Submission to Australian Energy Market Commission: *Preliminary Findings* Report

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1. INTRODUCTION

The Australian Energy Market Commission (AEMC) is undertaking a review into the use of total factor productivity for the determination of prices and revenues. This review is examining whether to add a "TFP-based" option for network price regulation to Australia's current energy regulation framework. In December 2009, the AEMC issued its *Preliminary Findings: Review into the use of Total Factor Productivity for the Determination of Prices and Revenues* (the *Preliminary Findings* Report), which presents its preliminary conclusions regarding the merits of a TFP-based option.

Overall, the *Preliminary Findings* Report finds that a TFP-based methodology will contribute to the promotion of the National Electricity Objective and the National Gas Objective. In particular, the Report finds that a TFP-based methodology can:

- Increase the incentive for utilities to be innovative and seek cost efficiencies, compared with existing building block regulation
- Provide a reasonable opportunity for utilities to recover their efficient costs
- Be more appropriate for energy distribution than transmission utilities.

At the same time, the *Preliminary Findings* Report indicated that further work needs to done on the detailed design of a TFP-based methodology, finalizing the TFP specification, and ensuring that better data are provided by regulated firms. The AEMC appears particularly concerned about whether an accurate measure of TFP trends can be estimated for energy utility industries. It is also preliminarily recommending that any TFP-based approach not take effect for at least eight years, so that a suitable dataset can be developed.

These issues will be examined as the AEMC prepares its Final Recommendations and Stage I Final Report. In light of the Preliminary Findings, however, the AEMC has indicated that it intends to progress to Stage II of the Review. This Stage will involve preparing draft Rules and finalizing the data and specification to be used to estimate TFP trends.

Coincident with the release of the *Preliminary Findings*, the AEMC issued the following three reports by consultants involved in the Review:

1. *Total Factor Productivity Index Specification Issues* by Economic Insights (the EI Report);
2. *Review of Incentive Power and Regulatory Options in Victoria* by the Brattle Group (the Brattle Incentive Report); and
3. *Options for Reforming the Building-Blocks Framework* by the Brattle Group (the Brattle BB Report).

A significant share of these consultant reports responds to work that I have put forward in this Review or other proceedings. For example, Brattle reviewed the Incentive Power report that Pacific Economics Group (PEG) developed for the Essential Services Commission of Victoria (ESCV). The EI Report responds to my TFP specification and advocates an alternative. TFP specification and measurement issues will be crucial to the preparation of the AEMC's Stage I Final Report as well as the Stage II Review.

In evaluating the debates between EI and personnel and myself regarding TFP measurement, United Energy Distribution/Multinet Gas (UED/MG) commented that

> As much 'heat' as 'light' seems to have been generated by the accompanying debates, including in the reference material circulated by the Commission during this review. At present, the debate sees alternative (TFP) index specifications favoured by Economic Insights and Pacific Economics Group. In these circumstances, it is unsurprising that stakeholders are uncertain about the preferred method of calculation. Service providers have also taken the initiative to advance methods which would then be assessed by the regulator.
> In the Companies' view, a considerable amount of further work is required on determining the most appropriate method for calculating the annual percentage change in industry TFP before any service provider would consider seeking to be regulated under a TFP methodology. The Companies are dismayed that, after more than a year, the Preliminary Findings are somewhat bereft of detail about how the TFP index might in practice be calculated.[1]

[1] *Submission to the AEMC by United Energy Distribution and Multinet Gas,* February 2010, p. 18.

I empathize with UED/MG regarding the lack of consensus on TFP measurement but respectfully disagree with their conclusion. It may not be immediately obvious, but I believe the debates in this proceeding *have* shed light on the most appropriate TFP specification. Moreover, I believe these debates can be resolved expeditiously, without "a considerable amount of further work." As UED/MG indicate, a resolution is necessary, since two different TFP specifications have been put forward yet "stakeholders are uncertain about the preferred method of calculation." How TFP is measured will be critical for how stakeholders evaluate and respond to a TFP-based option, so the debate over the merits of the TFP alternatives cannot simply be swept under the rug.

I believe there is a relatively straightforward means of identifying the most appropriate TFP specification in this Review. I also believe this process will clarify much of the confusion that the current debates have unfortunately engendered. In addition, I believe this review process will ultimately lead to widespread (although perhaps not universal) agreement among stakeholders about the most appropriate way to measure TFP when implementing the TFP-based regulatory option.

This Submission will present my views on the AEMC's Preliminary Findings and a way forward for both the Stage I and Stage II Reviews. In general, I recommend that the debate over TFP specifications move beyond theory and rhetoric and towards developing a concrete, transparent and verifiable empirical record. This can be done in two related ways.

First, to the greatest extent possible, theoretical differences between the EI and the PEG TFP recommendations should be resolved through direct empirical tests. This is of course how scientific debates are normally resolved, and I believe the scientific method is appropriate and feasible in this Review. Many of the most important differences between the EI and PEG TFP specifications are amendable to empirical investigation. In this submission, I develop a number of concrete testable hypotheses that can illuminate the differences and implications the EI and PEG TFP specifications and can put *both* specifications to the test.

Second, the Review should develop a concrete and verifiable factual record on TFP measurement issues that are disputed by EI and PEG. Such a record will complement the direct empirical tests and provide another source of information for

determining the most appropriate means of TFP specification. This factual record must be stated plainly, with a minimum of rhetorical flourish or interpretation, to lay bare the most basic facts regarding (*inter alia*) how TFP has been measured in regulatory and official government applications.

This submission will also begin to develop what I believe is a factual record arising from this Review and a series of testable, empirical hypotheses the AEMC/AER can explore to finalize the TFP specification and data requirements. I encourage other stakeholders and consultants to supplement this factual record and recommend additional empirical hypotheses. However, this record must consist of statements of fact that can be verified by other parties in an open, transparent manner. Resolving the TFP measurement debates requires moving beyond rhetoric, theory and opinion, not more of the same.

Based on my understanding of the institutional framework and division of regulatory responsibilities in Australia, I believe the AER should play a key role in resolving the TFP debate. One reason is that the AER will have the final responsibility for implementing and administering the TFP-based regulatory option. It is therefore critical for the AER to understand and have confidence in the way industry TFP trends are computed. This confidence and understanding will be furthered if the AER tests and evaluates the rival TFP specifications proposed by EI and myself.

In addition, the AER is responsible for efforts to develop more standardized data reporting across Australia. These efforts should give the AER a better understanding of the incremental costs and benefits associated with new reporting requirements. This knowledge would clearly be relevant for evaluating the relative merits of the EI and PEG TFP specifications, since they differ considerably in terms of the new information needed to implement each approach.

This Submission begins by addressing the conditions needed to develop a TFP methodology. These conditions were discussed in Chapter Five of the *Preliminary Findings* Report and appear to represent the most significant topics the AEMC needs to address for finalizing the Stage I recommendations. I present my views on data availability and requirements; accurately measuring industry TFP trends; the stability of the TFP index; and the treatment of regulatory depreciation and other issues.

The Submission then turns to the TFP specification. I begin by addressing the areas of agreement between the EI and PEG TFP specifications. I then turn to the main areas of disagreement between EI and myself, in particular: 1) physical versus deflated monetary metrics of capital inputs; 2) the need to include unbilled outputs in the TFP specification; 3) the merits of using marginal costs to weight individual outputs when computing the TFP index; and 4) the extent to which the EI and PEG TFP specifications account for different contributions to industry TFP growth and the heterogeneity in business conditions among regulated companies. In all instances, I attempt to develop a factual record and series of testable empirical hypotheses the AEMC/AER can examine as it finalizes the Stage I review and (potentially) commences the Stage II review.

Chapter Four of the Submission evaluates the Brattle Incentive Report. Finally, I present a Way Forward and a list of concrete steps the AER and/or AEMC can take to develop a transparent factual and empirical record for this Review. This factual and empirical record can provide the basis for developing a practical and appropriate TFP specification that is used to implement the TFP-based option.

There are also two appendices to this submission. The first develops a concrete, factual record (subject to verification) regarding the regulatory experience in Ontario Canada. The second evaluates the theoretical claims EI has made about PEG's TFP specification, as well as one new theoretical point they raise.

2. CONDITIONS NEEDED FOR A TFP METHODOLOGY

This section will address what the AEMC terms the "conditions needed for a TFP methodology." These issues were addressed in Chapter Five of the *Preliminary Findings* Report, although there is some discussion in Chapter Six of related topics. I will not address the incentive and related issues that were treated in Chapters Two through Four of *Preliminary Findings* Report, unless those issues are later discussed in Chapters Five and Six. I overwhelmingly support the AEMC's analysis of the incentive effects of TFP-based regulation; the relatively minor exceptions I have to the AEMC's analysis have already been noted in my prior submission, or in previous ESC submissions.

2.1 Data Availability and Requirements

My most fundamental concern with the *Preliminary Findings* Report is its conclusion that TFP-based regulation cannot be implemented for at least eight years. This conclusion is motivated by the need to develop a "robust and credible data-set" that is used to estimate industry TFP trends. Obviously, it is desirable to have high quality data, and it is acknowledged that data quality needs to be improved in Australia. But the AEMC's conclusion that TFP-based regulation must essentially commence with eight years of fresh data is both unnecessary and undesirable, for a number of reasons.

One is that data quality is even more important for building block regulation, where regulated prices depend directly on the reported costs of individual companies. In building block regulation, data errors lead directly to price "errors." This is not necessarily true in TFP-based regulation, where price changes depend on industry-wide changes in TFP and input prices. In spite of the data problems that currently exist, the AER is now using existing data to set prices under the building block methodology. Clearly, waiting for better data to become available is not an option for applying building blocks. If the current (imperfect) data are good enough to be used for setting regulated prices under the building block method, then these *same data* are good enough to use for calculating TFP trends. Indeed, since the regulatory consequences of using imperfect data are greater under building block than TFP-based regulation, data concerns actually

argue for TFP-based regulation to be implemented more rather than less rapidly. Doing so reduces the potential for data "errors" to be directly reflected in regulatory prices.

In addition, it is not clear that current data will necessarily bias the computation of industry TFP trends. Indeed, industry TFP trends will not be biased by inconsistent or non-comparable data *if* those inconsistencies are random across utilities in the industry. Whenever this is true, data discrepancies or errors will tend to balance out across the cross section of firms, leaving the TFP index for the entire industry to be a good measure of the industry's "real" index (*i.e.* the TFP index that would be measured using an internally consistent and comparable dataset across the industry). Moreover, the impact of data errors for any individual company to impact *industry* TFP is clearly diminished by the fact any individual company will be small relative to the industry.

In addition, for data errors to have a material impact on the TFP trend, they would have to impact the growth rate of TFP, not (in most instances) the level of the TFP index in any year. For example, if a data error in one year was entirely reversed in the following year, and both years were included in the sample period used to compute the TFP trend, the TFP trend would be unchanged. Even a one-time error in the *industry* (as opposed to individual company) data used to calculate TFP in any given year will have a smaller impact on the TFP trend, since flawed data from a single year will be averaged in with industry data from other years when computing the industry's TFP growth rate over a multi-year period.

It should be recognized, however, that errors in *industry* data will be more of a concern when they take place in either the starting or ending years of the sample used to calculate the TFP trend. When this occurs, errors in the level of the TFP index are likely to have a greater impact on the computed TFP trend. This assumes that the TFP trend will in fact be calculated directly using from the index data, rather than via an auxiliary regression.

In sum, it should be recognized that for data errors to impact the measured TFP trend, they would have to be: 1) systematic across the industry, rather than relevant to any individual company's data; 2) systematic regarding the *direction* of the bias (*e.g.* making industry costs too high), otherwise errors by some companies in one direction will at least partially offset errors in the other direction by other sampled companies; and

3) impact the industry's TFP growth *rate* rather than index level in any given year. All of these factors tend to reduce the regulatory impact of data errors compared with the building block methodology, which establishes a direct link between each individual company's data and that company's regulated prices.[2]

I believe adopting TFP-based regulation quickly will also create broader benefits. The *Preliminary Findings* Report states that calculating industry TFP trends will enhance the information available to regulators and provide a benchmark for assessing expenditure forecasts under the building block methodology. This implies that the development of a TFP-based regulatory option will have spillover benefits, since this option can enhance the effectiveness of building block regulation. Given the need to improve energy regulation in Australia, delaying the onset of the TFP methodology in order to refine data collection is an example of making the perfect the enemy of the good.

Getting a TFP option up and running quickly will also allow companies, customers and regulators to become more comfortable with the concept. If the AEMC waits eight years to develop appropriate data and relies exclusively on building block methods during the interim, the building block approach will become even more institutionally entrenched. This may have the effect of making the TFP-based option look more like a long-term research project than a viable regulatory approach. Indeed, the proposed eight year implementation delay is already prompting some companies (*e.g.* Jemena) to recommend that the Stage II Review (which would lead to a concrete TFP methodology) also be delayed by at least five years. The longer implementation is delayed, the more likely it becomes that TFP-based regulation will wither on the vine.

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[2] It may be interesting to consider an example where systematic data errors did impact the measured TFP trend. The example is when EI personnel first estimated TFP trends for electricity distributors in New Zealand in 2003. The sample period (1996 to 2002) contained a structural change in the electricity distribution industry, where distributors that were previously combined distribution-retailing utilities had to decide whether to be a "lines" business or a retailing business, and divest their other operations accordingly. This change in the structure of the industry led some distributors that chose to become pure lines businesses to report markedly lower costs in the year they divested their retailing businesses, since the distributors now avoided the costs of these retailing operations. In its original industry TFP study, EI personnel did not appropriately account for this structural shift and included some of those cost reductions in its measure of electricity distribution costs. These errors in EI's measure of industry costs were translated directly into greater input quantity reductions and therefore more rapid industry TFP growth than was warranted with accurate industry cost data. This error was: 1) systematic, because it impacted multiple companies; and 2) pointed in a single direction *i.e.* divesting retailing operations only leads companies to avoid the costs of retailing.

In addition, it should not be forgotten that the TFP-based approach will be an *option*. No company would be compelled to adopt the TFP-based methodology. Distributors could examine the industry TFP trend that is computed using existing data and decide whether the resulting X factor is appropriate for its circumstances. This does not diminish the importance the TFP specification, which is critical for the long-run stability of the methodology, but it does reduce the risks associated with data errors. Even if data errors are reflected in the measured TFP trend (which is by no means assured), companies would not be forced to accept those risks in their price adjustment formula, since they would adopt the TFP-based approach on their own volition.

For all these reasons, I believe that waiting eight years to implement the TFP-based regulatory option would be a significant mistake. The *Preliminary Findings* Report indicates that a TFP methodology may lead to immediate improvements in Australian regulation. Rather than assuming that "existing data (which have already been used to set regulated prices) are not consistent, reliable nor robust," it would be more fruitful for the Stage II Review to address the following questions:

1. What errors and inconsistencies exist in current data?
2. Are these errors and inconsistencies systematic across regulated companies in a given industry?
3. If so, do errors and inconsistencies across the industry create biases in one direction or another, or do data imperfections tend to offset one another?
4. Do systematic data errors tend to impact the TFP growth rate, or simply the TFP index in a given year?

