelines are HHI < 1000 is not concentrated, 1000 < HHI < 1800 is moderately concentrated, and HHI > 1800 is concentrated.

[30] See Cowling, *et al*. (1976) for a discussion of market structure and price-cost margins.

[31] This task is important but not simple in many cases. As a starting point, a market is in some sense 'where' a price for a product is established. This approach to market definition determines whether movements in prices for products in different geographical regions or similar product types in the same geographic region move together. If the price movements are significantly correlated, the products are grouped in the same market. See Stigler and Sherwin (1985) for a detailed discussion of this issue.

Cournot solution equals the HHI divided by the market elasticity of demand, *i.e.*:

(2) $$\alpha_1\left(\frac{\hat{P}-c_1}{\hat{P}}\right)+\alpha_2\left(\frac{\hat{P}-c_2}{\hat{P}}\right)+\ldots+\alpha_n\left(\frac{\hat{P}-c_n}{\hat{P}}\right)=\frac{HHI}{\eta}$$

where c_i, $i = 1,\ldots n$ is the constant marginal cost of firm i, α_i is firm i's market share, $\hat{P}$ is the equilibrium Cournot price, and η is the market elasticity of demand[32]. The fact that the Cournot equilibrium is a solution to an imperfectly competitive game gives theoretical justification to the application of the HHI as a proxy for market power potential.

The strength of this theoretical justification, however, does not reduce the significance of its limitations. The HHI is a function of the number of firms in a market and their size. Several additional factors impact the degree of competition among firms within a market:

- nature of the product: characteristics of products, such as substitutability, storability, and capital intensity (of production) affect the ability of firms to exercise market power;
- producer behaviour: producers are likely to respond differently to the market conditions that characterise the competitive environment - this behaviour is especially relevant in markets of imperfect competition, in which each firm considers its optimal strategy given these market conditions and the potential reactions of competing firms, as well as the fact that such competitors make a similar assessment of their own;
- elasticity of demand: price-responsive demand places a limit on the extent to which a firm or firms can exercise market power – if demand is relatively unresponsive, however, the potential for the exercise of market power is relatively more prevalent, *ceteris paribus*; and[33]
- ease of market entry: the threat of entry into the market by potential competitors may reduce the scope for the exercise of market power.

As a result, two markets can possess identical HHI measures but exhibit substantially different degrees of market power. This situation is possible because the HHI provides information about the distribution of sales (or capacity) among producers in a market, but it conveys no information about the impacts of an increase or decrease in price by one or more firms. Further, the fact that a weighted average of firm price-cost margins in a Cournot equilibrium equals the HHI divided by the demand elasticity is a result that holds only under special assumptions.

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[32] In the Cournot model, firms compete against each other using quantities as strategy choices. The Cournot model assumes that each firm correctly anticipates its rival's quantity choice, such that the quantity it chooses in equilibrium maximises its profit (given the quantity choices by its rivals). See Blake (2003) for an overview of the Cournot model.

[33] Latin for 'all else equal,' meaning holding other influencing factors or variables fixed.

This discussion of strengths and limitations is in a general context and naturally leads to the issue of their relevance in an electricity market setting. The initial obstacle to applying the HHI in this context is defining the relevant market. In the present setting, this task is not necessarily straightforward on either a geographical or product definition basis.

First, assume for a moment that the product, 'electricity' is homogeneous and one MWh is perfectly identical and substitutable for another. Applying the HHI to measure changes in market concentration (attributable to interconnection) would require HHI calculation on both a pre- and post-interconnection basis. For the pre-interconnection calculation, two HHI are calculated (one for each market). With interconnection, however, the definition of the market for purposes of calculating the marginal price depends on whether, in a given trading period, the interconnector is constrained or unconstrained. There are two separate markets in the former case, while there is only one market in the latter case. As a result, two HHI and one HHI calculation are required (respectively).

The dynamics of interconnection, therefore, raise the relevant issue of how the post-interconnection HHI are compared to the pre-interconnection HHI. For example, if the proposed interconnector is forecast to be unconstrained for 85% of the year in a year then for these periods one HHI would be calculated during the appropriate trading periods. In this situation, it is not clear which pre-interconnection region's HHI should be compared to the post-interconnection, combined region HHI or how to make such a judgment.

Consideration of the relevant product range requires the relaxation of the prior assumption that electricity is homogeneous. In some sense, electricity is a homogeneous good – one MWh is a perfect substitute for another MWh at a specific point in time and at a given location. This qualifier is equally applicable to other products as well but is especially pertinent to electricity since it is generally non-storable and it is costly to transmit from one location to another[34]. Consequently, it is arguable that, for example, a 'peak' MWh is a different product than an 'off-peak' MWh, and the HHI calculation should distinguish between these two 'product types'. By the same reasoning, it may be relevant to distinguish between summer/winter, weekday/weekend, *etc*. markets. As a result, the previous discussion would need to consider such distinctions and whether they are 'significant enough' to warrant the calculation of separate HHI, *e.g.* one for 'peak' periods and one for 'off-peak' periods.

Second, calculation of the HHI requires data on pre-interconnection and post-interconnection market shares. Several measures of market share are possible: installed capacity, available capacity, total production, or actual sales. It is not obvious *a priori* which of these measures of market share is the most appropriate determinant of market concentration.

Third, an important weakness of the application of the HHI is that it does not capture several factors that influence the degree of competition in a market, such as the nature of the product, producer behaviour, price responsiveness,

[34] In the former case, hydroelectric resources serve as an exception, and in the latter case, transmission costs include the marginal costs of losses and congestion.

and ease of market entry. These factors are particularly relevant in an electricity context. First, electricity is not a typical product because it possesses several characteristics that differentiate it from other commodities: i) non-storability, ii) short-run lack of substitution possibilities, and iii) capital intensity of generator construction. These characteristics increase the potential for the exercise of market power, *ceteris paribus*, relative to competitive markets. The exercise of market power in electricity markets can take the form of unilateral or collusive strategic behaviour. The HHI calculation does not take such behaviour and its potential effects on market prices into account.

The HHI, as a stand-alone approach, does not measure competitive benefits. Importantly, project implementation is likely to alter firm incentives, and the HHI does not capture these potential changes in participant behaviour since it often relies on historical data.[35] Under certain market conditions, it may provide a reliable indicator of industry concentration, but it is far from clear that it is applicable to electricity markets in any useful sense.

The Modified HHI

Without diving into the mathematical justification of the Modified HHI, it is clear that this measure does better account for capacity-constrained units in the market better. Nevertheless, it still suffers from two primary weaknesses given the present context. First, although it may provide a 'metric' for gauging the extent of market power in a market, the index provides no explicit measure of the potential benefits from market power reduction. Second, it is not clear how it would be applied with any realism in the context of interconnections (see previous discussion). Third, calculation of the post-interconnection Modified HHI still requires some determination of the movement of post-interconnection pool prices. As a result, the measure would need to use simulation outcomes as inputs.

3.4 Residual Supply Analysis (RSA)

3.4.1 Description[36]

The RSA is an empirical approach that estimates a relationship between observed price-cost mark-ups and certain market variables. Specifically, it estimates the following relationship for each hour and for each zone using historical data:

$$(3) \qquad L_{t,r} = a + b(RSI_{t,r}) + c(TUC_{t,r}) + d(D_{t,r}) + e(SP_{t,r}) + f(NS_{t,r})$$

where:

L_{tr} Lerner Index for hour (t) in region (r)[37]

RSI_{tr} Residual Supply Index in hour (t) and region (r)

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[35] The United States Federal Energy Regulatory Commission (FERC) proposed using production-cost simulation results to replace historical data. See FERC (1998).