I believe that structuring the data review in this way would focus attention on the issues that are most pertinent for establishing a TFP-based regulatory option. It may also help regulators to better understand the industry data that currently exist. Most importantly, it would expedite the introduction of a TFP-based regulatory option and not simply assume that current data are inadequate.

2.2 Accurately Measuring the Industry's Productivity Growth

One of the *Preliminary Findings* (p. 54) is that "(i)t is desirable that a TFP methodology include all outputs of the service provider. This would include outputs that are not directly billed to users of the asset as well as billable outputs." Furthermore, the Report says that if "relevant" but unbilled activities are not included as outputs, "the TFP index may not be a reliable measure of the sector's productivity. If this is the case, the TFP index will not set a price path that recovers industry cost."

With respect, I believe this conclusion is almost certainly not true. This can perhaps be seen by considering how this issue is handled in the regulatory approach the AEMC/AER is familiar with, building block regulation. "Unbilled" activities like security are no less important when utilities are regulated by building blocks. It also remains essential for these costs to be recovered in utility prices. How is this done in the building block methodology? The costs of providing security are included in the utility's overall (actual and forward-looking) cost of service. Prices for the different billing determinants are then set so that, in aggregate, they recover the costs of these and other activities. Energy security is therefore an unbilled "output" in the building block model, but the costs of providing energy security are still recovered through billed outputs.

Indeed, **there is no other way to recover the costs of 'unbilled' outputs than through the prices charged for billed outputs**. Costs are recovered through the revenues earned from customers, and revenues can only be earned from billed outputs. The issue of "unbilled outputs" is therefore irrelevant in building block regulation. There are many utility activities for which customers are not billed explicitly, yet the costs of these activities will be recovered from the prices charged on the outputs that *are* billed.

The same is also almost certainly true in TFP-based regulation. The P_0 in TFP-based regulation is clearly analogous to the building block model, where initial prices reflect the costs of energy security and other unbilled outputs. Any change in the costs of energy security and other "unbilled" outputs are necessarily recovered through the prices charged for the billed outputs. The **only** change in output quantities that can recover the

costs of these activities are billed outputs. These are the outputs that, accordingly, should be reflected in the measure of industry TFP which are used to set price changes (which are designed to grow at the same rate as the industry's historical growth in unit cost).

Ultimately, I believe this view reflects confusion between outputs and inputs. This stems, in part, from the way that EI has defined "outputs" to include billed and unbilled activities. They write that "(t)he main reason that it is necessary to include all functional outputs is that they are cost determining."[3] EI supports this opinion with a passage from the submission of Jemena Ltd. which they say is an "illustration of the disparity that can exist between network output and the basis of charging:

> 'Actual throughput and actual peak demand are not significant cost drivers in the short term: the provision of capacity to accommodate forecast maximum peak demand is a much more significant driver of input requirements and costs.
>
> 'Despite the fact that capacity is one of a distribution business's principal outputs, it is accepted practice to set network tariffs for some classes of end use at least, on the basis of ender user throughput and consumption. A significant proportion of costs may be recovered in that way, but that does not alter the fact that network users are actually buying (and being supplied with) guaranteed capacity.'[4]

I believe Jemena's statement illustrates the underlying confusion vividly. An important part of any business is managing inputs so that they can meet their customers' demand. It may even appear to managers that their customers are "actually buying" the inputs that must be procured in order to provide the products customers are paying for, but this confuses the two sides of the income statement. Costs are associated with the inputs companies purchase; revenues come from the outputs they sell. I do not dispute that "the provision of capacity to accommodate forecast maximum peak demand is a…significant driver of input requirements and costs" – but in this (remote and indirect) transaction, the provision of capacity is the input and peak demand is the output. Simply knowing that an activity is "cost determining" does not make it an output; it makes it a cost, and in building block regulation the regulated prices that the regulator sets to recover those 'cost determining' activities are necessarily applied to billed outputs.

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[3] Economic Insights, *Total Factor Productivity Index Specification Issues,* December 2009, p. 32.
[4] Economic Insights, *Total Factor Productivity Index Specification Issues,* December 2009, p. 6.

It is also not unusual for "the basis of charging" to differ from the main driver of costs in non-regulated industries. In printing, for example, the main cost driver is not paper or ink, but printing equipment (which companies attempt to operate at full capacity as much as possible). However, customers pay for the printed material that comes off the presses, and it would be nonsensical for printers to say that their real output is their most expensive input (the printing press) rather than the copies printed and sold to customers.[5] Another example may be cellular phone companies, which must construct and co-ordinate a "network" of capital assets to meet customers' peak demand but nevertheless have a fee structure (for most customers) that is broadly similar to electricity distributors: a monthly access charge and a fee for usage, which may vary depending on time of use.

I believe this example also applies to toll roads. For years, EI has used the analogy of the road to argue that "functional" outputs that are not billed to customers must be included when measuring energy network TFP. They argue that energy networks are like roads; they provide the basic underlying infrastructure, which is sized to meet the expected maximum demand for the assets, but networks have no control over the "traffic" that goes down the road itself. EI therefore contends that the capacity of the underlying infrastructure itself is an appropriate measure of the output being provided.

I do not believe this analogy is valid or reflects the reality of private toll roads. Of course, the underlying asset is the road itself, but that does not make the road the output that is provided to the public or that customers are demanding. These customers are demanding access to the road, at a given point in time, and for a certain distance. These are also the services that customers actually pay for; a flat fee for access, plus (perhaps) a mileage rate depending on the point of entry and exit. These access and mileage fees could be differentiated by time, which would constitute an additional service of being allowed use of the road during a peak period. The road infrastructure is therefore the input which, while clearly necessary to supply the outputs, does not become an output itself. The outputs depend on the specific services that customers wish to use the road for, and for which they are paying.

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[5] Because it is important to utilize available capacity at all times, printers often charge discounted prices for customers that print in bulk. But this simply makes the units sold in bulk a different output from smaller batch print jobs, it does not transform the input into an output.

This analysis extends naturally to energy networks. Customers demand access to the energy delivery infrastructure and for kWh (or therms) to be delivered into their premises at the times they desire (including peak periods). Energy distributors accordingly charge for access, usage and perhaps peak demand. Again, the infrastructure is needed to deliver the electrons or natural gas molecules that customers are ultimately demanding, but this network capacity is an input and not the output itself.

The *Preliminary Findings* Report conclusion therefore seems to be erroneous. I believe that if the TFP index includes changes in outputs that are not billed to customers, it will drive a wedge between changes in costs and changes in revenues and frustrate rather than promote cost recovery. This is true for the same reason that, if a unbilled output was inserted into a building block model, it would drive a wedge between costs and the recovery of costs. Unbilled outputs do not, and cannot, recover costs. I therefore believe that they should not be included when setting either initial prices (the P_0) or the rate of change in prices (*i.e.* the industry rate of TFP growth in TFP-based regulation).

I also believe that the issue of whether unbilled outputs should be included in the TFP specification is amenable to empirical testing. Spreadsheet models can examine whether the addition of unbilled outputs to a TFP specification will frustrate or promote cost recovery. In that regard, it is promising that the AEMC found PEG's spreadsheet model (prepared for the ESC), which compares the building block and TFP-based approaches, to be instructive (p. 39). I believe similar spreadsheet tools can be similarly effective in exploring the unbilled outputs and related issues.

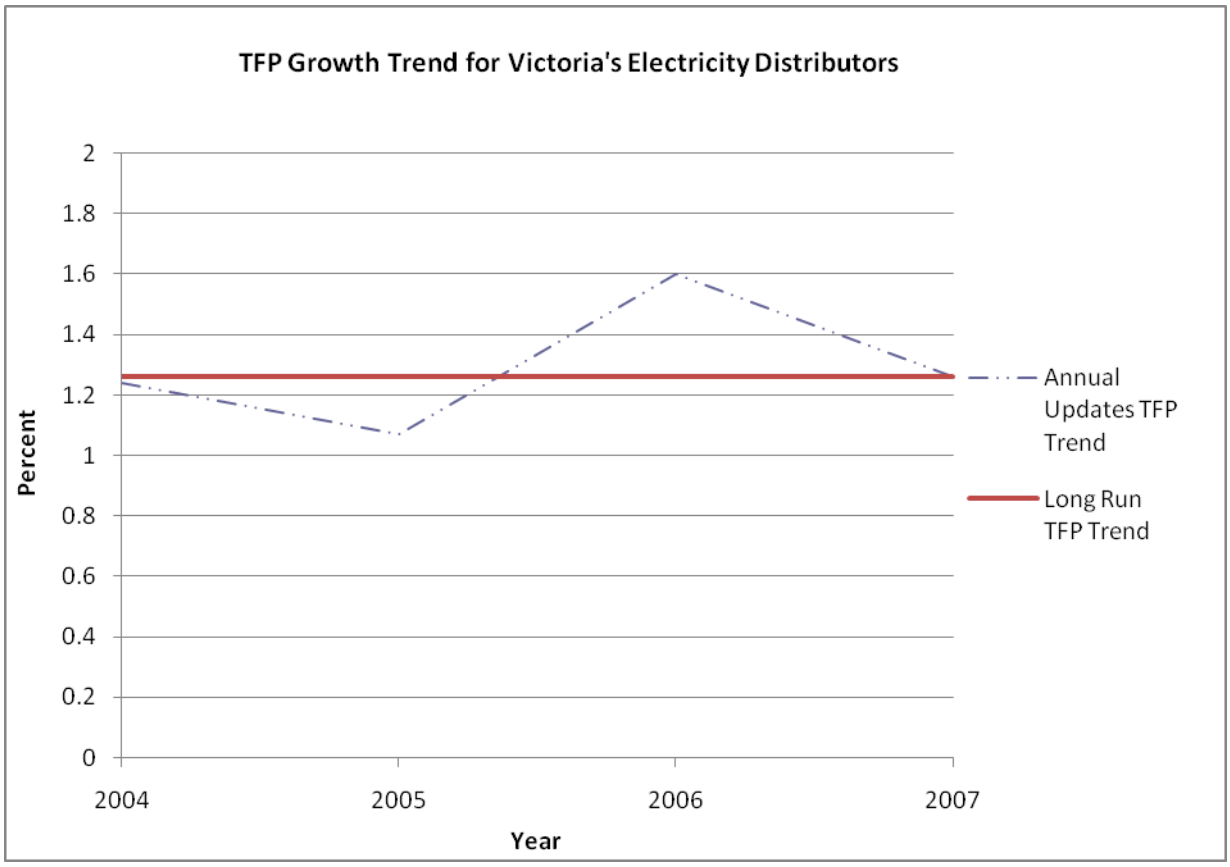
2.3 Stability of TFP Index

The *Preliminary Findings* Report puts considerable emphasis on the criterion that a TFP measure should lead to "a stable (TFP) index and be able to provide a stable price path." At least as those issues are discussed in the Report, it should be noted that these are in reality two separate criteria. The discussion of index stability in the Report essentially refers to its year-to-year volatility. This has no necessary implications for the "stability of the price path," which depends on the behavior of the long-term trend over a multi-year period.

I believe the *Preliminary Findings* Report puts too much emphasis on year-to-year stability when evaluating alternate TFP specifications. Ultimately, the year to year change in a TFP index does not translate into year to year variability in prices under TFP-based regulation. Instead, allowed price trends are determined by the average change in TFP growth over a multi-year period.

Observed data from Victoria and other jurisdictions shows that this longer-trend trend is in fact relatively stable. The discussion of PEG's TFP research in Victoria, and particularly Figure 5.1, greatly exaggerates the volatility of our specification. Any TFP series will look volatile if you plot annual changes in TFP, as in Figure 5.1. This is why a multi-year average of TFP growth is necessary to compute the long-term trend. It is also necessary to measure the Victorian TFP trend from 1998 rather than 1995, since there was an identifiable, one-time "burst" of TFP growth between 1995 and 1998 (following privatization) which will not be repeated and is therefore not representative of the long-term trend. This fact was discussed extensively in PEG's 2004 TFP report and has been evident in every reported TFP update in subsequent years.

Our work shows a clear trend emerging for electricity distribution TFP growth in Victoria. This is reflected in the graph below, which shows the annual average TFP growth for the Victorian electricity distribution industry, as this trend is updated annually for new information. The value for 2004 reflects average TFP growth for the industry from 1998 through 2004. The 2005 observation is equal to average TFP growth from 1998 to 2005. Similarly, the 2006 and 2007 observations are equal to the average growth in TFP for Victorian electricity distributors from 1998 through each of these respective years. This graph represents the actual "price path" that would result if PEG's TFP study was, in fact, used in a TFP-based methodology, and PEG's TFP index was updated annually to roll in new Victorian data (on outputs, revenue shares, costs, and input prices).



This presents a very different, and more accurate, picture of the stability of the price path under PEG's TFP research. Average TFP growth for Victorian electricity distributors was 1.24% over the 1998-2004 period, 1.07% over 1998-2005, 1.60% over 1998-2006, and 1.26% over 1998-2007. We will soon be updating this study to roll in 2008 data, which we expect will not greatly impact the results.

We believe this price path is relatively stable. It should also be noted that the volatility depicted above almost certainly exaggerates the volatility that would, in fact, result if PEG's TFP specification was employed throughout Australia in a TFP-based approach. The reason is that the TFP growth trends plotted above correspond to average growth rates over six, seven, eight and nine year periods, respectively. TFP series almost always become more volatile as fewer years are used to compute the trend. I generally recommend that a minimum of nine years be used to compute a long-run industry TFP

trend. Therefore, the series above reflects more volatility than would likely be experienced if PEG's TFP specification was extended to all of Australia and ten or more years of Victorian data were initially used to compute this trend, with data from other Australian States and Territories rolled into the TFP industry index over time.

In sum, I believe the "stability" criterion should focus squarely on the volatility of the longer-term trend. This is the only issue that is relevant to the operation of a TFP-based regulatory approach. I also believe the actual evidence from PEG's TFP research (presented above) shows that, if our specification was used as the basis for a TFP-based methodology, it would lead to a stable price path.