[36] For a complete description, see CAISO and London Economics (2003).

[37] The Lerner Index is (P-c)/P, where P is the market price and c is marginal cost.

TUC_{tr} total uncommitted capacity of the largest single supplier for hour (t) and region (r)

D_{tr} load in hour (t) and region (r)

SP_{tr} dummy variable for summer periods

NS_{tr} dummy variable for whether the zone is NP15 or SP15[38]

The linear regression yields estimates of the coefficients (a,b,c,d,e,f) of the explanatory variables for each hour and each region. The technique then assumes that the estimated relationship between the Lerner Index and the explanatory variables does not change over time *i.e.* the estimated coefficients do not change. Forecast data for the explanatory variables for each hour and region over all years of the modelling horizon are obtained from a production cost model. The estimated equation is then applied to the derived data to compute a Lerner Index for each hour and each region for every year of the study. This step yields a calculated Lerner Index for each region and hour; therefore, it appears that all generation units within the same region receive the same mark-up. In order to derive the actual market-clearing prices, the calculated Lerner Indices are converted to price-cost margins and applied to the competitive prices produced by a simulation model.[39]

3.4.2 Discussion

This approach is relatively complex because it involves two primary steps: i) regression estimation and ii) modelling simulation. In terms of methodology, the approach possesses both advantages and disadvantages. With respect to advantages, the approach utilises simulation techniques to forecast movements in pool prices; therefore, it makes an attempt to model regional prices in a robust manner. Second, it specifically addresses market power by providing a method for both identifying and measuring its exercise (and hence, the benefits from market power mitigation). In regard to disadvantages, the approach implicitly assumes a specific relationship between mark-ups on marginal cost (by region and hour), based on historical data, and this relationship is assumed to remain fixed over time. Importantly, the approach does not assume any type of generator behavioural model that describes possible reactions of generators in the regions to interconnection. These issues and several additional ones are discussed in the remainder of this section.

An important assumption of this approach is that estimates of the Lerner Index (by hour and region), obtained from a regression analysis on historical data, are relatively accurate predictors of mark-ups on expected, future prices. Consequently, to the extent that market power is exercised in post-interconnection periods, its effects are determined by estimated changes in the Lerner Index. Given this assumption about how prices are related to costs,

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[38] This regression equation is the actual one estimated by CAISO. The CAISO regression uses 1999-2000 data and shows a statistically significant relationship between the Lerner Index and all explanatory variables. Overall, the explanatory variables as a set explain 62% ($R^2 = .62$) of the variation in the Lerner Index, and the coefficients of the explanatory variables have the expected sign. Interestingly, the estimate of the RSI coefficient is -.26.

[39] The price-cost margin is $(P\text{-}c)/c$.

this methodology, therefore, does not explicitly model the behaviour that leads to these price mark-ups and as a result, it excludes consideration of generator responses (in either) region to interconnection. Consequently, even if the calculated price-cost margins for a region (based on the regression coefficients estimated from historical data) tend to track price deviations from marginal cost reasonably, there is no assurance that they will continue to follow that pattern subsequent to interconnection.

Another issue with this approach is the calculation of the Residual Supply Index (RSI), a primary explanatory variable in the regression analysis. The RSI is a measure of the ratio of the total capacity of all but the largest producer and the total demand. An RSI less than one indicates that at least some of the output of the largest producer is necessary to satisfy demand, making this producer a ‘pivotal’ player in the market. Following interconnection, it is not clear how the methodology works if the interconnector is constrained versus unconstrained. Only one pricing region would exist after interconnection when the interconnector is unconstrained. The RSI and other data would be calculated given the combined region’s data. This situation, however, raises the issue regarding which pre-interconnection pricing region’s estimated regression coefficients are used for calculating the price-cost margin in the combined post-interconnection region.

Finally, this approach assumes that the mark-up over marginal cost in a given region and hour is equal across generators in that region. The implication, for example, is that baseload units mark-up price over marginal cost by the same percentage as peaking units. This equivalency is not likely to be realistic since the operating roles of the classes of plant, *i.e.* baseload, shoulder, and peaking, are likely to interact with their incentives for strategic behaviour in a different manner.

3.5 Commercial Benefits Test (CBT)

3.5.1 Description

The ACCC suggests that an approach could utilise the Inter-regional Settlements Residues (IRSRs) as a basis for measuring competition benefits and that this approach may serve as an initial step in the eventual development of Financial Transmission Rights (FTRs).[40] The basic methodology involves using a rolling average (over either 12 or 24 months) of the sum of the historical IRSRs between two regions to serve as a proxy for competition benefits attributable to interconnection. For example, if a proponent intends to construct an interconnector between Snowy and New South Wales in 2002, it could include the rolling average of the sum of IRSRs for the 12 (or 24) months prior to the actual Regulatory Test assessment. In this example, based on historical IRSR data, such a proponent could include $15,500,000 ($22,000,000), based on a 12 (24) month rolling average, as competition benefits.

[40] One apparent motivation is that the Council of Australian Governments Energy Markets Review recommends that augmentation proposals should be subject to a ‘commercial benefits’ test that accounts for regional price separation.

3.5.2 Discussion

The use of IRSRs as a proxy for benefits attributable to interconnection investment has merit as a concept, but the proposed approach possesses several significant flaws and also requires important qualification.

The premise of this approach is sound, in the sense that it is attempting to attribute benefits to a proposed project if that project will reduce or eliminate an expected cost, specifically the cost of avoided, future transmission congestion. The fundamental problem with the approach, however, is that it uses historical, as opposed to expected future, congestion costs as the relevant costs. This issue, along with several other problems with the proposal, is discussed below.

To better understand the historical cost issue, suppose that a proponent is considering the expansion of an existing inter-regional interconnector. Assume that the Regulatory Test operates in conjunction with this proposal and that the proxy for competition benefits is a rolling average of the sum of the previous years' IRSRs, as described. Further, let the rolling average of this sum be $15M; therefore, under this proposal, a proponent could include $15M as a benefit when applying the test. Finally, assume, for simplicity, that there are no other expected benefits aside from these 'competition benefits' and that costs of the project are $12M. Suppose that transmission modelling reveals that this expansion will avoid $10M in expected, future congestion costs (properly discounted) over the life of the asset. Under this scenario, the project should not proceed from an economic perspective, since $10M - $12M = $-2M. Application of this proposal as it currently stands, however, will lead to this project's approval since $15M - $12M = +$3M. Acceptance of the proposal is clearly not correct because it will only avoid $10M in expected, future congestion costs but will incur a net cost of $-12M. Using historical data to proxy benefits circumvents the complexities of market modelling, but it may produce outcomes that are entirely uneconomic.

This problem aside, the proposal introduces another source of sub-optimal transmission investment. As it is formulated, a proponent of a transmission project is able to claim a rolling average of the sum of previous IRSRs as a benefit for the investment, regardless of the choice of project size. Consequently, a proposed investment in a 1 MW interconnector expansion of the interconnector between Victoria and South Australia that occurs in 2002 may reduce expected congestion costs by $1.5M, but the proponent is nevertheless allowed to claim approximately $9.7M, based on a rolling average of the sum of IRSRs for the previous year. Consequently, the proposal allows the proponent to include the full benefit associated with relieving all of the historical congestion costs, independent of the size of the proposed investment. As a result, a proponent could propose a project that relieves $1.5M in congestion costs but claim $9.7M (benefit) in its regulated asset base. This flaw in the construction of the approach would obviously bias the proposed investment size downward when it the optimal investment size is likely to be greater.

Finally, positive IRSRs on an interconnector represent benefits from interconnection, but they do not necessarily represent benefits from reduced market power. For example, an interconnector joins two regions that are competitive, *i.e.* generators price at marginal cost. Assume that the regions remain competitive following interconnection. During periods when the interconnector is constrained, rentals are positive, but these rentals have nothing to do with reduced market power.[41]

3.6 Stanwell Competition Index (SCI)

3.6.1 Description

According to the ACCC discussion paper, the Stanwell Competition Index (SCI) is intended to serve as a qualitative, as opposed to quantitative, measure of competition benefits and include (in some manner) the:

- number of consumers affected by the network limitation;
- incremental electricity capacity supplied to the market following augmentation;
- fuel mix of the incremental capacity (indicating underlying cost structure); and
- number of independent entities supplying the market following augmentation.

3.6.2 Discussion

The SCI, as outlined in the ACCC paper, is intended to serve as a qualitative measure of competition benefits. Such an approach is consistent with qualitative benefit-cost analysis. The primary rationale for the use of qualitative benefit-cost analysis as a solution approach is when some or all of the predicted impacts of a proposed project cannot be monetised due to limitations on time, data, and/or practicality. In such an instance, the qualitative benefit-cost analysis requires that arguments are put forward regarding the likely order of magnitude of the identified potential impacts.

In the present context, it has not been established that potential competition benefits cannot be properly monetised. It is recognised, however, that such quantification, and even the initial step that identifies such benefits, may involve significant methodological complexity, at least in certain steps of the process. In fact, the extent of such methodological complexity is implicitly part of the discussion in this paper, since the ACCC discussion paper requests public comments on "the appropriateness and practicality of the methods for calculating competition benefits."[42]

Even if it is demonstrated that all quantitative approaches to measuring competition benefits present insurmountable obstacles to the monetisation of competition benefits (due to one or more of the limitations mentioned

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[41] If both of the interconnected markets are fully competitive and no market imperfections exist, such as lumpy investment, then the addition of an increment of transmission capacity changes welfare, *i.e.* social surplus, by an amount equal to the incremental change in the value of the rentals.

[42] ACCC (2003), p. 43.

previously), it is not clear how the test - at least in its present form - would incorporate the SCI benefit categories on a qualitative basis. The integration of these benefit categories qualitatively would require the advancement of ‘possible ranges’ of benefits by the project proponent that are supported by qualitative claims. Given that competition benefits predicted to arise from interconnection inherently involve price changes and comparisons to costs, it is not clear how qualitative claims can robustly support ranges of benefits without at least some minimal reliance on simulation studies, *i.e.* quantitative analysis.

This conclusion is particularly relevant given the complexity of electricity market operations and the important role of participant, especially generator, behaviour in such circumstances. For example, incremental capacity supplied to the market following augmentation may result in lower prices in the importing region due to the incremental competition forcing previously uncompetitive prices downward. The magnitude of such benefits from augmentation will vary depending on a number of factors, including, but not limited to, the size of the augmentation, the market conditions, the reaction of incumbent generators, *etc*. It is not apparent how a qualitative measure would enable a distinction between ‘small’ and ‘large’ competition benefits for this category.

The inclusion of such a qualitative analysis to the test would be unlikely to result in any reductions of disputes among interested parties relative to quantitative approaches. Further, integration of a qualitative component may lead to reconsideration of the nature of the test and the role of qualitative benefit-cost analysis. The ACCC and market participants would need to consider whether or not they want to ‘open the door’ to this possibility.

Given these issues, it is understood that the four benefit components of the SCI have merit as competition benefit categories. It is unclear from the brief description how the SCI proponents envision that a qualitative methodology for the ‘measurement’ of competition benefits would work in practice and relate to the test in its current form. Also, it is not convincing that the incorporation of such an approach would be more practical or less controversial than a quantitative approach.

4 Evaluation

Given the description and discussion of the proposed approaches in section 4, this section describes four criteria for evaluating the proposals and then ranks the proposals based on these criteria.

4.1 Description of Evaluation Criteria

Four criteria are applied to evaluate the current proposals:

- Methodological Transparency;
- Economic Accuracy;
- Completeness; and
- Ease of Implementation.

This set of criteria is not intended to be exhaustive but to capture the more important issues in the policy debate regarding the assessment of benefits and costs as they relate to the test. Almost unavoidably, each criterion will tend to be correlated with one or more of the other criteria. As a result, the criteria are defined to minimise these overlaps.

4.1.1 Methodological Transparency

Methodological transparency refers to the accessibility of the basic ideas underlying the methodology to the layman. Methodologies that are potentially complex, such as pool simulations for example, may receive a higher mark than an equally complex approach if the former tends to follow a commonly accepted and standardised form. Standardised methodologies tend to possess more transparency relative to unconventional ones.

4.1.2 Economic Accuracy

This criterion represents the potential for the approach to correctly assess – from an economic perspective – and quantify the competition benefits (as defined in section 2). Since an accurate measurement of competition benefits must necessarily consider regional prices changes, high marks in this category will require at least consideration of such changes and the potential for the approach to capture them.

4.1.3 Completeness

Given the definition of competition benefits discussed previously, each proposed approach should (ultimately) provide a method for i) identifying market power, and as a result, the potential competition benefits from its reduction and for ii) measuring these benefits. For example, an approach that relies on a quantitative assessment of market power may identify (accurately or inaccurately) the potential for competition benefits from a reduction in that market power, but it is a separate issue whether or not the approach actually implies a methodology for measuring them. If an approach does not directly measure them or readily lend itself to their measurement then it is incomplete. The adoption of such an approach would require development of the measurement component for it to serve as a practical ‘measure’ of competition benefits (as opposed to serving only as a ‘screening test’ for their existence). A low mark implies that the approach as it currently stands is significantly incomplete in this respect, while a high mark implies that the approach is relatively complete.

Whether an approach accurately identifies and/or accurately measures competition benefits is taken into account by the Economic Accuracy category.

4.1.4 Ease of Implementation

Ease of implementation is distinct from the Methodological Transparency criterion and refers to the data, modelling, and computation required to implement the approach effectively. Almost all of the approaches require at least some data, modelling, and computation – the issue is to what extent.[43] Factors considered in awarding marks include, but are not limited to, nature of the data – public or private, the volume of data, the extent and sophistication of modelling, and volume of calculations.

4.2 Relative Rankings of Proposals

Table 1 shows the relative ranking of the proposed approaches, based on the prior discussion in this section. For each criterion, a rating from one to five ‘stars’ is awarded, spanning a range of ‘weakest’ to ‘strongest’ (respectively) with regard to satisfying the given criterion. The ranking awarded to each approach for a specific criterion is relative to the other projects. For example, the HHI is likely to be easier to implement in comparison to Market Simulations; therefore, it receives a higher mark in that category. Rankings are awarded based on the descriptions in ACCC (2003). All rankings are, of course, subjective.