2.4 Other Issues

I largely agree with the analysis and conclusions in the other parts of Chapter Five. I concur with the Report's Findings that:

- Service providers will have little or no ability or incentive to manipulate the measured TFP trend (Section 5.3)
- Empirical research should determine whether utility industries should be divided into more than one group on the basis of utilities' differing potentials to achieve TFP growth; however, I believe the evidence for dividing industries into multiple groups must be very compelling, since there will clearly be benefits (*e.g.* in terms of reducing the potential for manipulation, and for having the TFP trend be "external" to any given utility's performance) from defining utility industries to be as large and comprehensive as possible (Section 5.4)
- The two design features (service provider discretion in selecting a TFP-based approach, and a capital module) will help make the TFP index a good estimate of future TFP growth (Section 5.5)

In Chapter Six, my main concern is the discussion surrounding regulatory depreciation in Section 6.7. The AEMC's concern is utilities' ability to "front load" their depreciation profiles, and whether or not these regulatory depreciation patterns are consistent with the capital depreciation profile reflected in the TFP study. The

Preliminary Findings Report concludes (p. 78) that "the solution to this issue is to require service providers to select depreciation profiles that are more consistent with the service potential of their assets – and which do not involve front end loading – upon their move to a TFP methodology."

I believe this recommendation is fundamentally misplaced. If "front loading" of depreciation is a concern, this problem will be more pronounced under building block regulation than the TFP-based option. Building blocks tie company prices directly to their cost projections. Returns are also linked to the regulatory asset base (RAB). Under building blocks, utilities may have incentives to front-load depreciation and reduce their regulatory asset base, since doing so accentuates pressure to make ambit claims for large capital expenditure forecasts in an effort to rebuild the RAB. Thus, flexible depreciation schedules will likely lead to worse outcomes – including the potential for higher customer prices and "gold plated" networks - when this discretion is allowed under a cost-based regulatory approach that links price changes to cost forecasts (building blocks) than under a TFP-based regulatory approach, which breaks the link between changes in company prices and company costs.

If it is appropriate to restrict depreciation schedules, this should certainly be done under the building block methodology and not only when companies elect the TFP-based option. A restriction under the TFP-based option may still be appropriate, but only because there will still be price resets where the company's regulated rates are reset to its actual costs. In the theoretical case where a company adopts a TFP-based approach in perpetuity without cost-based reviews, there would be no need to restrict the company's depreciation profile, since it could never have any impact on its regulated rates. I therefore believe the AEMC's current recommendation regarding regulatory depreciation is not appropriate. This proposal is also inconsistent with the more light-handed regulatory philosophy the TFP-based regulatory option is designed to represent.

It should also be noted that the AEMC's fundamental concern – about a mismatch between regulatory depreciation and the depreciation rate used in the TFP study – disappears under PEG's TFP specification. The reason is that our TFP measure uses regulatory depreciation rates when computing capital input quantities. This allows the industry price trends computed under our TFP-based approach to mirror the change in

industry costs. Our specification is therefore consistent with how companies measure capital stocks, as well as with how those capital stocks will be updated at price reviews. If restrictions are placed on regulatory depreciation profiles, our TFP specification would reflect such a policy change automatically.

3. TFP SPECIFICATION AND THE ECONOMIC INSIGHTS REPORT

This chapter addresses the evidence that EI and I have put forward in support of our TFP specifications. The purpose is not to perpetuate this debate. Instead, I will: 1) outline the areas of agreement and disagreement between EI and PEG; 2) compile a series of factual statements regarding issues that are disputed by EI and PEG, as well as some logical implications; and 3) develop a series of concrete empirical hypotheses that the AEMC/AER can examine, and which can help determine what TFP specification will best satisfy the criteria for an effective TFP methodology. I believe this approach can help to focus the AEMC/AER's review and move the TFP specification debate beyond theory and rhetoric and towards solid factual and empirical evidence.

I begin by discussing aspects of TFP measurement where EI and myself are in complete, or near complete, agreement. I then turn to the areas where we disagree.

3.1 Areas of Agreement

One area where EI and myself are in nearly complete agreement is with respect to the form of the index used to measure TFP growth. EI advocates the Fisher Ideal Index. PEG has used both the Fisher Ideal and Tornqvist index forms in our TFP work. As EI has indicated, both are "superlative" indexes and in practice yield almost identical measures of TFP growth. I have no objections to using the Fisher Ideal to measure TFP growth.

We also largely agree on the input price index that is used to deflate operating expenditures (opex). EI writes that "(w)hile the approach adopted by PEG (2004) to forming an opex price index appears reasonable, there is scope for refinement of both the labour and non-labour price indexes used."[6] EI does not mention any specific "refinement" of the labor price index we adopted in that study, but it does point to a number of sub-indexes that could be used to measure price trends for more narrowly-defined components of costs than PEG used for three categories of opex: advertising and marketing expenses, billing and revenue collection, and meter data services.

[6] Economic Insights (2009), *Total Factor Productivity Index Specification Issues*, p. 15.

EI personnel first made this suggestion when evaluating TFP studies that I performed for the gas and electricity distribution industries in Victoria. I considered their suggestions but decided not to adopt them for a simple reason: EI was proposing input price indexes for subsets of opex for which there were no reported data. The lowest level of aggregation for the advertising/marketing, billing and revenue collection, and meter data services operating expenses were the categories that PEG actually used. EI's suggestion could therefore only be implemented by making assumptions about the breakdown of costs within these categories, since the actual costs (of say, advertising itself within the advertising/marketing category) were not available.

I still believe this was the correct decision. Any assumed breakdown of costs within these opex categories would have been arbitrary. EI's proposal could therefore have led to less precise rather than more precise measures of input price trends – but since their input price measure was dependent on an unverifiable assumption, there would be no way to determine one way or the other. EI's approach would also introduce new assumptions into the computation of the input price index that were empirically unfounded and not subject to empirical verification. I believe making unnecessary assumptions should be avoided whenever possible, as it clearly was in this case.

Having said that, I agree that the opex input price index should be constructed by assigning the most appropriate, available input price subindexes to the most narrowly defined sets of operating expenditures *for which data are available*. The overall opex input price index would then be computed by aggregating the opex input price subindexes on the basis of each opex category's share of total opex. When computing an opex input price index for the national electricity or gas distribution industries, the appropriate choices for these opex input price deflators should be consistent with the data that are available on opex categories nationally, not by arbitrary assumptions on the composition of opex.

The scope for refining the opex input price index in the future therefore depends on what new opex data are collected. Greater detail on opex spending will allow more disaggregated and precise input price indices to be constructed. The extent of these refinements depends on whether the AER chooses to collect more detailed opex data and, if so, in what opex categories more data become available.

3.2 Areas of Disagreement

There are four primary practical differences between the PEG and EI TFP specifications: 1) the use of physical or monetary metrics to measure capital input quantities; 2) the merits of adding unbilled outputs to the output quantity specification; 3) the use of revenues or marginal costs to weight output quantities; and 4) the complexity of the X factor formula and its ability to deal with firm-specific issues. This last issue is on the border between being 'practical' and 'conceptual,' but I will address it here since it does pertain to practical issues regarding TFP measurement.

3.2.1 Physical versus Monetary Capital Measures

Recent Experience in Ontario

An important source of factual information on the relative merits of physical and monetary capital measures is the third generation incentive regulation (IRM3) proceeding in Ontario, where the Ontario Energy Board (OEB, or Board) carefully considered this issue. The AEMC is clearly not bound by this precedent, but it should be recognized that the OEB is one of the leading regulatory agencies in North America. In fact, on incentive regulation issues, I believe the OEB has become *the* leading North American regulator in the last few years.

Moreover, the IRM3 proceeding is relevant to this Review because EI personnel made essentially the same arguments to the OEB as they are advancing now.[7] The OEB carefully reviewed EI's arguments and rejected them decisively and unambiguously. The AEMC and AER will undertake their own independent review of alternative capital measures in this proceeding, and their analysis may clearly differ from the OEB's. Nevertheless, a clear and accurate description of the Ontario proceeding should be part of the record in this Review, and it should be objectively considered by all parties.

This factual record is laid out clearly in Appendix One. For our purposes, the following statements of fact are most relevant:

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[7] Since it is largely a reprise of what occurred in Ontario, one of the 20th century's great philosophers might call the current debate between EI and myself on capital measurement "déjà vu all over again." This quote comes from Yogi Berra who, technically, was a catcher for the New York Yankees and not a philosopher at all. Nevertheless, he had a remarkable gift for insightful observations (possibly because "you can observe a lot just by watching," which he also said).

- The OEB stated that the consulting team that EI was a part of argued that "economic theory, empirical evidence, industry experience and recent regulatory precedent all support the recognition of this approach when calculating the annual capital input quantity of electricity distribution assets and that accounting depreciation adjustments under the monetary approach bias the quantity of capital input"
- The OEB stated that " most participants (in the proceeding), as well as Dr. Cronin and Dr. Kaufmann, disagreed with the use of physical counts of capital in the calculation of TFP. Both of them recommended the customary use of monetary values. Dr. Kaufmann noted that when a utility sets its rates to recover depreciation and carrying costs associated with these capital goods, it does so with reference to the aggregated monetary values of these disparate assets net of their depreciation. He submitted that LEI's TFP study ignores this monetary valuation of assets in favour of a physical method for estimating capital stock. Since physical asset measures are not used to set rates at the outset of a plan, Dr. Kaufmann expressed concern over LEI's proposal to use a productivity factor to adjust distribution rates that, over time, bears no relationship to how those rates were originally set. Dr. Kaufmann also noted that the LEI TFP model assumes that there is no physical decay of distribution assets over time. He stated that there is no theoretical or empirical support for this assumption and cautioned that this is not an academic point but a practical one, because depreciation is a reality."
- The OEB ultimately accepted my TFP specification in its entirety; the only change made by the OEB was the sample period that would be used to measure TFP growth (I recommended 11 years; the OEB chose 18 years).
- The OEB rejected the EI TFP specification in its entirety; it concluded that the TFP methodology used by the EI consulting team was "not appropriate."
- The OEB's "greatest concern" with the EI consulting team's TFP "approach is the measurement of capital, which is inconsistent with the prior Ontario TFP studies and does not appear to have been adopted in any jurisdiction other than New Zealand."

The logical implication of these facts is that the OEB was aware of the arguments from EI personnel regarding the merits of physical capital metrics in TFP studies but, rather than accepting these arguments, the OEB found EI's proposed physical capital measures to be its greatest concern with EI's proposed TFP approach. The appendix presents further details from the Ontario proceeding, all of which are verifiable.

Industry Experience and One Hoss Shay Depreciation

EI maintains that conditions in energy distribution industries are consistent with one hoss shay depreciation. The factual statements that follow below have been compiled from the record in this proceeding and are relevant for analyzing this claim:

- A defining characteristic of one-hoss shay depreciation is that the asset undergoes *no* physical decay from the time it is installed until the time it is replaced.
- The productive services provided by a given capital good depend on how efficiently that asset is operating compared with its potential.
- Economists sometimes characterize the relationship between actual and potential services in terms of the "efficiency units" associated with a given capital good.
- Whenever there is *any* physical asset decay, then the efficiency units of older capital must be less than the efficiency units of the newer capital.
- When this is the case, then old and new capital goods cannot be added together to measure capital input because less input quantity is effectively provided by older capital goods; some adjustment of physical capital measures is necessary in this instance to reflect the loss in "efficiency units" as capital goods age.

It follows logically that physical capital counts can be used to measure capital quantity *only* when the capital stock satisfies one hoss shay depreciation; if the capital stock obeys **any** other depreciation pattern (*i.e.* if there is **any** physical decay in capital), you cannot simply add physical counts of assets installed in different years together and obtain an accurate measure of capital input quantity.

In addition, the factual record shows:

- My submissions have discussed the potential importance of the "portfolio effect" for assessing the appropriate depreciation pattern for a group of diverse assets.
- My submissions argue that the main implication of the "portfolio effect," is that the depreciation profile associated with a group of disparate assets – such as those owned by energy networks – will differ from the depreciation of any individual asset that exhibits one hoss shay depreciation.
- My submissions cited the passage below when discussing the portfolio effect:

> "Moreover, what may be true on a case-by-case basis may not be true of an entire population of assets. If so, this has important implications for evaluating econometric results, which typically reflect the average experience of whole populations and not individual units. For instance, it may well be true that every single asset in a group of 1000 assets depreciates as a one-hoss shay, but that the group as a whole experiences near-geometric depreciation. This fallacy of composition arises from the fact that different assets in the group are retired at different dates: some may last only a year or two, others ten to fifteen years. When the experience of the short-lived assets is averaged against the experience of the long-lived assets, and the average cohort experience is graphed, it will look nearly geometric if the 1000 assets have a retirement distribution of the sort used by the Bureau of Economic Analysis (i.e., one of the Winfrey distributions). Thus, the average asset (in the sense of an asset that embodies the experience of 1/1000 each of 1000 assets in the group) is not one hoss shay, but something that is much closer to the geometric pattern. This can easily be verified by performing this experiment using the parameters of the Bureau of Economic Analysis's capital stock program."[8]

- In its December 2009 Report *Total Factor Productivity Specification Issues*, EI writes several times (*e.g.* p. 54) of the "geometric approach" to depreciation "advocated by PEG." These statements are not factually correct for any of PEG's TFP research presented in Victoria since December 2004; none of this work uses geometric depreciation.
- It is also factually incorrect that PEG is advocating geometric depreciation in this proceeding.

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[8] Hulten, Charles R & Wykoff, Frank C. (Jan 1996). Issues in the measurement of economic depreciation: Introductory remarks. *Economic Inquiry 34*(1), pp. 10-24.

It follows that every EI reference to "the geometric approach advocated by PEG" has no relevance to evaluating what PEG (and I) advocate in this proceeding. The factual record also shows:

- EI writes that PEG "raises the issue of whether a 'portfolio effect' might apply whereby even if individual assets exhibit one hoss shay depreciation, the aggregate of those assets may still exhibit geometric depreciation. This proposition may have some traction if there was a large number of firms with a wide spread of asset ages. By definition it does not apply for the case of a single firm. In the case of New Zealand EDBs there are relatively few firms and the age characteristics of the assets are likely to be similar. Indeed, the EDBs have previously highlighted the bunched nature of previous network rollouts and the likelihood of an impending 'wall of wire' as assets all of similar age require replacement. These characteristics mean that this 'portfolio effect' argument in favor of geometric depreciation in the aggregate does not apply in this case."[9]

- In the passage above, EI accepts that the portfolio effect can in principle apply across a cross section of firms.[10]
- If the portfolio effect applies, then even if every asset exhibits one hoss shay depreciation, the industry-wide depreciation pattern would not be consistent with one hoss shay depreciation.
- Given the logical deduction that one hoss shay depreciation is necessary to use physical capital counts, it follows that if the portfolio effect applies, physical capital counts of capital are not appropriate.

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[9] Economic Insights, *Total Factor Productivity Index Specification Issues*, December 2009 pp. 56-57.

[10] EI also claims that the portfolio effect cannot by definition apply to a single firm. I believe this is view is incorrect, and that the portfolio effect logically applies to a collection of assets not a collection of firms; this interpretation is certainly consistent with the passage quoted above. If this is in fact the case, then the portfolio effect can apply to a single firm with a collection of assets. However, I have not had time to verify this claim, but it can be a subject for further research in the Stage II Review.