[43] Even the Stanwell proposal, although qualitative in nature, would seemingly require at least some minimum level of modelling in order to determine a relative ranking of magnitudes.

Proposed Approach	Selected Evaluation Criteria			
	Methodological Transparency	Economic Accuracy	Completeness	Ease of Implementation
Market Simulation Studies (MSS)[1]	***	*****	*****	**
Powerlink Public Benefits Test (PBT)	**	*****	*****	**
Residual Supply Analysis (RSA)	***	***	*****	*
Herfindahl-Hirschmann Index (HHI)	****	**	**	***
Commercial Benefits Test (CBT)	****	*	**	*****
Stanwell Competition Index (SCI)	?	*	*	?

Table 1: Relative Rankings of Proposals

4.2.1 Methodological Transparency

The HHI and CBT approaches scored the highest for transparency because their basic concepts are more or less straightforward. Two of the three approaches that involve detailed pool studies, MSS and RSA scored next highest because they involve reasonably standard and commonly accepted simulation concepts. Although the RSA is less transparent than MSS, due to the additional use of regression analysis, this aspect is offset by the fact that the former does not really attempt to model changes in generator behaviour as a result of interconnection. The PBT is a simulation-based approach that also includes a preliminary screening test. The screening test adds an extra layer to the overall methodology; therefore, it receives a lower mark than the two other simulation approaches. The transparency of the SCI is unknown because the approach does not offer a methodology to assess.

4.2.2 Economic Accuracy

The MSS and PBT approaches score the highest for economic accuracy because they basically consider and attempt to assess competition benefits by measuring changes in regional prices. The RSA approach receives a lower mark because it does not address the response of generators to interconnection since it assumes that estimates of price-cost margins, based on historical data, continue to apply into the future and in an entirely different, *i.e.* post-interconnection, market environment. An omission of a generator behavioural model compromises the realism of this simulation-based approach. The HHI receives a lower mark because it is unclear how it would be applied to capture regional price movements. Calculation of the HHI for a post-interconnection world, subject to the challenges discussed, would require data on market shares, which are affected, in part, by prices. Presumably then, applying the HHI would require some at least implicit assumption about price movements in order to examine market shares. The CBT and SCI received the lowest marks; the CBT uses historical data, which does not necessarily have any relation to post-interconnection prices, and the SCI approach is qualitative.

4.2.3 Completeness

The MSS, PBT, and RSA all receive high marks because they provide the scope for both identifying and measuring competition benefits. The HHI is a screening test for market power, and it only measures market concentration, not competition benefits. The HHI is proportional to the Lerner Index under a special set of assumptions. Since the Lerner Index is the ratio of a firm's profit margin to price, computation of the HHI could ultimately lead to using the Lerner Index to proxy potential gains from reduction in market power (assuming it is possible to modify the relationship in equation (2) to account for electricity market specific assumptions). In this (indirect) sense, the HHI offers the potential for measuring competition benefits. The CBT does not necessarily identify the potential for competition benefits, *i.e.* the existence of market power. The historical data issue aside, expected future IRSRs can exist on a constrained interconnector between two competitive regions. The SCI does not provide a way to either identify or measure competition benefits, as defined for purposes of this paper. It gives several factors that an index could include to indicate 'competitive levels', but 'competitive' in its description is used in a much broader sense than simply the reduction in market power.

4.2.4 Ease of Implementation

The MSS and PBT approaches receive low marks because they require some private data, a significant volume of data, and extensive modelling and calculations. The RSA receives an even lower mark because it faces the same implementation burdens as the MSS and PBT, as well as the additional requirement of performing pre-simulation regressions. The HHI implementation mark is average since it only requires firms' market shares as inputs. Data and modelling requirements for determining these shares for the pre-interconnection (base) case would be straightforward and rely on historical data, but calculation of the market shares post-interconnection would require further analysis and modelling. It is not clear what techniques would be applied in the latter case. The CBT receives the highest mark for implementation since it relies only on historical data. Although the SCI appears to be more of a qualitative approach, it presumably would utilise some data or analysis to identify potential competition benefits and determine their relative rankings. Given the lack of detail in the description, data and analytical requirements are unknown at this point.

5 Conclusions and Recommendations

As a starting point, a reading of excerpts (from prior submissions) in the ACCC discussion paper demonstrates a high variation in participants' level of understanding about economic issues surrounding the components of the test. Although education about basic economic concepts and principles of quantitative benefit-cost analysis explain some of this variation, it is likely that some of the confusion and lack of understanding in the debate results from the lack of clarity of the test itself. Joint consideration of all of the issues covered in this report suggests that the test, in its current form, does not provide sufficient guidance to enable participants to understand it fully and to apply it on a consistent basis for project evaluation purposes.

It is recognised that the applicant is ultimately responsible for making a case for the inclusion of individual benefit and cost items in an assessment. The ACCC could enhance the clarity and understanding of the overall assessment process, however, by providing a more structured framework for project evaluation.

Some participants will claim that a more structured test will inevitably make it unworkable. A more structured test, however, is not mutually exclusive with a more practical test. In fact, the opposite is true - the lack of clarity that characterises the current test is one of the primary sources of confusion and misapplication of the test. Although the development of a clearer framework for the test may present a short-run hurdle, once such a framework is developed and properly vetted, the medium- and long-run outcome will be to eliminate confusion regarding the meaning and application of the test, ensure that its application occurs on a consistent basis and as a result, to minimise prospective disputes.

In conclusion, Drayton Analytics provides the following recommendations as a useful starting point for consideration:

Recommendation 1: The definitions of producer and consumer surplus should be explicitly stated, and the test should clarify that if these measures are calculated correctly, they include all relevant economic benefits and costs.

Recommendation 2: If it is decided to include an explicit definition for 'competition benefits', it should *not* be in specific reference to market power reductions but more generally, to any real benefits (or costs) that accrue from interconnection creating changes in the value of consumption (positive or negative) in both regions. A more appropriate descriptor is 'consumption benefits', as opposed to 'competition benefits', because it aligns itself more clearly with the benefit-cost concepts of producer and consumer surplus that are the actual basis of the test.

*Recommendation 3***:** The test should clarify that the current framework already allows for the inclusion of 'competition benefits' *and* for the inclusion of other consumption benefits not associated with market power reductions - in short, all relevant changes in the value of consumption in both interconnected regions. These effects are real economic impacts; simply because they occur on the demand-side of the market, as opposed to the supply-side, does not give them any less importance than supply-side effects, such as benefits from fuel savings, in the final benefit-cost analysis.

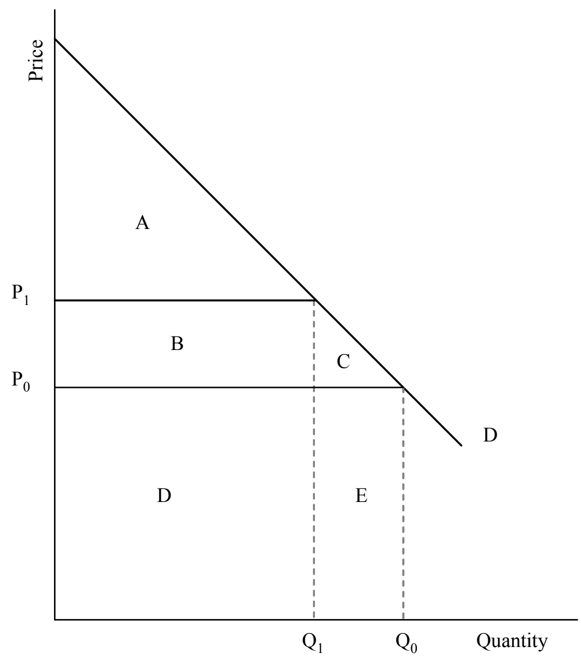
Recommendation 4: In order to ensure that changes in the value of consumption are properly accounted for in the test, it is incumbent on the ACCC to develop some general guidelines for participants, addressing both data and methodology issues in this area. In particular, such guidelines should recognise that i) electricity demand (even short-run) is not completely insensitive to price changes and that modelling can estimate such relationships and the resulting price impacts on consumption and that ii) modelling anticompetitive, *i.e.* strategic, behaviour by generators under a range of plausible scenarios is an integral component of assessing ‘competition benefits’.

Appendix A Consumer and Producer Surplus

A.1 Consumer Surplus

Suppose that an individual has the demand function for a good, as illustrated in Figure 2. The horizontal line at P_0 implies that the consumer can purchase as many units of the good at this price. The consumer decides to purchase Q_0 since this quantity is the quantity for which the marginal valuation, given by the demand function, equals the marginal cost. At this consumption level, the consumer's *total* willingness to pay, or gross benefit, is equal to A+B+C+D+E, the area below the demand function up to the purchase quantity. The total cost to the consumer is D+E, and the consumer surplus is (A+B+C+D+E)-(D+E) = A+B+C.

Figure 2: Consumer Surplus Example



If the consumer instead purchases less than Q_0, *i.e.* $Q_0 - \varepsilon$, where $\varepsilon > 0$ and 'small', then at that quantity, the consumer's marginal valuation exceeds the marginal cost (given by P_0). In this situation, the consumer would be better off by increasing consumption, since the marginal benefit of consumption exceeds the cost at this point.

Suppose now that the price increases from P_0 to P_1. The optimal consumption choice for the consumer is now Q_1. If the consumer chooses a consumption, $Q > Q_1$ then marginal willingness to pay is less than marginal cost at this point. For example, if the individual chooses $Q_1 + \varepsilon$, then the individual would improve its situation by reducing consumption, since at $Q_1 + \varepsilon$, the marginal willingness to pay is less than the marginal cost, P_1. As a result, given the price increase from P_0 to P_1, the individual should choose to consume Q_1 at price P_1. Consumer surplus decreases from area A+B+C to area A only.

A final note about consumer surplus involves measuring actual changes in consumer welfare. Given the price change from P_0 to P_1 in Figure 2, the loss of consumer surplus given by area B+C approximates the most common measure of individual welfare, the compensating variation. The compensating variation of a price change is the amount by which a consumer's budget would need to be changed in order that the individual would have the same level of utility after the price change as before it.

If the demand schedule is derived through observations of how the consumer varies its purchases in response to price, holding utility constant at its initial level, then the consumer surplus exactly equals the compensating variation. Typically, however, it is impossible to ascertain a demand function given constant utility. Instead, empirically estimated demand functions hold constant an individual's income (as opposed to utility) and all other prices. This constant income, or Marshallian, demand function involves increases (decreases) in utility as the price decreases (increases).

In reference to a demand function that holds utility constant at the initial level, the Marshallian demand function is higher (lower) for price decreases (increases). As long as the price change is 'small' or expenditures on the good are a 'small' part of the individual's overall budget, estimates of consumer surplus with the Marshallian demand function approximate the compensating variation. Regardless, the consumer surplus change will lie between the compensating variation and the equivalent variation.[44]

A.2 Producer Surplus

In Figure 3, the supply function indicates the number of units a firm is willing to supply at various prices. For example, if the price is P_1, the firm is prepared to offer Q_1 units. As the price increases, the firm is willing to offer greater quantities of the good, yielding a typical upward-sloping supply function.[45]

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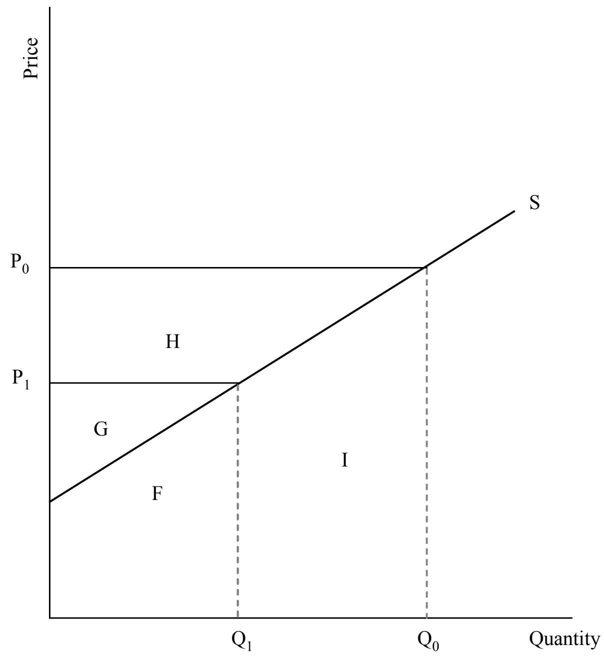
[44] The equivalent variation is the amount by which the consumer's initial budget would have to change such that the individual would have the same utility before the price change as after the price change. For an excellent discussion of the use of consumer surplus changes as a measure of changes in individual welfare, see Willig (1976).

[45] In a market with multiple firms, the (market) supply function is the horizontal summation of the marginal cost functions of the individual firms.

Figure 3: Producer Surplus Example



A given point on the function reveals the amount it would cost to produce another unit of the good. Beginning with a zero quantity and moving incrementally toward Q_0, the summation of the marginal amounts, *i.e.* the vertical distances between the supply function and the horizontal axis for each Q, yields the total variable cost of producing quantity, Q_0. In Figure 3, this total variable cost equals the area under the marginal cost curve between 0 and Q_0.

If the output of the firm is Q_0, then the firm's total revenue is $P_0 \times Q_0$ = F+G+H+I. The total revenue less total variable costs (F+I) yields the total rent, or producer surplus, accruing to the firm at price P_0, area G + H. Suppose now that for some reason, the price decreases from P_0 to P_1. Producer surplus then decreases to area G as a result.

Appendix B The Economics of Interconnection

This section uses some basic examples to highlight fundamental economic impacts of interconnection and to highlight the potential pitfalls of defining 'competition benefits' strictly as reductions in market power. Although the examples are set in a static framework, they serve to illustrate the salient issues.

The examples analyse two states of the world, pre- and post-interconnection (abbreviated to pre-IC and post-IC) under different assumptions about the degree of competition among firms in the regions. The qualitative implications of these examples apply equally to an analysis of existing interconnector augmentation as well.

B.1 Assumptions and Notation

The following assumptions are made in order to simplify the examples in this section; however, these assumptions do not change the fundamental, qualitative implications of the analyses.

The assumptions are:

- the interconnector is constrained in the post-IC world such that the regions are treated as separate markets;[46]
- sufficient spare capacity exists in the exporting region to constrain the interconnector (given the relative demands of the two regions);
- transmission losses are zero;
- project capital costs are zero (for ease of calculation);
- producer fixed costs are zero; and
- hydro and must-take generation are excluded from the analysis without any loss of generality.