These factual statements and elementary deductions imply (at least) two necessary conditions that *must* be satisfied for physical capital metrics to be used to measure the industry's capital stock:

1. Every capital asset good measured by physical counts must exhibit one-hoss shay depreciation.
2. The portfolio effect – wherein firms in an industry have different asset retirement patterns – must not apply.

The factual record also shows:

- EI asserted that the portfolio effect does not apply "(i)n the case of New Zealand EDBs (since) there are relatively few firms and the age characteristics of the assets are likely to be similar. Indeed, the EDBs have previously highlighted the bunched nature of previous network rollouts and the likelihood of an impending 'wall of wire' as assets all of similar age require replacement. These characteristics mean that this 'portfolio effect' argument in favor of geometric depreciation in the aggregate does not apply in this case."
- EI has presented no empirical evidence to support the claim above. However, this is an inherently empirical and not theoretical issue.[11]

This leads to two concrete empirical propositions that *must* be satisfied for physical capital counts to be used in a TFP study.

- There must be empirical evidence to support the view that every capital good measured by physical counts exhibits one-hoss shay depreciation.
- There must be **no** evidence of a "portfolio effect" in the regulated industry.

The latter issue is amenable to empirical investigation in the Stage II investigation. The AEMC/AER can gather information on asset vintages, planned retirement dates, useful lives of capital etc. on all firms in an industry. It can then

[11] The reference to New Zealand EDBs does not appear relevant to the present discussion and is probably an error on EI's part.

compare whether relative retirement patterns are identical for, say, the EDB serving Sydney's central business district and suburban Sydney; or between distributors serving Hobart and those serving Perth; or between distributor serving Adelaide and tropical Queensland; and other industry comparisons. If these retirement patterns are not identical or nearly identical, then the portfolio effect will exist and physical capital metrics **cannot** be used to measure the capital stock. The existence of a portfolio effect is sufficient for ruling out the use of physical capital measures.

Other Studies

The other empirical issue that must be satisfied is that every asset measured using physical counts must obey one hoss shay depreciation. The factual record shows the following:

- On pp. 54-57 of its December 2009 *Total Factor Productivity Index Specification Issues* Report, EI presents evidence on the actual depreciation patterns used in only four applications: the US Bureau of Economic Analysis (BEA); the US Bureau of Labor Statistics (BLS); Statistics New Zealand (SNZ); and the Australian Bureau of Statistics (ABS).
- EI say that the BEA uses geometric depreciation, which is not one hoss shay depreciation.
- Regarding the SNZ and ABS depreciation treatments, EI writes:

  > Importantly, both Statistics New Zealand and the Australian Bureau of Statistics have adopted the hyperbolic age–efficiency profile in their productivity studies. A key parameter in the hyperbolic age–efficiency profile can be set to influence the degree of curvature. A value of one for this parameter leads to a flat or one hoss shay profile while a value of zero would give equal deterioration each year (ie approximate straight line deterioration). Both SNZ and the ABS set this parameter at 0.5 for equipment and 0.75 for structures. That is, they are assuming closer to one hoss shay deterioration for structures. This is the complete opposite of the geometric deterioration profile advocated by PEG.[12]

- As previously discussed, PEG does not advocate geometric depreciation in this proceeding, so EI's conclusion above is factually incorrect.

[12] Economic Insights, *Total Factor Productivity Index Specification Issues*, December 2009 p. 56.

- EI says that in a hyperbolic age-efficiency profile, a value of a curvature parameter equal to one leads to one hoss shay depreciation.
- EI says both SNZ and the ABS set this curvature parameter at 0.5 for equipment and 0.75 for structures.
- EI's evidence therefore shows that neither SNZ nor ABS are using one hoss shay depreciation for equipment or structures.
- EI never define what it means to be "closer to one hoss shay depreciation" for depreciation but, in any event, unless one hoss shay depreciation itself is used, physical capital counts cannot be used to measure capital.
- EI also says that BLS uses a hyperbolic depreciation treatment but do not report the curvature parameter; however, it can be easily confirmed that the BLS also does not use one hoss shay depreciation.

The factual record in this proceeding therefore shows no evidence of any official, national statistical agency using one hoss shay depreciation. In fact, all evidence presented by EI shows that one hoss shay depreciation is not used by national statistical agencies.

Consistency with Regulation

Another potentially relevant issue is whether the physical count approach to measuring capital is consistent with regulatory applications of TFP methodologies. The factual record shows the following:

- In my September submission to AEMC, I provided information on 42 separate instances where TFP information was used to set rate adjustments, and in every one of these instances monetary rather than physical metrics were used to measure capital.[13]

[13] These plans are for Southern California Gas, Southern California Edison, San Diego Gas and Electric – gas, San Diego Gas and Electric – electric, Pacificorp California (twice), Boston Gas (twice), Berkshire Gas, Bay State Gas, Union Gas, electricity distributors in Ontario Canada (twice), US oil pipelines (twice), AT&T, local exchange carriers subject to FCC jurisdiction (twice), US West-North Dakota, NYNEX-MA, NYNEX-PA, and Class I US railroads (a total of 21 times – original plan, plus 20 annual updates). It could be argued that the latter example constitutes a single plan, although in principle that is not the case, since the regulator is able to propose changes in the TFP specification at any time.

- The only known instance where physical capital metrics have been used in regulatory applications of TFP methodologies is in the two plans EI personnel have been involved in New Zealand.
- In the most recent New Zealand price control plan adopted in November 2009, the Commerce Commission said that it "based its decision on the long-run average productivity improvement rates as derived by the TFP analysis of both Economics Insights and PEG." [14]
- It is therefore not factually accurate to say that the most recent decision by the New Zealand Commerce Commission was based on the framework proposed by EI in that proceeding, and advocated in this proceeding as well; the Commerce Commission relied equally on evidence from PEG and its advisor EI.[15]
- This contrasts with the Ontario proceeding, where the OEB rejected the proposal of the EI consulting team in its entirety and accepted the PEG TFP specification in its entirety.

Summary

I believe this factual record points a clear path forward on resolving this issue. The facts and elementary deduction show that both of the following empirical propositions must be satisfied for physical capital counts to be used in a TFP study:

1. There must be empirical evidence to support the view that every capital good measured by physical counts exhibits one-hoss shay depreciation.
2. There must be no evidence of a "portfolio effect" in the regulated industry.

Even if the more restrictive interpretation of this plan is accepted, however, there are at least 22 separate indexing plans – and almost certainly more – that have adopted a TFP specification that does not use either physical capital measures or infrastructure-based system capacity outputs.

[14] Commerce Commission, *Decisions Paper: Initial Reset of the DPP*, November 2009, p. 47.

[15] It is notable that the Commerce Commission relied on PEG's TFP evidence even though their Draft Decision echoed some of the points that EI was making about PEG's TFP approach, especially that it assumed a competitive market exists and capital was entirely fungible, which made our results irrelevant for regulated industries. If the Commerce Commission accepted these claims, it would have almost certainly placed no weight on our TFP results, which EI argued were irrelevant for electricity distributors. The fact that the Commerce Commission did use PEG's TFP evidence for its final decision is strong evidence that it did not accept EI's theoretical claims regarding PEG's TFP specification.

The latter issue is amenable to empirical investigation in the Stage II investigation and, in the interests of efficiency, it should be where the AEMC/AER begins its investigation. If there is any evidence of a portfolio effect in Australia, physical capital measures must not be used in the TFP specification. This is a definitive empirical test that is sufficient to rule out one hoss shay depreciation and, therefore, physical capital measures. If there is **no** evidence of a portfolio effect, then the AEMC/AER can evaluate the evidence on depreciation patterns for all assets to be measured by physical counts.

To date, no tangible evidence has been presented that supports one hoss shay depreciation. In fact, all available evidence (as opposed to rhetoric) shows that one hoss shay depreciation is not supported in empirical studies by national statistical agencies. There is also no evidence that physical capital metrics have been used in any TFP methodology for regulated companies other than in EI personnel's two assignments in New Zealand. The most relevant regulatory precedent comes from Ontario, where the regulator carefully considered the arguments from EI personnel (nearly identical to their arguments in this proceeding) but rejected them.

It is also not sufficient to note that assets are long-lived or that a depreciation treatment is "closer" to one hoss shay than to an alternative method. One hoss shay is an extreme depreciation assumption, since it is literally impossible to have less than *no* physical decay in an asset from the day it is installed until the day it is replaced. But this is what one hoss shay requires, and this condition *must* be satisfied if physical counts of assets from different years are to be added together to measure the capital stock. *Any* physical decay in an asset over time is sufficient to rule out the use of one hoss shay deprecation and physical asset metrics.

3.1.2 Unbilled Outputs

The previous section presented my views on the merits of using unbilled outputs. I also believe this issue is directly amenable to empirical testing. The AEMC/AER can:

- Take an existing spreadsheet model and simulate the impact of step changes in providing security or other unbilled activities on a company's (or industry's) cost; all else equal, this cost increase will be reflected in an increase in input quantity

- Calculate TFP using PEG's specification which involves billed outputs only, and revenue share weights
- Calculate the resulting price trend using PEG's TFP specification
- Calculate the impact on industry profits, calculated using the price path from PEG's TFP specification and the assumed cost change
- Calculate TFP using EI's specification which involves adding a new unbilled output to the TFP specification, which will (all else equal) tend to increase the growth in output quantity and increase TFP growth (compared with PEG's TFP specification, under the same scenario)
- Calculate the resulting price trend using EIs TFP specification
- Calculate the impact on industry profits, calculated using the price path from EI's TFP specification and the assumed cost change
- Compare the results from the PEG and EI TFP specifications

It should also be noted that my October 2009 submission to the AEMC presented an alternative empirical test that can be used to determine the TFP specification (not just the output specification) more generally. In that submission I wrote:

> Simply put, TFP must be specified in such a way so that, when it is combined with observed historical changes in industry input prices (*i.e.* the growth rate in industry TFP is subtracted from the growth rate in industry input prices), it leads to a rate of change that is equal to the observed change in the industry's unit cost of providing regulated services. This is the most important criterion that must be satisfied when identifying the correct TFP specification, because if it is not then the underlying rationale for TFP-based regulation is violated. Moreover, this criterion is amenable to direct empirical tests: rival TFP specifications can be examined to see which is most consistent generating the observed change in the industry's unit cost of providing regulated services. Clearly, for this to be a practical regulatory approach, this unit cost of service must also be one that can be computed from, and is consistent with, the industry's actual observed data.[16]

The criterion discussed above can also be translated straightforwardly into empirical tests of the PEG and EI specifications.

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[16] Kaufmann, L., *Submission to Australian Energy Market Commission: Design Discussion Paper*, pp. 4-5.

Finally, it should be noted that the output specification should obey certain formal tests. For example, Diewert and Nakamura have written:

> The *Product Test* was already introduced in subsection 3.2. On the output side, this rule states that the product of the output price and output quantity indexes, P and Q, should equal the nominal revenue ratio for periods t and s:
>
> (4-1) $PQ = R^t / R^s$.
>
> If the functional form for the output price index P is given, then imposing the product rule means that the functional form for the output quantity index must be given by the expression
>
> (4-2) $Q = (R^t / R^s) / P$.
>
> Thus, unlike the other tests introduced below that are applied to the alternative price indexes of interest and that may be passed or failed by each of the index number formulas tested, the product test is imposed as part of the (TFP) formula choice process. [17]

Diewert and Nakamura therefore emphasize the importance of the Product Test. This test is critical for the fundamental decision of selecting the formula to be used to estimate TFP. Diewert is also part of the EI team, so I am certain he would agree that the PEG and EI specifications should both be evaluated by the Product Test. If one specification satisfies this test and the other does not, that is very compelling evidence in favor of the specification that passes. I believe this comparison can be practically implemented in the following manner:

- Use an existing spreadsheet to simulate the prices that would result under the PEG TFP specification.
- Construct an index of these prices (using the Fisher Ideal form)
- Construct an index of PEG's proposed outputs (using revenue shares as weights and the Fisher Ideal form)
- Multiply the output price and output quantity indexes computed above and check to see whether it is equal to the index of regulated revenue

[17] Diewert, W.E. and A. Nakmura (2002), "The Measurement of Aggregate Total Factor Productivity Growth," Working Paper, p. 19; footnotes suppressed.

- Use an existing spreadsheet to simulate the prices that would result under the EI TFP specification.
- Construct an index of these prices (using the Fisher Ideal form)
- Construct an index of EIs proposed outputs (using their preferred weights and the Fisher Ideal form)
- Multiply the output price and output quantity indexes computed above and check to see whether it is equal to the index of regulated revenue
- Compare the results from the PEG and EI specifications

3.1.3 Output Weights

The PEG and EI proposals also differ regarding how outputs should be weighted. I have always advocated that revenue shares are the preferred output weights. However, in some circumstances, the necessary revenue share data do not exist, and cost elasticity weights can be a second best proxy in these instances.

The views of EI personnel on appropriate output weights have fluctuated over time. The factual record shows that, in 2005, EI personnel strongly advocated that cost elasticity shares be used to weight outputs.[18] They have now apparently changed that position, and recommend that both price and marginal cost information be used to weight outputs.

I believe these alternative recommendations should be evaluated using the Product Test. Alternative output and output weight specifications can be evaluated, in a manner similar to that outlined above, to determine which best satisfies the Product Test. The output weights that best satisfy this Test should be preferred for the TFP specification, all else equal.

In addition, the AEMC/AER must evaluate data requirements for the rival specifications. My proposal uses revenue data that are readily available in Australia. EI's uses revenue and marginal cost data. It is not clear whether they are referring to

[18] For example, see D. Lawrence (2005), *Review of Pacific Economics Group Report "TFP Research for Victoria's Power Distribution Industry"* p. 5and D. Lawrence (2005), *Response to Pacific Economics Group "Evaluation of Meyrick and Associates Review of PEG TFP Report,"* pp. 2-4; the latter document also mistakenly claims that the Denny, Fuss and Waverman TFP study does not use revenue weights.

short-run or long-run marginal costs, but it would appear to be the latter since short-run marginal costs for many delivery services are close to zero. Long-run marginal costs are notoriously difficult to estimate for utility services. It is not clear what marginal cost estimates already exist, but it should be recognized that EI's approach would require marginal costs for *every* service currently provided to regulated customers (*e.g.* the marginal cost of access services for residential customers, the marginal cost of delivery services for small commercial customers, the marginal cost of peak demand for industrial customers) by every utility in Australia. In addition, EI would require information on marginal costs for services that are *not* billed but which they believe should be included in the output index.

One of the criteria for a TFP-based methodology is that it not result in reporting requirements that are onerous. The *Preliminary Findings* Paper also states that it believes a TFP-based methodology can be implemented without imposing substantial new data burdens. The AEMC/AER should specifically consider whether it believes this to be true with respect to the marginal cost information required for the EI TFP specification. I strongly suspect that much (and perhaps most) of the marginal cost information needed for EI's approach will not exist, and developing these estimates will be a costly and contentious process.