Revenues and costs indicated in the figures are the amounts accruing to the relevant participants in that region only.

Payments to the network service provider (NSP) by region 1 consumers for imports are an 'import cost', and payments received by producers in region 2 are an 'import revenue.'[47] The inter-regional settlements surplus (IRSR) is equal to the payment by consumers in the importing region less the payment received by the producers in the exporting region, over the interconnector flow.[48]

Social surplus is the sum of producer surplus (PS), consumer surplus (CS), *and* transmission rentals (TXR).

The subscripts on prices and quantities indicate the relevant region, and the post-IC prices and quantities are denoted with a ′ (prime).

B.2 Interconnection Between Two Competitive Regions

B.2.1 Description

Assume that two separate regions (1,2) exist in a national market. There are many small producers in both regions and as a result, producers in both regions behave competitively. The supply costs in region 1, however, are higher in general, but costs in region 2 are relatively lower. The linear marginal cost function in each region is assumed to represent the supply function for the individual markets.[49] The pre-IC demands are D_1 and D_2 respectively. Figure 4 illustrates this situation, using a single diagram for each region (pre- and post-interconnection).

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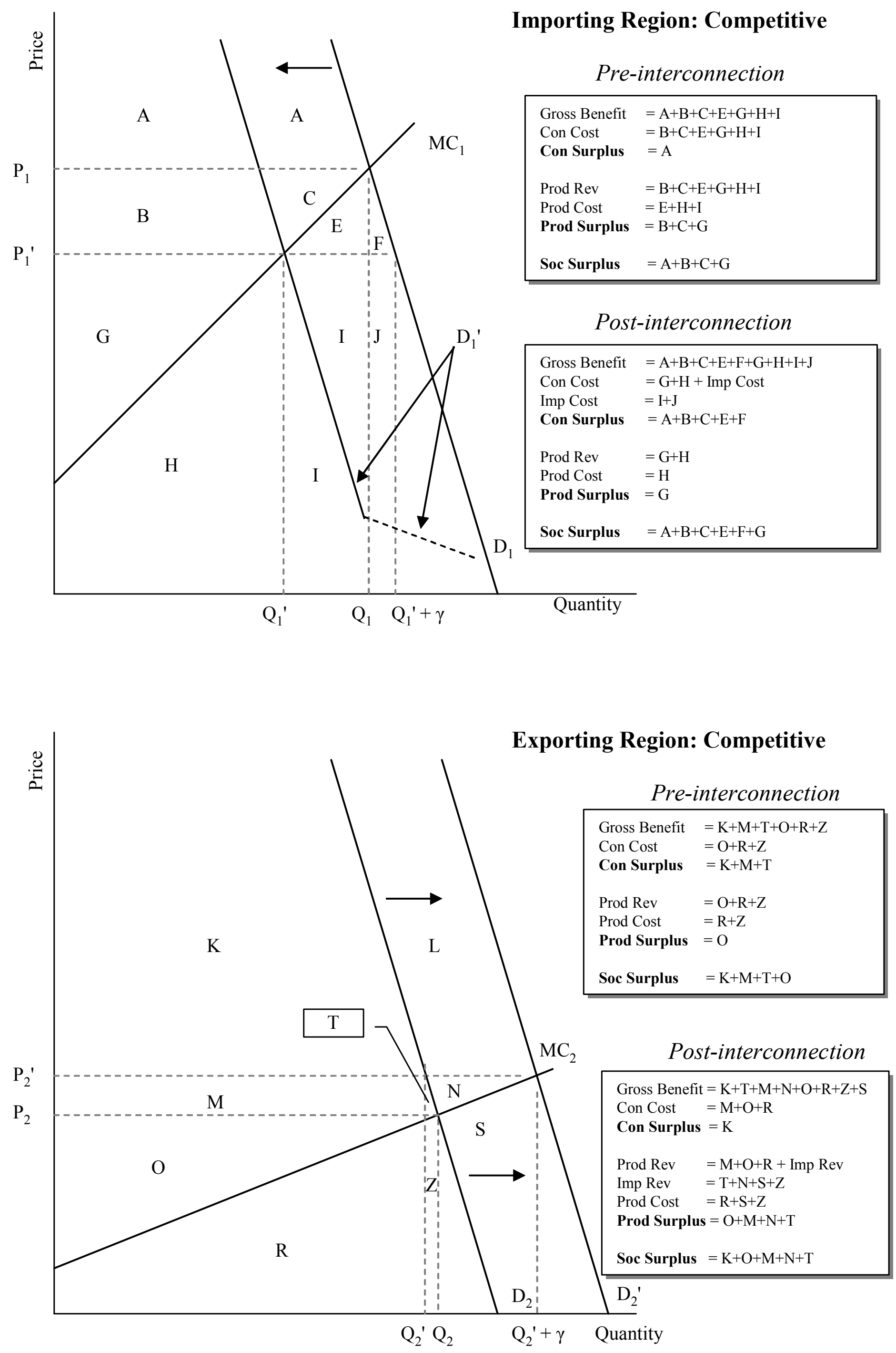
[46] Obviously, any comprehensive benefit-cost analysis would need to consider the frequency of the constraint, in order to assess the benefits and costs correctly, and also to model the 'combined' pricing region (and predicted participant behaviour) when the interconnector is unconstrained.

[47] In the Australian NEM, NEMMCO collects the rentals or IRSRs) and auctions them.

[48] This report uses the term, 'rentals', as opposed to inter-regional settlements residues, for convenience.

[49] The market supply can be thought of as the 'stack' of generator offers, increasing from lowest to highest. For the competitive markets, the offers are assumed to be at marginal cost. For the monopoly market, the supply is given by the monopolist's marginal cost function.

Figure 4: Interconnection Between Two Competitive Regions



In the pre-IC world, the markets clear at the competitive prices, P_1 and P_2, yielding quantities, Q_1 and Q_2, respectively. Consumer and producer surplus amounts are given in the boxes in the diagram for both regions. *Social surplus calculations in the figure boxes disregard the NSP rentals, but the final benefit-cost calculation accounts for them.*

Assume now that an interconnection between the two regions is proposed and the post-IC world is described by an interconnector with the capacity limit, γ. The producers in each region now face the post-IC demands, denoted with a ′ (prime). Given both sets of producers are competitive, they still price at marginal cost, yielding the new regional prices and quantities.

In region 1, consumers pay P_1' per unit for consumption, $Q_1' + \gamma$. Region 1 producers, however, only produce Q_1'; the remaining consumption (γ) is supplied by imports. Consequently, producer revenue falls to (G + H), and producer surplus is area G only. Consumer surplus increases from A to (A+B+C+E+F). Note that (B+C) is a transfer of *surplus* from producers to consumers. Region 1 consumers pay (I+J), the import cost, to the NSP, which will, in turn, compensate the region 2 producers for their region 1 sales (but at the region 2 market-clearing price).

In order to determine the economic impact of interconnection on region 1, it is necessary to calculate the *change* in social surplus for that region:

(B1) $\Delta(\text{Soc Surplus})_1 = \Delta(\text{CS})_1 + \Delta(\text{PS})_1 + \Delta(\text{TXR})_1$

$= [\text{A+B+C+E+F}) - \text{A}] + [\text{G} - (\text{B+C+G})] + (\text{I+J})$

$= (\text{E+F+I+J}).$

The area (E+I) is production savings for region 1 producers since they no longer produce the output, ($Q_1 - Q_1'$), and as a result, they save the area below marginal cost over that range of output. The area (F+J) is a gross consumption benefit that results from the lower price stimulating additional consumption in region 1 equal to $(Q_1' + \gamma) - Q_1$. The cost for this consumption is incurred by region 2 producers.

In region 2, producers produce $Q_2' + \gamma$ and receive price, P_2', for all units. Consequently, consumers in region 2 pay $(P_2' - P_2)$ more per unit for their consumption, which is less relative to the pre-IC level due to the higher price. The area (N+T+S+Z) is a payment from the NSP for the imports purchased by region 1 consumers. Consequently, the NSP rentals are (I+J) – (T+N+S+Z). The *change* in social surplus for region 2 is:

(B2) $\Delta(\text{Soc Surplus})_2 = \Delta(\text{CS})_2 + \Delta(\text{PS})_2 + \Delta(\text{TXR})_2$

$= [\text{K} - (\text{K+M+T})] + [(\text{O+M+N+T}) - \text{O}] - (\text{T+N+S+Z})$

$= - (\text{T+S+Z}).$

The area S is the cost to region 2 of producing the incremental output, $(Q_2' + \gamma) - Q_2$. Note that $(Q_2' + \gamma) - Q_2 < \gamma$ since $Q_2' < Q_2$. The area T+Z is a gross consumption loss attributable to the higher post-IC price suppressing region 2 demand relative to the pre-IC level.

As a result, the change in social surplus across both regions attributable to the project is (E+F+I+J) – (T+S+Z). If this net social surplus is positive then the project will have a positive net benefit.

B.2.2 Implications

There are several implications from this example. First, there are two basic types of 'competition benefits' for region 1 from interconnection (with opposite impacts in the exporting region): i) cost savings on the production side from less expensive generation in region 2 replacing more expensive generation in region 1, and ii) consumption benefits due to the lower price in the importing region stimulating additional demand. Second, both of these sources of competition benefits from interconnection have nothing to do with reducing market power.

B.3 Interconnection Between an Anticompetitive and a Competitive Region

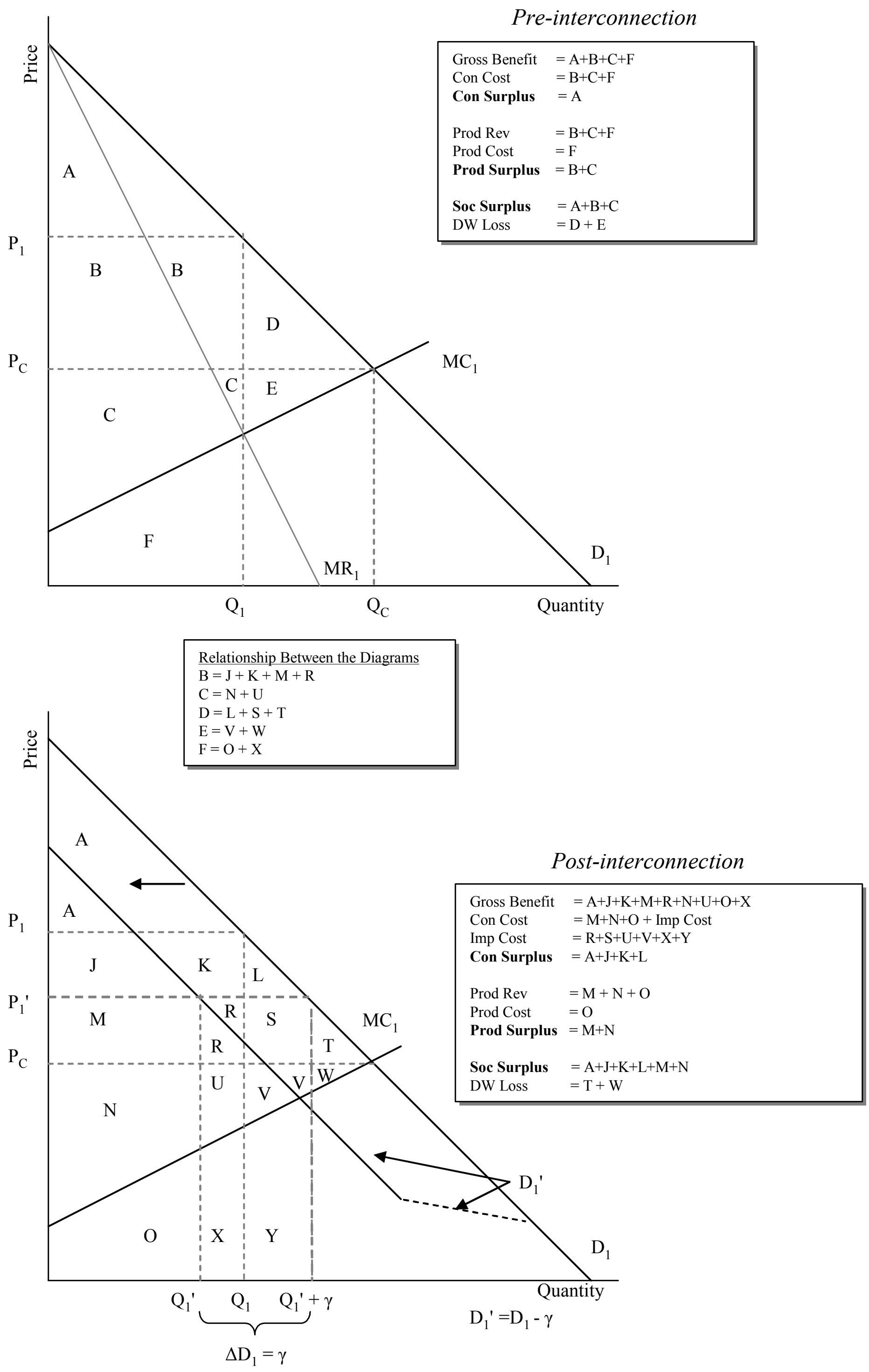
In this example, the regions are now represented on separate figures.

B.3.1 Description

Assume again that two separate regions (1,2) exist in a national market. There are many small producers in the exporting region (2), and this region is competitive. In the importing region (1), however, a monopoly producer wields market power and can maximise its profit by restricting its output below the competitive level. The pre-IC demands are D_1 and D_2 respectively. Figures 5 and 6 illustrate regions 1 and 2 (pre- and post-interconnection) respectively.[50]

[50] The pre- and post-IC marginal revenue functions for the monopolist are not illustrated in order to reduce the clutter in the diagrams; however, the optimal outputs and prices are derived using them.

Figure 5: Importing Region - Monopoly



In the pre-IC world, the markets clear at the prices, P_1 and P_2, yielding quantities, Q_1 and Q_2, respectively. In the case of the importing region, the monopoly withholds output in order to raise the price above competitive levels. The pre-IC producer surplus for the monopoly is area B+C, where area C is the competitive rent, and area B is the monopoly rent. The area D+E is the deadweight loss from monopoly behaviour. This amount is a social loss because consumers' marginal valuation exceeds marginal cost over the range of output, $Q_C - Q_1$; this output should be produced but it is not, due to the exercise of market power.

Assume now that an interconnection between the two regions is proposed and the post-IC world is described by a constrained interconnector that limits imports to γ. The producers in each region now face the post-IC demands, denoted with a ′ (prime).