Before any such studies are commenced or new burdens imposed, the AEMC/AER should undertake the more straightforward empirical tests I have recommended in this Section. The output specification tests can help to determine what outputs will be used in the TFP specification and therefore require weights. The Product tests can help the AEMC determine if it is appropriate in a conceptual sense to use marginal cost or revenue weights. After these empirical tests are conducted, the AEMC can (if necessary) examine the incremental costs and incremental benefits associated with whatever studies would be needed to develop new information for weighting outputs.

3.1.4 Company Heterogeneity and Complexity of X Factor Formula

On multiple occasions, EI claims that its TFP specification can capture a range of contributions to TFP growth whereas PEG's TFP cannot. It claims that this feature of their TFP specification allows their TFP estimates to better reflect heterogeneity in

utilities' business conditions. In contrast, they state that PEG's TFP specification does not do this and effectively assumes that achievable TFP growth will be the same for all firms in an industry. For example, in its *Total Factor Productivity Index Specification Issues* Report, EI writes that PEG's TFP specification

> implicitly assumes that achievable TFP growth is the same for all firms. However, actual TFP growth in a natural monopoly industry is influenced by factors other than technical change. These mainly relate to the divergence of prices from marginal costs. While technical change may be relatively similar across DBs (or at least those with similar operating environments), the large differences in pricing structures adopted by DBs and the relative extent of unbilled functional outputs will mean that achievable TFP growth will be different across DBs. Because the framework advocated by Dr Kaufmann does not distinguish these factors, it effectively assumes that achievable TFP growth is the same across all DBs.[19]

EI concludes that "a more sophisticated framework than that advocated by Dr. Kaufmann is clearly required to address the range of issues that is likely to arise and to ensure that network regulation is contributing to improved economic welfare."[20]

These claims are demonstrably untrue. This is also not a matter of interpretation, nor does it require specialized economic knowledge to determine the truth of this matter. Any interested party can consult documents that are in the public domain, including those presented in this proceeding, which demonstrate that PEG's TFP specification measures "factors other than technical change."

For example, in submissions to both the AEMC and the Commerce Commission, I have replicated PEG's earlier work in Victoria which showed that the 'conventional' TFP growth I recommend can be decomposed into a number of components, including the impact of scale economies and non-marginal cost pricing on TFP growth as well technical change.[21] The full decomposition of our TFP growth measure into its various components is given below. Moreover, the text explaining this decomposition is unchanged from when we first presented it in Australia in December 2004. The only additions to this text that did not originally appear in our December 2004 TFP report are highlighted in yellow.

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[19] Economic Insights (2009), p. 40.
[20] Economic Insights (2009), p. 41.
[21] Kaufmann, L. *et al* (2004), *TFP Research for Victoria's Power Distribution Industry*, Prepared for the Essential Services Commission of Victoria, pp. 99-102.

$$
\begin{aligned}
T\dot{F}P &= \dot{Y} - \left(\dot{C} - \dot{W}\right) \\
&= \dot{Y} - \left[\left(\sum_i \varepsilon_{Y_i} \cdot \dot{Y}_i + \sum_n \varepsilon_{Z_n} \cdot \dot{Z}_n + W^* + \dot{g} + \dot{\eta}\right) - \dot{W}\right] \\
&= \dot{Y} - \left[\left\{\left[\left(1 - \frac{1}{\sum \varepsilon_{Y_i}}\right) \cdot \sum \varepsilon_{Y_i} \cdot \dot{Y}_i + \sum_i \frac{\varepsilon_{Y_i}}{\sum_i \varepsilon_{Y_i}} \cdot \dot{Y}_i\right] + \sum_n \varepsilon_{\dot{Z}_n} \cdot \dot{Z}_n + W^* + \dot{g} + \dot{\eta}\right\} - \dot{W}\right] \\
&= \dot{Y} - \left\{\left[\left(\frac{1}{\sum \varepsilon_{Y_i}} - 1\right) \cdot \sum \varepsilon_{Y_i} \cdot \dot{Y}_i + \dot{Y}^{\varepsilon} + \sum_n \varepsilon_{\dot{Z}_n} \cdot \dot{Z}_n + W^* + \dot{g} + \dot{\eta}\right] - \dot{W}\right\} \\
&= \cdot\left(1 - \sum \varepsilon_{Y_i}\right) \cdot \dot{Y}_i + \left(\dot{Y} - \dot{Y}^{\varepsilon}\right) - \left(W^* - \dot{W}\right) - \sum_n \varepsilon_{\dot{Z}_n} \cdot \dot{Z}_n - \dot{g} - \dot{\eta}
\end{aligned}
$$

The expression above shows that growth rate in TFP has been decomposed into six terms. The first is the **scale economy effect**. Economies of scale are realized if, when all other variables are held constant, changes in output quantities lead to reductions in the unit cost of production. This will be the case if the sum of the cost elasticities with respect to the output variables is less than one.

EI says that PEG's TFP trend measure does not capture or take account of the economies of scale that exist in regulated industries. This decomposition of our TFP growth formula shows this claim is factually false; the first component of our TFP decomposition captures the impact of scale economies.

The second term is the **nonmarginal cost pricing effect**. This is equal to the difference between the growth rates of two output quantity indexes. One is the index used to compute TFP growth. The other output quantity index, denoted by $\dot{Y}^{\varepsilon}$, is constructed using cost elasticity weights. The Tornqvist index that we use to measure TFP should theoretically be constructed by weighting outputs by their shares of revenues. It can be shown that using cost elasticities to weight outputs is appropriate if the firm's output prices are proportional to its marginal costs, but revenue-based weights will differ from cost elasticity shares if prices are not proportional to marginal costs. Accordingly,

this term is interpreted as the effect on TFP growth resulting from departures from marginal cost pricing.[22]

EI says that PEG's TFP trend measure does not capture or take account of differences between regulated prices and marginal costs in regulated industries. This decomposition of our TFP growth formula shows this claim is factually false; the second component of our TFP decomposition captures this impact.

The third term is the **cost share effect**. This measures the impact on TFP growth of differences in the growth of input price indexes based on optimal and actual cost shares. This term will have a non-zero value if the firm utilizes inputs in non-optimal proportions.

The fourth term is the **Z variable effect.** It reflects the impact on TFP growth of changes in the values of the Z variables that are beyond management control.

The fifth term is **technological change**. It measures the effect on productivity growth of a proportional shift in the cost function. A downward shift in the cost function due to technological change will increase TFP growth.

EI says that PEG's TFP trend measure essentially assumes that TFP growth is equivalent to technological (or technical) change. This decomposition of our TFP growth formula shows this claim is factually false; technological change is only one of six terms identified in our TFP trend.

The sixth term is the **inefficiency effect**. This measures the effect on productivity growth of a change in the firm's inefficiency factor. A decrease in a firm's inefficiency will reduce cost and accelerate TFP growth. Firms decrease their inefficiency as they approach the cost frontier, which represents the lowest cost attainable for given values of output quantities, input prices, and other business conditions.

My December 2004 report to the ESC also went beyond this theoretical decomposition and presented quantitative estimates of the impact of different factors on TFP growth for different Victorian DBs; the AEMC has referenced this work in its *Preliminary Findings* Report.

EI personnel are well aware of this work. In fact, they reviewed PEG's decomposition formula as it applies to operating expenditures partial factor productivity

[22] See Denny, Fuss and Waverman *op cit*, p. 197.

(PFP) growth, which is equivalent in all respects to the TFP decomposition except that it includes an additional variable in the decomposition analysis (*i.e.* the impact of the capital stock on opex PFP growth; this variable would not be relevant in a TFP analysis which captures both opex and capital productivity). At the time, EI personnel concluded that PEG's measure of productivity growth

> Incorporate(s) a range of factors including scale economies, capital interaction effects, the impact of changes in operating environment factors, technological change and changes in efficiency levels. No additional allowance, thus, needs to be made for any of these factors as they should be captured by the change in opex partial productivity. The PEG approach… can, thus, be seen to be well grounded in economic theory.[23]

It can be seen that the "range of factors" EI personnel say are present in PEG's measured opex PFP trend reference many of the same effects that are identified above (and one new one – capital interaction effects – which will only be relevant for opex PFP growth and not TFP growth).

Clearly, the TFP framework I advocate is capable of distinguishing the impact of different factors on TFP growth and does not assume that TFP growth is the same for all companies (and equivalent to technical change). Concrete written and empirical evidence proves that PEG undertook a TFP decomposition about five years before EI presented its own, related analysis in New Zealand. Why EI continues to make assertions that can so easily be shown to be false is a mystery. EI's theoretical work simply takes a different approach to undertaking this TFP decomposition than PEG. Moreover, as I demonstrated in my submissions to the New Zealand Commerce Commission, EI's decomposition rests on a number of untenable assumptions. EI's approach and ability to distinguish the components of TFP growth is therefore not different in kind from PEG's, but it will be less accurate.

It is also perplexing why EI continues to emphasize their TFP index captures the impact of a variety of factors, and can therefore better reflect heterogeneity among companies in a regulated industry, because in a practical sense this will not be done unless there the TFP index is decomposed and tailored to individual companies. If there is a single X factor in a TFP methodology for an industry, that single X factor will apply

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[23] Lawrence, D. (2007), *Victorian Gas Distribution Business Opex Rate of Change*, March 26 2007, p. 3; prepared for Envestra, Multinet and SPAusNet and submitted to the ESC Victoria.

to all firms in the industry regardless of their circumstances; whether TFP is calculated using PEG's or EI's TFP specification will have no bearing on whether the single X is relevant for different firms which, because of differing circumstances, may plausibly require *different* X factors.

It may be argued that differences in company circumstances can be captured in the methodology by dividing the utility industry into subsets of firms that operate under similar business conditions. Thus while there may be a single X factor for all firms within a defined industry sub-group, there will still be multiple X factors in the industry. It is true that the TFP methodology can be designed this way, but both the EI and PEG TFP specifications can be applied to these sub-groups and, if the components driving TFP growth do in fact differ among the groups, then both specifications will lead to differing TFP trend estimates for different groups (although the EI and PEG estimates may still differ from each other, for any given group). EI's approach is therefore no more or less theoretically effective than PEG's in reflecting company heterogeneity, and potentially developing different X factors, under this type of TFP methodology.

If the AEMC/AER does wish to explore econometric decompositions of TFP growth, and potentially having company-specific adjustments to an industry X factor, this is certainly feasible under PEG's TFP approach. Indeed, we have already presented evidence of such a TFP decomposition in our indexing work in Victoria. EI has presented no such evidence to date but I would expect some type of decomposition is possible with their approach as well. It should be noted, however, that EI personnel were vociferous opponents of using econometric methods to tailor X factors for individual companies when I proposed such a concrete decomposition for gas distributors in Victoria. This issue was eventually appealed to an Independent Appeal Panel, which accepted my productivity decomposition and rejected EI's criticisms and alternative approach.[24]

[24] The Appeal Panel described my estimate of productivity growth as an "objective quantitative analysis undertaken by a qualified and experienced consultant," while it said the productivity estimate supported by EI personnel "does not itself appear to the Panel to derive from an entirely objective analysis."

In sum, it is factually untrue that EI's TFP specification captures multiple components of TFP growth while PEG's does not; both capture multiple components of TFP growth. Simply having multiple sources of TFP growth reflected in a TFP growth trend also does not, in itself, allow company heterogeneity to be captured in a TFP methodology. I believe the most important source of company heterogeneity concerns where companies are in their capital replacement cycles, and this difference will be accommodated in the AEMC's proposal through the incremental capital module (as was the case in Ontario). PEG's approach can capture any additional company heterogeneity by applying its TFP specification to different company sub-groups or by using econometric methods to decompose index-based estimates of TFP trends.

The AEMC/AER can and should explore the extent to which the PEG and EI specifications capture company heterogeneity in its Stage II Review. This can be done by:

- constructing spreadsheet models of companies with large differences in cost pressures;
- estimating TFP growth using the PEG and EI specifications; and
- quantifying the extent to which each specification leads differential cost pressures to be captured more effectively for different firms in the industry.

This process can be done using a single X factor for the entire industry, and using multiple X factors for different sub-sets of the industries.

The AEMC/AER can also use econometric methods as a means of capturing company heterogeneity. This can be done by:

- using econometric techniques to decompose the PEG and EI TFP specifications into different components (to ensure comparability, the same econometric techniques must be applied to each specification);
- quantifying the impact of different components of TFP growth for each specification;
- developing tailored X factors for different companies under each specification; and

- quantifying the extent to which the tailored X factors resulting from each specification leads differential cost pressures to be captured more effectively for different firms in the industry

4. THE BRATTLE INCENTIVE REPORT

The AEMC issued Brattle Group's *Review of Incentive Power and Regulatory Options in Victoria* (the Brattle Incentive Report) at the same time as its *Preliminary Findings* report. The Brattle Incentive Report is only nine pages long, including the cover page, and a page and a half summary of their analysis. In this section, I respond page by page to the Brattle Incentive Report, beginning with the body of the report beginning on page three. This systematic, page by page response is feasible given that the Brattle Incentive Report is short. It is also illuminating, since nearly every page contains new and fundamental misunderstandings of the Incentive Power model Brattle was asked to review.

On page 3, Brattle says that the Incentive Power model is a heuristic simulation model that contains some assumptions about how a firm might operate, although those assumptions are not calibrated against any actual firm or regulatory experience. This is not true. The parameters that link cost reduction efforts, costs and revenues were carefully calibrated using "real world" experience on cost and productivity trends for US utilities. PEG maintains extensive databases and is the world's leading consultant on productivity measurement for energy utilities, and we consulted our data and empirical results carefully when calibrating the model. Although the report did not go into details about the bases for the calibrations, they do exist, and Brattle should have asked if they had questions about the bases for the parameter values rather than speculating and arriving at an incorrect conclusion.[25]

However, it is clear from the Report that many scenarios were calibrated to replicate actual regulatory outcomes. In particular, the "Victorian Parameterization" and "UK Parameterization" of the building block models were explained on pages 10-14 of

[25] There are inevitably editorial decisions about what to include and exclude in any technical study that is released to the public; any study that is too technical may be too dense and intimidating to be read by the general public. We tried to minimize the technical complexity in this Report by separating the technical appendix from the main body of the report and making the former available only on request by interested parties. It is not clear whether Brattle actually read this technical appendix, which does provide some information on the parameter values but does not contain a full discussion. However, we would have been happy to discuss specific concerns they had to ensure that there was no misunderstanding.

the report. These simulations were meticulous and successful efforts to replicate the outcomes of two actual building block regulatory decisions. Brattle's statement that the models were not calibrated against regulatory experience is therefore factually incorrect.