The producers in region 2 still produce at marginal cost since they are competitive. Given the potential for imports, the monopolist re-optimises against its residual demand function, producing Q_1' and charging price, P_1'.

In region 1, total consumption is $Q_1' + \gamma$, with imports equal to γ. Producer revenue falls to (M+N+O), and producer surplus is (M+N). Note that interconnection reduces the monopoly rent from B (=J+K+M+R) to M only. Consumers receive J+K as a transfer from producers in region 1, and R is part of the payment that producers in region 2 receive for their exports (also effectively a transfer from producers in region 1).

Consumer surplus in region 1 increases from A to (A+J+K+L). Region 1 consumers pay the import cost, R+S+U+V+X+Y, to the NSP, which will, in turn, compensate the region 2 producers for their region 1 sales (but at the region 2 market-clearing price). In order to determine the economic impact of interconnection on region 1, it is necessary to calculate the *change* in social surplus for that region:

(B3) $\Delta(\text{Soc Surplus})_1 = \Delta(\text{CS})_1 + \Delta(\text{PS})_1 + \Delta(\text{TXR})_1$

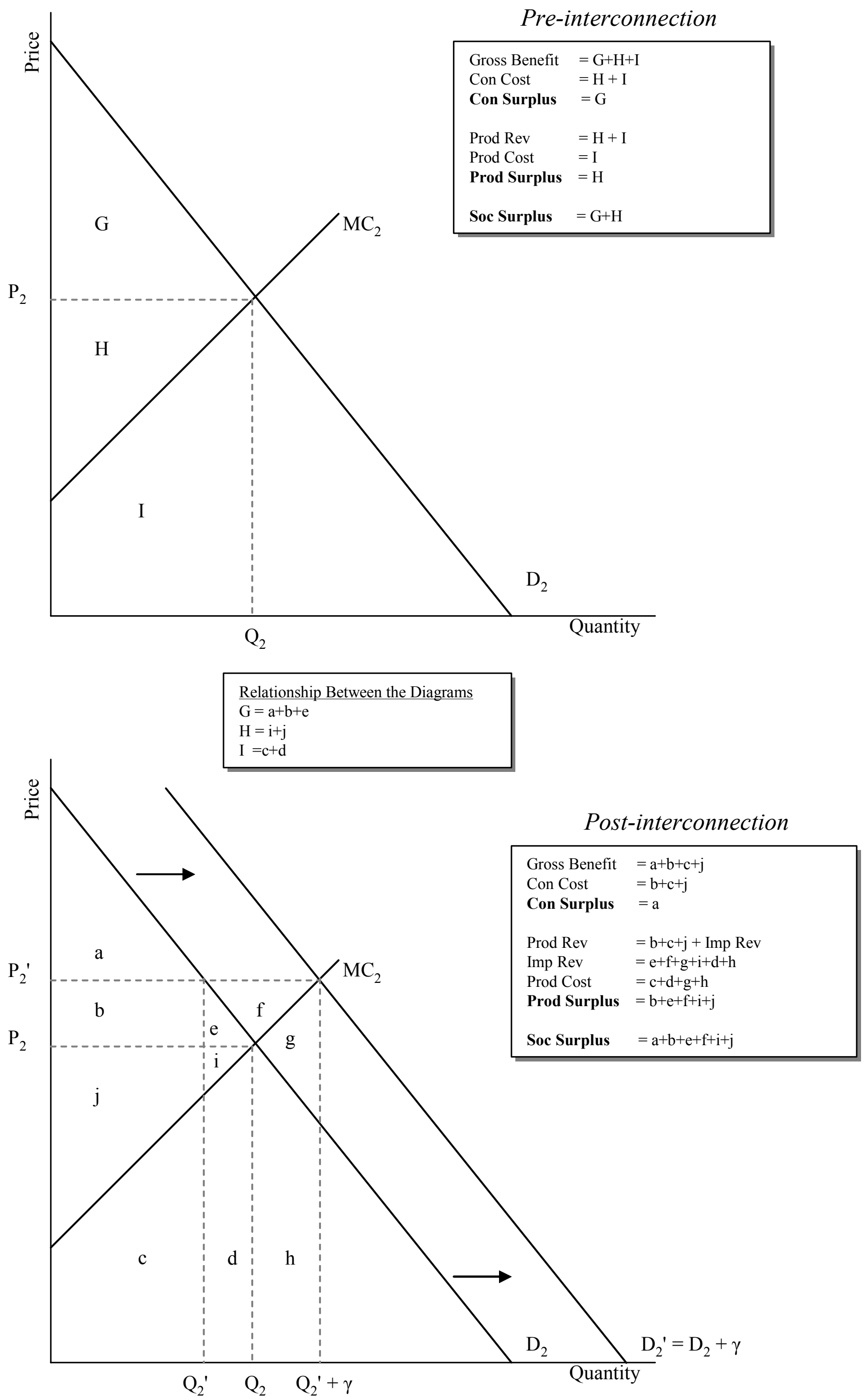
$= [(A+J+K+L) - A] + [(M+N) - (B+C)] + (R+S+U+V+X+Y)$

$= L+S+V+X+Y$.[51]

Similar to the first example, the area X is a production cost savings for region 1 producers since the monopolist no longer produces the output, $(Q_1 - Q_1')$. The area (L+S+V+Y) is a gross consumption benefit that results from the lower price expanding output by the amount, $[(Q_1' + \gamma) - Q_1]$, eliminating part of the pre-IC deadweight loss. Note that the production cost for this consumption benefit is incurred by region 2 producers.

[51] Using the diagrammatical relationships, B+C = (J+K+M+R) + (N+U).

Figure 6: Exporting Region - Competitive



In region 2, producers produce $Q_2' + \gamma$ and receive price, P_2', for all units. Consequently, consumers in region 2 pay $(P_2' - P_2)$ more per unit for their consumption, which falls relative to the pre-IC level due to the higher price. The area (e+f+g+i+d+h) is a payment from the NSP for the imports purchased by region 1 consumers. Consequently, the NSP rentals are

[(R+S+U+V+X+Y) – (e+f+g+i+d+h)]. The *change* in social surplus for region 2 is:

(B4) Δ(Soc Surplus)$_2$ = Δ(CS)$_2$ + Δ(PS)$_2$ + Δ(TXR)$_2$

= (a-G) + [(b+e+f+i+j) – H] - (e+f+g+i+d+h)

= - (e+g+i+d+h).[52]

The area (g+h) is the incremental cost to region 2 of producing the additional output, $(Q_2' + \gamma) - Q_2$. Area (e+d+i) is a gross consumption loss to region 2 consumers due to the higher post-IC price. Note that area d is not a production cost savings from reduced output because producers still incur (c+d+g+h) producing $Q_2' + \gamma$.

As a result, the change in social surplus across both regions attributable to the project is (L+S+V+X+Y) – (e+g+i+d+h). If this net social surplus is positive then the project will have a positive net benefit.

B.3.2 Implications

There are several implications from this example. First, interconnection reduces the monopoly price in region 1, but it does not entirely eliminate the deadweight loss in this particular case. Second a correct analysis cannot assume that the region 1 monopolist will continue to charge P_1 in a post-IC world. The monopolist perceives how the potential imports alter its demand, and it re-optimises based on the post-IC (residual) demand.

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[52] Using the diagrammatical relationships, G = a+b+e, and H = i + j.

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