On page 4, Brattle says that "several features of the model might lead one to question its usefulness." As I will soon show, Brattle fails to recognize the usefulness of the model largely because they do not understand it. On page four this attitude is evident in Brattle's assertion that PEG's model is not capable of studying detailed designs. Of course, not all potential scenarios lend themselves to straightforward simulation, but it should have been clear that PEG's incentive power model can evaluate literally thousands of alternative regulatory designs that differ in both large and small details.

However, Brattle does make one fair point on page 4, which is that this particular variant of the incentive power model does not simulate the impact of uncertainty. In other instances we have modeled uncertainty, but this ramps up the complexity of the analysis dramatically, and we believed the model was already complex enough for a non-technical general audience without delving into expectations and uncertainty (extremely complex areas under any circumstances). This simplification does not, however, vitiate the usefulness of the model. The impact of different regulatory options on company behavior, costs and profits can still be quantified and the options thereby compared. This provides a useful "base case" for comparing the welfare effects of different regulatory approaches under the assumption that firms have rational expectations and maximize a stream of future profits in whatever regulatory environment they operate under.[26]

Brattle begins page five with the sentence "Essentially all of PEG's results can be understood in terms of the following simple concept: if a firm knows that its future prices will be at least partly independent of its costs, it has an incentive to reduce costs because by doing so it will increase profits." This is not an accurate statement of PEG's results, nor does it do justice to the model. A more accurate description would be the following:

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[26] Uncertainty can affect welfare comparisons if it impacts company behavior differently under different regulatory designs. For example, if cost of service regulation allows uncertainty to be dealt with more effectively than a pure TFP-based approach, this can impact the relative welfare of these regimes. However, if uncertainty is neutral with respect to company behavior under different regulatory designs, the welfare comparisons will generally not be impacted when uncertainty is introduced into the analysis.

- There are costs and benefits associated with any strategies/specific initiatives that utilities can pursue to become more cost efficient.
- The benefits depend on how profits are shared between customers and shareholders while the regulatory plan is in place; how long the plan is in place; and how prices are updated when the plan expires.
- These benefits will, in turn, depend directly on how incentive regulation is designed.

This is a relatively simple framework, but it is much richer than what Brattle contends (it also directly undercuts Brattle's contention on the top of page 6 – the incentive power model can and does examine a wide variety of rent-efficiency tradeoffs). This framework is also quite powerful in practice and allows potentially thousands of different scenarios to be explored. I also believe it is relatively uncontroversial, and the behavior resulting from how firms optimize under different regulatory environments directly drives our simulation results.

Page 6 contains the main conclusion of Brattle's analysis and also its most significant mistake. In the fifth line of the second paragraph, Brattle states in bold letters "PEG has no TFP scenario with a true up" (*i.e.* a full true-up of revenues to costs when the plan expires). Yes, we do: it is Scenario Five. Scenarios Six and Seven also contain a 90% true-up and an 80% true-up.[27] Dozens of people have read this manuscript, and Brattle is the first that I am aware of to draw this fundamentally incorrect conclusion, which invalidates all of their remarks that follow in this section (until the middle of page 7) and much beyond.

On the new section that begins on page 7, Brattle writes that "if we make a proper comparison between TFP and building blocks, we would hold constant everything apart from the method for determining X." I agree, and this is possible in our Incentive Power Report. The difference between TFP-based regulation and building block regulation with

[27] Under these scenarios, when the plan expires, prices are set at a weighted average of the company's own costs in the final year of the plan and the prices that would result from a continued operation of the TFP-based mechanism; Scenario Six puts a 90% weight on the company's own cost, and Scenario Seven puts an 80% weight on company costs.

a full true-up of revenues to costs can be seen by comparing Scenario 5 (TFP) to Scenario 8 (Victorian Parameterization) or Scenario 17 (UK Parameterization). The difference between TFP-based regulation and building block regulation with a 90% true-up of revenues to costs can be seen by comparing Scenario 6 (TFP) to Scenario 11 (Victorian Parameterization) or Scenario 20 (UK Parameterization). The difference between TFP-based regulation and building block regulation with an 80% true-up of revenues to costs can be seen by comparing Scenario 7 (TFP) to Scenario 14 (Victorian Parameterization) or Scenario 23 (UK Parameterization). An actual comparison of these scenarios could prompt valuable discussions on the merits of these alternative regulatory designs, but Brattle failed to recognize that these comparisons were possible. Its conclusions on the bottom of page 7 (and on the last paragraph of page 9) are also unsubstantiated, in part because they are not informed by a proper understanding of the incentive power model or how the incentives under building blocks can affect customers.[28]

This last point is evident on page 8 (extending into page 9), where Brattle does not accurately state why welfare can be lower under building blocks that cost of service regulation. The reason stems directly from the role of cost forecasts and information asymmetries, which under building blocks provide an opportunity for firms to raise prices above what could be supported by regulatory designs where prices were based only on observed, historical cost data. This is an important point that is rarely recognized in regulatory debates, where it is often assumed that cost of service regulation represents the nadir of customer welfare and building blocks-type incentive regulation necessarily represents an improvement. Our results, calibrated from Victorian data, shows that this is not always true. I believe this result also strengthens the case for looking for options to the building block approach.

In the *Preliminary Findings* Report, the AEMC has indicated that it has benefitted from the simulation model that PEG developed on behalf of the ESC. This model examined how TFP-based regulation and building blocks regulation would operate for an industry comprised of two prototype companies. It also simulated results on the path of prices and profits for each company and the industry under the building block and TFP-

[28] Although this result is sensitive to the degree of information asymmetries, as is evident by comparing the simulation results from the two parameterizations.

based approaches. In many ways, the model that the AEMC has found instructive is a simplified version of the incentive power model. I believe simulation models can play an extremely valuable role in the remainder of Phase I and in Phase II of this proceeding, particularly in providing concrete empirical evidence that can be used to make more informed choices on the most appropriate TFP specification. It is not clear whether the incentive power model itself will be of further use since, in the Australian context, this model primarily assesses the relative incentives created by TFP-based and building block regulation, and I believe the AEMC's *Preliminary Findings* on incentive issues *per se* are overwhelmingly sound and consistent with our incentive power findings.

Regardless, Brattle's analysis of the Incentive Power model has not been helpful to this Review, nor to assessing the merits of simulation models more generally, since it was marred by fundamental misunderstandings on their part. These misunderstandings could have perhaps been rectified if they had discussed their concerns with PEG. I am also confident that, if Brattle keeps an open mind and is asked to examine the model again, it would be persuaded that it has value, and I would be happy to assist in these efforts or any subsequent reviews.[29]

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[29] Parenthetically, it may also be instructive to make some general observations about the role that simulation models are playing in our present economic environment. It is fair to say that many of the most important economic decisions facing the world today are driven by the results of simulation models. The issue is climate change, and climate change policy is driven overwhelmingly by the outcome of computer models that simulate the future path of global temperatures (and climate more generally) under various scenarios for carbon emissions. Literally tens of trillions of dollars in investments, reallocations of economic activity, and/or economic losses are riding on the outcome of these models. I am not an expert on climate change modeling, but I strongly suspect that while the profit-maximizing utility behavior we simulate under the incentive power model is complicated, it is much more straightforward than the complex, interdependent and dynamic systems that will determine the path of the world's climate for the next century.

Given the importance that policymakers are placing on simulation exercises in other contexts, I believe it is important for any simulation model presented in this proceeding not to be dismissed out of hand. Of course, any such model should be subject to review and criticism; I welcome and encourage any constructive comments. But a balanced review should also recognize that the optimizing behavior built into the incentive power model is consistent with neoclassical economics, and if Brattle had examined the Technical Appendix, it would have been aware of this. And although this is probably not known, it should also be noted that Mark Lowry of PEG and I have both worked closely with computer programmers/PEG interns who wrote the computer programs that solve for firms' profit-maximizing path of actions given the structure of the optimizing framework. The original programmer is now a software engineer at Google, his successor is a Ph.D. student in finance at Stanford (and started his own computer consulting company while in his teens), and both have confidence in the soundness of the program and the quality of the results. This is not to say that the incentive power model cannot be improved, but there is little evidence in the Brattle critique that they were interested in offering constructive suggestions or presenting a balanced assessment of the pros as well as the cons of the model.

5. A WAY FORWARD

This Submission is designed to help the AEMC and AER move forward as it finalizes its Stage I Review and commences the Stage II Review. Frankly, the "Issues to be Resolved" presented in the EI Report are not tenable, for they rest on the assumption that EI's preferred TFP specification is to be used. I have recommended an alternative way forward, which requires that *both* the EI and PEG TFP specifications be put to the test. I believe this is absolutely necessary to resolve the TFP debates in the most transparent and rigorous manner possible. These tests should also build understanding and consensus among stakeholders, and managing this process will create institutional capabilities within the AEMC and AER that should help the TFP methodology be implemented and monitored more effectively. Everyone will also have more confidence in the selected TFP specification if the two options are evaluated using concrete and verifiable facts and empirical evidence, particularly evidence that addresses how well each specification satisfies the criteria the AEMC established for this Review.

I have outlined a number of empirical tests that I believe can be instrumental for such a resolution. In brief, they are the following:

Finalizing Stage I Review

Testing Adequacy of Existing Dataset

AEMC/AER Should investigate:

- What errors and inconsistencies exist in current data?
- Are these errors and inconsistencies systematic across regulated companies in a given industry?
- If so, do errors and inconsistencies across the industry create biases in one direction or another, or do data imperfections tend to offset one another?
- Do systematic data errors tend to impact the TFP growth rate, or simply the TFP index in a given year?

Accuracy and Bias of TFP Estimate

- Test whether TFP estimated under a given specification, when subtracted from the observed growth in industry input prices, leads to a rate of change equal to the observed change in the industry's unit cost of providing regulated services; this is the most important criterion that must be satisfied when identifying the correct TFP specification, because if it is not then the underlying rationale for TFP-based regulation is violated.

Efficient Cost Recovery Test

- Take an existing spreadsheet model and simulate the impact of step changes in providing security or other unbilled activities on a company's (or industry's) cost; all else equal, this cost increase will be reflected in an increase in input quantity
- Calculate TFP using PEG's specification which involves billed outputs only, and revenue share weights
- Calculate the resulting price trend using PEG's TFP specification
- Calculate the impact on industry profits, calculated using the price path from PEG's TFP specification and the assumed cost change
- Calculate TFP using EI's specification which involves adding a new unbilled output to the TFP specification, which will (all else equal) tend to increase the growth in output quantity and increase TFP growth (compared with PEG's TFP specification, under the same scenario)
- Calculate the resulting price trend using EIs TFP specification
- Calculate the impact on industry profits, calculated using the price path from EI's TFP specification and the assumed cost change
- Compare the results from the PEG and EI TFP specifications

Testing the Volatility of Price Paths

- Data has been presented showing that the price path under PEG's TFP specification is quite stable; additional information should be available no later than June 2010, which updates our TFP trends to include 2008 data

- Comparable data should be developed on the price path that would be generated under EI's specification

Stage II Review

Accuracy and Bias of TFP Estimate

- Test whether TFP estimated under a given specification, when subtracted from the observed growth in industry input prices, leads to a rate of change equal to the observed change in the industry's unit cost of providing regulated services; this is the most important criterion that must be satisfied when identifying the correct TFP specification, because if it is not then the underlying rationale for TFP-based regulation is violated.

Physical Capital Metrics

- The AEMC must first examine whether there is **no** evidence of a "portfolio effect" – or differences in asset retirement patterns - in a regulated industry
- If there is any evidence of a portfolio effect, physical capital measures must not be used
- If there is no evidence of a portfolio effect, the decision on physical versus monetary capital measures should depend on concrete, factual evidence that verifying that energy network assets are characterized by one-hoss shay depreciation

Product Test: Relevant for Determining Output Specification and Choice of Weights

- Use an existing spreadsheet to simulate the prices that would result under the PEG TFP specification.
- Construct an index of these prices (using the Fisher Ideal form)
- Construct an index of PEG's proposed outputs (using revenue shares as weights and the Fisher Ideal form)
- Multiply the output price and output quantity indexes computed above and check to see whether it is equal to the index of regulated revenue

- Use an existing spreadsheet to simulate the prices that would result under the EI TFP specification.
- Construct an index of these prices (using the Fisher Ideal form)
- Construct an index of EIs proposed outputs (using their preferred weights and the Fisher Ideal form)
- Multiply the output price and output quantity indexes computed above and check to see whether it is equal to the index of regulated revenue
- Compare the results from the PEG and EI specifications

Accounting for Company Heterogeneity: Test 1

- Construct spreadsheet models of companies with large differences in cost pressures
- Estimate TFP growth using the PEG and EI specifications; and
- Quantify the extent to which each specification leads differential cost pressures to be captured more effectively for different firms in the industry.

This process can be done using a single X factor for the entire industry, and using multiple X factors for different sub-sets of the industries.

Accounting for Company Heterogeneity: Test 2

- Use econometric techniques to decopose the PEG and EI TFP specifications into different components (to ensure comparability, the same econometric techniques must be applied to each specification);
- Quantify the impact of different components of TFP growth for each specification;
- Develop tailored X factors for different companies under each specification; and
- Quantify the extent to which the tailored X factors resulting from each specification leads differential cost pressures to be captured more effectively for different firms in the industry

I do not know the outcome of any tests but, provided they are conducted fairly and competently, I am willing to let them determine my recommendation for the TFP specification. If it can be demonstrated empirically that EI's specification satisfies the criteria for this Review better than PEG's (including the criteria of not imposing onerous data requirements), I will endorse EI's specification. I hope EI would do the same if the empirical tests support PEG's TFP specification. It is also important that the outcome of all tests be made available to all parties, in real time, so that the review process can be as open and transparent as possible.

I also believe PEG's spreadsheet and simulation models can play an important role in the remainder of the Stage I and Stage II Reviews. Indeed, the AEMC has already found them to be instructive. PEG is willing to work with the AEMC, AER or any other stakeholder to ensure that our spreadsheet models are adapted as effectively as possible to the tasks that need to be addressed. I can guarantee that any assistance we provide on these issues would be objective and subject to review and check by any interested party. However, it would be understandable if the AEMC concluded that, since PEG has long advocated one of the two TFP specifications that would be reviewed, we should not be involved with the final review of the TFP specification. While I would understand such a decision, I would request that this rationale be applied equally to EI, to ensure that all parties involved with the final review of the TFP specification have no stake in the outcome and to ensure that this review is as objective as possible.

APPENDIX ONE: THE CAPITAL MEASUREMENT ISSUE IN ONTARIO

The Board came to two sets of decisions in 2008 on the appropriate TFP methodology and value for the TFP trend in IRM3 for electricity distributors in the Province of Ontario. EI was part of a team led by Julia Frayer from London Economics International (LEI), which was advising a coalition of large electricity distributors and actively involved in the proceeding. I was a representative from PEG and the main advisor to the Staff of the Ontario Energy Board – but not to the Board itself. This is an important distinction in Ontario (and in fact, most North American jurisdictions). There is typically a stronger separation between the regulators and regulatory Staff in North American jurisdictions than in Australia. The Board also has a duty to consider the recommendations of its Staff (and any advisors to Staff) on an equal footing with submissions by industry, customer groups, environmentalists and other intervenors. All evidence is to be considered impartially, and Staff's analysis is not given preferential treatment.

The experience in Ontario shows that the Board takes this role seriously and does not blindly accept the recommendations of its Staff or the Staff's advisors. For example, in the "first generation" incentive regulation plan approved in Ontario in 2000, the Staff's advisors recommend a "menu" of X factor and earnings sharing options be presented to the industry, from which they would be allowed to choose. The Board rejected this advice and instead implemented a single X factor for all distributors, with its reasons for rejecting the Staff's advice presented in the Decision.

In the IRM3 proceeding, the OEB's initial decision was presented in the Report of the Board in July 2008. Page 15 of this Report only briefly discusses the TFP methodology and results from Julia Frayer, including a discussion of physical capital measures [i.e. "Ms. Frayer developed an alternative TFP measure that included peak demand and substituted a physical measure of capital (total distribution line length) for the inflation-adjusted, monetary value of capital"]. On page 20 of this initial decision, the Board approved the use of an index-based measure of the TFP trend but said "the

Board would be assisted by further consultation on the interpretation of the results" presented by different stakeholders. The Board therefore opened a new round of consultation on the methodologies and results put forward by different parties, before deciding on a final value for the TFP trend.

This consultation involved new submissions by Ms. Frayer, myself, and others, as well as several more days of presentations, questioning and debate before the Board. The Board's decision following this consultation was presented in the "Supplemental Report" in September 2008. This report contains more discussion of the differences in TFP estimates among the stakeholders, including differences in the measurement of capital. For example, page seven says

> In particular, the Cronin and King Study and the PEG Study used the monetary approach to account for capital quantities. In its five-year study, LEI chose to measure capital input quantity based on the physical length of distribution lines because of physical depreciation profile effects. That is, Ms. Frayer proposed that the carrying capacity of distribution lines does not decline consistent with accounting depreciation methods. Ms. Frayer submitted that economic theory, empirical evidence, industry experience and recent regulatory precedent all support the recognition of this approach when calculating the annual capital input quantity of electricity distribution assets and that accounting depreciation adjustments under the monetary approach bias the quantity of capital input.[30]

Page eight of the September 2008 Board Report discusses my response to this argument:

> In relation to the LEI study, most participants (in the proceeding), as well as Dr. Cronin and Dr. Kaufmann, disagreed with the use of physical counts of capital in the calculation of TFP. Both of them recommended the customary use of monetary values. Dr. Kaufmann noted that when a utility sets its rates to recover depreciation and carrying costs associated with these capital goods, it does so with reference to the aggregated monetary values of these disparate assets net of their depreciation. He submitted that LEI's TFP study ignores this monetary valuation of assets in favour of a physical method for estimating capital stock. Since physical asset measures are not used to set rates at the outset of a plan, Dr. Kaufmann expressed concern over LEI's proposal to use a productivity factor to adjust distribution rates that, over time, bears no relationship to how those rates were originally set. Dr. Kaufmann also noted that the LEI TFP model assumes that there is no physical decay of distribution assets over time. He stated that there is no theoretical or empirical support for this assumption and cautioned that this is not an academic point but a practical one, because depreciation is a reality.[31]

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[30] Ontario Energy Board, *Supplemental Report of the Board*, September 17, 2008, p. 7.
[31] Ontario Energy Board, *Supplemental Report of the Board*, September 17, 2008, p. 8.

Readers will notice the similarity to the debate in the current Review. The OEB clearly took note of the "economic theory, empirical evidence, industry experience and recent regulatory precedent" arguments put forward at length by Ms. Frayer and EI personnel. The OEB also accurately reiterated my position, which I have also expressed in this proceeding.

Pages 11 and 12 present the Board's analysis of these options. It can be seen here that my TFP specification was accepted in its entirety; the specification of EI and LEI was rejected in its entirety. The *only* change that the Board made to my recommendation was the length of the period over which the TFP trend was measured; I recommended 11 years, while the Board selected 18 years (the entire sample period presented in the proceeding). It is also clear that the main reason the Board rejected the LEI/EI TFP study was its approach to capital cost measurement. In fact, on page 12, the Board wrote that

> "(o)f greatest concern with Ms. Frayer's approach is the measurement of capital, which is inconsistent with the prior Ontario TFP studies and does not appear to have been adopted in any jurisdiction other than New Zealand. While the Board recognizes Ms. Frayer's efforts to construct an Ontario-specific TFP trend, the Board does not believe that the methodology advocated by Ms. Frayer is appropriate."[32]

The Board's reasoning here is clear and unequivocal. It ruled that it "does not believe that the (TFP) methodology advocated by Ms. Frayer (and EI) is appropriate." Its "greatest concern" with this methodology is the measurement of capital, which is "inconsistent with prior Ontario TFP studies and does not appear to have been adopted in any jurisdiction other than New Zealand." These findings are clear, but I invite interested parties to read the entire Board Reports as well as the voluminous material from the proceedings to assure themselves that no relevant context is ignored or distorted. The Board rejected physical capital measures decisively and unequivocally.

In its December 2009 report, EI does not acknowledge these facts, but instead makes three claims (all on p. 42). The first was that "the main issue in Ontario was the lack of relevant capital data to implement either the 'monetary' or the physical quantity proxy approach. Indeed, the lack of Ontario data was so problematic that US TFP results

[32] Ontario Energy Board, *Supplemental Report of the Board*, September 17, 2008, p. 12.

ended up being used by the OEB instead." However, on pp. 11-12 the OEB explicitly rejects this claim (which LEI/EI was also making in Ontario), when it wrote that "the data deficiencies noted by the consultants do not operate as an insurmountable obstacle to the development of an appropriate TFP value for 3rd Generation IR." Moreover, the Board says outright that its "main concern" with the LEI/EI study was how they measured capital, not the lack of data.

EI's second claim is that Dr. Frank Cronin did not accept PEG's recommended methodology for measuring TFP, and that Dr. Cronin advised the OEB in the first generation plan. Again, it should be noted that Dr. Cronin was actually advising OEB Staff and not the OEB, but it is true that he advocated a different approach in the proceeding. It is difficult to see how this is relevant, however, since: 1) the OEB did not accept Dr. Cronin's suggestions and instead accepted our TFP indexing specification in its entirety; and 2) Dr. Cronin supported monetary and not physical capital measures (see the quote from page 8 of the September 2008 Report, referenced on p. 8 above). EI raises the issue of Dr. Cronin's views in the context of whether physical or monetary capital metrics should be used in TFP measurement – and the record shows that Dr. Cronin supported my position on this issue, and opposed EI. If one were to put any weight on what other parties in Ontario were advocating, this point by EI actually provides more evidence in support of the monetary approach (indeed, nine of the ten stakeholders supported monetary and not physical capital measures; only EI/LEI did not).[33]

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[33] EI also points to a footnote that appeared on p. 63 of my October 2009 submission to the AEMC, which read "(s)ome EI personnel apparently were part of the team advising the OEB for the first generation incentive regulation plan." EI responds that "(t)his is incorrect. Dr. Frank Cronin from PHB Hagler Bailly advised the OEB on its first generation incentive regulation plan and the OEB drew directly on this work." Of course, I knew Dr. Cronin headed up the team involved in the first generation incentive regulation plan, a point that I have indicated in this report as well as other earlier published reports. Also, as noted, the OEB actually rejected Dr. Cronin's main recommendation, although they did use his TFP research differently than Dr. Cronin recommended to develop their own incentive regulation plan. Thus, while the OEB first generation plan did "draw directly" on Dr. Cronin's work, this wording is somewhat misleading since a reader who did not know the full story might conclude that the OEB was following Dr. Cronin's recommendation, when in fact the OEB rejected it.

On the issue of whether EI personnel were involved in the first generation IR plan, I used the word "apparently" because I recall Denis Lawrence telling me directly that he was part of the team (even though, as in the third generation plan, someone else was leading the team). I also recall that Dr. Lawrence's involvement in Ontario was discussed during the 2003 electricity thresholds proceeding or 2004 gas proceeding in New Zealand. If transcripts are available from these hearings, they may be able to confirm this. However, if my recollection is incorrect, I withdraw footnote 45 on p. 63 of my October 2009, which has no bearing on my conclusions or substance of my analysis in any case.

Finally, EI says that "it is of the view that these issues were not independently reviewed in the Ontario proceedings. Dr. Kaufmann, clearly an advocate of the so-called 'monetary' approach, was the advisor to the OEB. Furthermore, the topic received coverage of one paragraph in the OEB (2008b) report."

Two of the three points that EI makes above are factually incorrect. I have already quoted more than one paragraph from the report EI referenced, so that point is clearly inaccurate (and of questionable relevance even if true). In addition, my October submission pointed to at least 35 pages of transcripts in which the capital measurement issue was discussed before Board members.[34] The September Board Report also noted the "economic theory, empirical evidence, industry experience and recent regulatory precedent" that EI and LEI personnel used to support their capital recommendations. There is ample evidence that the OEB considered the arguments EI/LEI put forward and that the issue of capital measurement received considerable attention in OEB proceeding.

As discussed, it is also not true that I was an advisor to the OEB; I was advising the OEB Staff. This is a distinction with a difference, because Staff is a participant in the proceeding, and its views and evidence are put forward in an identical manner as industry, customer and other participating groups. This is, in fact, evident from the September 2008 Board Report, where on pp. 1-2 the Staff is listed co-equally with the other participating groups. Board members are independent of their Staff and decide based on their judgment which, as noted in the first generation plan, frequently differs from the recommendations of their Staff or Staff advisors.

EI's third point is that their evidence was not "independently reviewed" by the Ontario Energy Board. This charge is not amenable to factual verification since it goes directly to the integrity and independence of the Board members. Indeed, EI is making a serious charge when it suggests that the Board did not act independently. The Board's code of conduct requires that Board members not participate in a regulatory proceeding if for any reason they would be unable to render an impartial decision. If EI has any

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[34] For example, see pp. 55-61 and 67-75 of the transcripts from the March 27, 2008 stakeholder meeting; pp. 76-92 of the transcripts from the August 5, 2008 meetings; and pp. 17-20 and 31-33 in the August 6, 2008 meetings; previously referenced in footnote 44 on p. 62, in Kaufmann, L., *Submission to Australian Energy Market Commission: Design Discussion Paper*, October 2009.

evidence that Board members did not act independently, they should present it. If not, they should refrain from making insupportable allegations. To impugn the integrity of a regulator simply because it did not accept your arguments is, frankly, unconscionable.

APPENDIX TWO: THEORETICAL ISSUES

This appendix evaluates the theoretical claims EI has made about PEG's TFP specification, as well as one new theoretical point they raise. EI's previous claims have already been discredited, but it has chosen to re-assert several of these points without responding to my substantive arguments. A final statement is therefore required to summarize and close out these theoretical debates.

I should also note that, in my opinion, EI's attempt to create what it calls a "unified theory of regulation" has been unnecessary, sown extraordinary confusion here and abroad, and is ultimately unsuccessful. The AEMC/AER has practical issues they need to address, and this submission puts forward a roadmap that I believe can lead to a practical resolution of these issues by compiling factual evidence and empirically testing *both* of the proposed TFP specifications. Any further focus on economic theory would lead to a significant misallocation of time and resources and distract the AEMC/AER from these practical tasks.

Below I respond to the two main theoretical claims that EI has made regarding PEG's TFP work or its own TFP specification. These claims are: 1) PEG's TFP specification assumes regulated industries are characterized by competitive market conditions; and 2) PEG assumes that capital is entirely "fungible" and not sunk. I also respond to a new issue that EI has raised, that PEG's TFP specification and ex post capital measure is "circular."

A2.1 Assumption of Competitive Markets

In September 2009, the New Zealand Commerce Commission (the Commission) released its *Draft Decisions Paper: Initial Reset of the Default Price Quality Path for Electricity Distribution Businesses* (the Draft Decisions Paper). At the same time the Commission released the Economic Insights (EI) report *Electricity Distribution Industry Productivity Analysis: 1996-2008*. While both papers primarily focused on developing draft recommendations for the rate of change formula used for the default price-quality path (DPP) for the electricity distribution businesses (EDBs), they also presented some

comments on the methodology that PEG uses to estimate TFP growth. The Electricity Networks Association (ENA) in New Zealand asked me to respond to these comments on PEG's TFP methodology. The ENA believed that any potential misunderstandings of PEG's TFP study should be addressed, even if there are no immediate implications for the DPP.

Most importantly, I responded to the following claim by EI regarding PEG's TFP specification:

> …much of the PEG (2009a,b) analysis is not appropriate because it attempts to treat energy distribution as if it were a competitive industry. The PEG analysis does not recognise the increasing returns to scale nature of the industry and the presence of sunk costs which means the 'indexing logic' PEG uses is inappropriate. It is precisely because of these features that the industry is being regulated.
>
> Large parts of the PEG reports on Economic Insights (2009a,b) are thus based on assessing the Economic Insights framework and key conclusions using the PEG framework which does not take proper account of important economic characteristics of energy distribution businesses. If one were to accept the PEG competitive industry framework as a starting point this may give the impression that many of the criticisms that are raised have some credibility but this is based on assuming a framework that does not take explicit or adequate account of the underlying economic characteristics of the industry under consideration.
>
> Furthermore, even if the PEG framework were accepted there are numerous problems in its interpretation and implementation (although many of these problems are not considered specifically here). In particular, the PEG TFP framework assumes that all capital invested in electricity distribution businesses is not sunk, ie it is variable and can be readily bought and sold in a competitive market and switched to alternative uses. The PEG TFP framework also does not make any explicit allowance for the scope for prices to reflect monopoly or market power related mark ups, ie output prices are assumed to be competitive.
>
> It is well recognised by Economic Insights that a focus of the approach to regulation in New Zealand and in many other jurisdictions is to try to regulate natural monopoly industries to mimic the outcomes that would arise in a 'workably' competitive market. However, there is a big difference in assuming a framework that relies on assumptions that a competitive market exists, as PEG does, and developing a framework that takes account of relevant characteristics not consistent with a competitive market in order to provide guidance on appropriate regulatory decisions to help achieve conditions consistent with a competitive market outcome, which is what Economic Insights (2009a,b) does.[35]

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[35] Economic Insights (2009), *Electricity Distribution Productivity Analysis: 1996-2008*, p. 48.

The Commerce Commission initially appeared to accept these claims when it evaluated the "traditional" X factor formula. In the Draft Decisions Paper, the Commission wrote that "the traditional formula is underpinned by a number of assumptions that are not relevant to EDBs – notably that the relevant markets are perfectly competitive and that capital is perfectly fungible."[36] EI advanced the claim about capital fungibility in its earlier reports, but its new claim that the traditional approach to TFP estimation for regulated industries (ironically) assumes that these industries are competitive was presented for the first time in this proceeding in its September 2009 report.

My response demonstrated that these claims by EI are entirely without merit and categorically false. There is no need to reprise any of that analysis because EI has, literally, not disputed any of it. Instead, they wrote the following:

> Dr Kaufmann's confusion on what Economic Insights (2009b) was saying about the framework he advocates was likely influenced by inadequate wording in our earlier report. The point being made in Economic Insights (2009b) was that the traditional approach (and the one advocated by Dr Kaufmann) implicitly assumes that achievable TFP growth is the same for all firms. However, actual TFP growth in a natural monopoly industry is influenced by factors other than technical change. These mainly relate to the divergence of prices from marginal costs. While technical change may be relatively similar across DBs (or at least those with similar operating environments), the large differences in pricing structures adopted by DBs and the relative extent of unbilled functional outputs will mean that achievable TFP growth will be different across DBs. Because the framework advocated by Dr Kaufmann does not distinguish these factors, it effectively assumes that achievable TFP growth is the same across all DBs.[37]

This is a disingenuous response, since no one reading the September 2009 EI report could be confused by what they were saying. The section of the EI September 2009 report where it presented these arguments was titled "The Lack of Relevance of a TFP Framework Based on Assuming Competitive Conditions in Markets with Non–Competitive Conditions." Not surprisingly, EI then proceeds to argue that my TFP specification is not relevant because it assumes competitive market conditions exist in (regulated) markets with non-competitive conditions. This position is also clear in the

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[36] Commerce Commission, *Draft Decisions Paper: Initial Reset of the Default Price Quality Path for Electricity Distribution Businesses*, p. 79.

[37] Economic Insights (2009), p. 40.

summary of EI's opinion quoted at the outset of this section (*e.g.* "there is a big difference in assuming a framework that relies on assumptions that a competitive market exists, as PEG does, and developing a framework that takes account of relevant characteristics not consistent with a competitive market"). This is the most indefensible claim I have ever seen in ANZ (or anywhere else), so it is not surprising that EI has chosen not to defend it, but my October 2009 submission to the Commerce Commission (reproduced in my October 2009 submission to the AEMC) does explain how EI likely arrived at such an erroneous conclusion.

Moreover, EI's position in December 2009 directly contradicts what they said in September 2009. In the passage above, EI says that PEG's specification "implicitly assumes that achievable TFP growth is the same for all firms" and is equivalent to "technical change (which) may be relatively similar across DBs." However, the entire point of EI's September 2009 review is that PEG's TFP specification will *not* measure technical change because the assumptions necessary for conventional TFP growth to be equivalent to technical change are violated for regulated industries. This can be seen in EI's previous statement from September 2009:

> If there is marginal cost pricing, then $T^{*\prime}(t) = \tau(t)C(t)$; ie TFP growth is equal to technical change. This is just the dual expression of the usual Solow residual which is identified with technical change (an upward shift in the production function due to improving technology or equivalently, a downward shift in the cost function) and ***under the assumptions of competitive pricing and constant returns to scale, TFP growth is equal to technical change.*** However, if marginal cost pricing does not hold and there are not constant returns to scale, then conventionally defined TFP growth as defined by PEG (2009a) and PwC (2009) is not equal to technical change (pp. 58-59; bold in the original)

Regulated industries are not characterized by constant returns to scale or prices equal to marginal costs, so in September 2009 EI was *emphasizing* that PEG's measure is **not** equivalent to technical change. In fact, EI said outright that "conventionally defined TFP growth as defined by PEG…is not equal to technical change." Yet EI now claims that they really meant the opposite *i.e.* with PEG's TFP specification, TFP *is* equivalent to technical change and thus relatively similar across DBs. This is not "inadequate wording," but a complete inversion of EI's original position regarding PEG's TFP specification. It is clear where any "confusion" on these issues lies.

Moreover, EI is well aware that its statement that "the (TFP) framework advocated by Dr Kaufmann does not distinguish these factors" of increasing returns to scale and non-

marginal cost pricing on TFP growth is demonstrably untrue. In submissions to both the AEMC and the Commerce Commission, I have replicated PEG's earlier work in Victoria which showed that the 'conventional' TFP growth I recommend can be decomposed into a number of components, including the impact of scale economies and non-marginal cost pricing on TFP growth (as well technical change). My December 2004 report to the ESC also went beyond this theoretical decomposition and presented quantitative estimates of the impact of different factors on TFP growth for different Victorian DBs; the AEMC has referenced this work in its *Preliminary Findings* Report.

In addition, EI personnel have reviewed this decomposition formula as it applies to operating expenditures partial factor productivity (PFP) growth, which is equivalent in all respects to our TFP decomposition except that it includes an additional variable in the decomposition analysis.[38] At the time, EI personnel concluded that PEG's conventional measure of productivity growth

> (i)ncorporate(s) a range of factors including scale economies, capital interaction effects, the impact of changes in operating environment factors, technological change and changes in efficiency levels. No additional allowance, thus, needs to be made for any of these factors as they should be captured by the change in opex partial productivity. The PEG approach… can, thus, be seen to be well grounded in economic theory.[39]

EI personnel are clearly saying here that conventional productivity growth measures "incorporate a range of factors" beyond technological change and do **not** assume that TFP growth is the same for all companies (and equivalent to technical change). Concrete written and empirical evidence also proves that the conventional TFP growth measure can be decomposed into different components. EI's theoretical work simply takes a different approach to undertaking this TFP decomposition than PEG (which EI personnel once reviewed and found 'well grounded in economic theory'). Moreover, as I demonstrated in my submissions to the New Zealand Commerce Commission, EI's decomposition rests on a number of untenable assumptions. EI's approach and ability to distinguish the components of TFP growth is therefore not different in kind from PEG's, but it will be less accurate.

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[38] This variable is the impact of the capital stock on opex PFP growth, which would not be relevant in a TFP analysis which captures both opex and capital productivity.

A2.2 Capital Fungibility

EI has also asserted that PEG's TFP specification assumes that all utility capital is "fungible" or freely tradable and none of it is "sunk." Again, this is categorically untrue, and I have presented a detailed explanation that demonstrates why this is the case. EI has again not responded to any of that direct analysis but has, instead, simply re-asserted its points *ad hominem*. In the interests of clarity, I will reprise the crux of my analysis which was first presented in New Zealand in August 2009 and later included in my Submission to the AEMC.

EI motivates its approach by saying that ""(i)ntroducing sunk costs means that we can no longer use the standard Jorgenson (i.e. ex ante) user cost approach to measuring the annual cost of using capital or the total cost function in deriving parameters for optimal regulation. This is because sunk assets, by definition, cannot be freely traded in a second–hand market which is a key assumption of the standard user cost approach."[40] One of the papers they cite related to the 'standard user cost approach' is a well-known 1969 study by Christensen and Jorgensen entitled "The Measurement of U.S. Real Capital Input, 1929-1967." The first three paragraphs in the paper are replicated below:

> The measurement of social factor outlay in constant prices is not well established in social accounting practice. The chief problem is the measurement of capital input in real terms. A flow of capital services may be divided between price and quantity with price as the rental rate and quantity as the amount of capital service time utilized. Accounting problems arise from the fact that the supplier of the capital service and its ultimate user are typically within the same economic unit. An accounting imputation is required for separation of outlay on capital services or property compensation into price and quantity components.
>
> For property with an active rental market the price of capital services may be observed directly as the rental price for the use of a capital asset. The product of the rental price and the quantity of the asset used is the outlay on capital services or property compensation. This method for measuring capital services may be extended from rental property to property utilized by its owners if market rental values reflect the implicit rentals paid by owners for the use of their property. The main obstacle to application of this method of imputation is the paucity of data on market rental values.

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[39] Lawrence, D. (2007), *Victorian Gas Distribution Business Opex Rate of Change*, March 26 2007, p. 3; prepared for Envestra, Multinet and SPAusNet and submitted to the ESC Victoria.

[40] Economic Insights, *The Theory of Network Regulation in the Presence of Sunk Costs,* p. iv.

> An alternative method for separation of price and quantity components of outlay on capital services or property compensation is based on the correspondence between asset prices and service or rental prices implied by the equality between the value of an asset and the discounted value of its services. The service price depends on the asset price, the rate of return, the rate of replacement, and the tax structure. Given the quantity of assets held by each sector, the prices of the assets, rates of replacement, and data on the tax structure, the rate of return for all assets used in the sector may be determined from total property compensation. Combining the rate of return with other components of the service price, factor outlay on capital may be separated into price and quantity components.[41]

Readers should direct their attention to the difference between the second and third paragraphs above. In the second paragraph, Christensen and Jorgensen are discussing "market rental data" as a basis for estimating capital services. This is equivalent to the rentals that would be obtained if property was tradable and sold/rented on second hand markets. They note that this "method for measuring capital services may be extended from rental property" to the more standard case of "property utilized by its owners if market rental values reflect the implicit rentals paid by owners for the use of their property." However, this is often impractical, since "the main obstacle to application of this method of imputation is the paucity of data on market rental values." In most instances, therefore, Christensen and Jorgensen acknowledge that assets used in the economy are not traded freely and do not generate data on market rental rates.

In the third paragraph, the authors consider "an alternative method for separation of price and quantity components of outlay on capital services" when goods are not freely traded and market data on rentals do not exist. This alternative "is based on the correspondence between asset prices and service or rental prices implied by the equality between the value of an asset and the discounted value of its services. The service price depends on the asset price, the rate of return, the rate of replacement, and the tax structure...Combining the rate of return with other components of the service price, factor outlay on capital may be separated into price and quantity components." In the balance of the article, the authors go on to derive such a service price and use it to measure real

[41] Christensen, L. and D. Jorgensen (1969), "The Measurement of U.S. Real Capital Input, 1929-1967," *Review of Income and Wealth* 15, 293-320.

capital input for various sectors of the US economy, most of which have capital that is "sunk" to one extent or another. This service price is, in fact, a variant of the ex ante "Jorgensen" capital service price (in this case, the so-called "Christensen-Jorgensen" capital service price).

It is clear that Christensen and Jorgensen are drawing a *distinction* between two different options for measuring capital inputs and service prices. One uses direct, market-based rental rates that result from transactions when capital is freely tradable. The other is the ex ante cost of capital measure, which results from an imputation based on the discounted value of the capital services. The authors clearly state that these are *different* approaches towards estimating capital cost; the second option does **not** depend on, or otherwise assume, that assets are freely variable as in the first approach. All assertions by EI that standard TFP measures necessarily assume that all capital is freely tradable are flatly untrue.

It is also worth considering the implications of the EI position. There have been hundreds of TFP studies on utility and infrastructure industries with "sunk" capital for government, regulatory and academic applications. If EI is correct, every one of these TFP estimates is biased and unreliable, since all have used variants of the "standard" user cost approach. This is, literally, an extreme position, and any regulator should require very strong evidence that TFP methods that have been used for decades must be discarded for an approach the New Zealand Commerce Commission described as "new and untested" when EI proposed it there. Indeed, the Commerce Commission itself did not rely entirely on its advisor's approach and reject PEG's approach (as EI was recommending) but, instead, relied on both PEG's and EI's reported TFP trend results when setting the X factor.

A2.3 "Circularity"

In December 2009, EI raised a new theoretical concern about PEG's TFP specification. They now claim that my use of an ex-post approach to capital cost measurement may be 'circular.' EI says that "Dr. Kaufmann's approach runs the risk of being circular since costs are effectively set to reflect past revenues which then form the

basis for setting future revenues and so on."[42] Relatedly, EI says "(I)t should be noted that the approach to measuring the annual cost of capital that PEG (2009) adopt and which Kaufmann (2009) advocates departs from the traditional Jorgensonian formula referred to above."[43] While this is true, it is unclear why EI views this as necessarily problematic since it does not endorse the Jorgensen ex ante approach (because they falsely claim that it assumes all capital is freely tradable).

EI's concerns regarding the "circularity" of ex post capital measures are unfounded for at least two reasons. First, there is a temporal mismatch, since updated price controls are inherently forward looking and historical TFP trends are always based on the past. Under a TFP-based regulatory option, a company adopting a TFP-based approach would select an X factor that reflects the industry's historical TFP growth. That growth rate has already been calculated, and it will not be impacted in any way by whether or not a company has selected the TFP-based option. If the X factor is fixed, the TFP growth reflected in the forward-looking price controls will also therefore be fixed and reflect the industry's past observed TFP trends for the duration of the new controls. When the plan expires, the TFP trend would be updated to reflect the industry's new TFP trends. Simply updating a forward-looking formula to reflect new information on the past is not an example of a "circular" calculation.[44] [45]

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[42] Economic Insights (2009), *Total Factor Productivity Index Specification Issues*, p. 33.

[43] Economic Insights (2009), *Total Factor Productivity Index Specification Issues*, p. 41.

[44] This can perhaps be made clearer by considering a real world example that was previously put forward by EI in the 2007 Victoria Gas Access Arrangement Review (GAAR). EI personnel were recommending a growth rate for the forecast in gas distributors' opex partial factor productivity (PFP) growth. As part of the evidence to support their recommendation, they used cost projections provided by the Victorian gas distributors themselves. But these cost projections necessarily embody assumptions on the distributors' PFP growth over the relevant time frame. When you "solve" for the PFP growth reflected in the gas distributors' costs, all you have discovered is the PFP growth assumptions that were assumed at the outset. This process is inherently circular, since the conclusions about future PFP growth are driven entirely by *assumptions* about future PFP growth and are therefore entirely subjective. The PFP calculation therefore provides no objective information about the reasonableness of the assumptions, but only uncovers those assumptions. The approach recommended by EI personnel was rejected by the ESC and subsequently by an independent Appeal Panel, both of which accepted my recommended opex adjustment formula.

Compare this with a company that estimates its historical opex PFP growth and uses this as a forecast for its future PFP growth. If these forecasts are built into opex cost projections, the calculation does not become "circular," but it does assume that past PFP gains will persist in the future. This may or may not be reasonable for all companies, but it is an objective and verifiable source of information.

[45] Even with a "rolling X factor," this logic applies, although the lag between the past and the future updates is clearly reduced.

Second, TFP growth would be calculated for the industry but would be applied for an individual utility. As long as that utility has no ability or incentive to manipulate the industry's reported TFP trend, circularity is impossible. The industry TFP trend is entirely external to the Company, so there cannot be any circularity between the costs used to calculate the (industry) TFP trend and the application of that TFP trend for setting the rates of the individual company selecting the TFP-based option.

It should also be noted that there is considerable support for my recommended approach in the academic literature and regulatory applications. EI says that one of the problems with the ex ante or "Jorgensen" cost of capital is its volatility. This issue was analyzed in a well-known economic study, and the authors found that there was indeed considerable volatility in the ex ante cost of capital models they investigated. [46] They also assessed three alternative models that used ex post capital cost measures and found that, compared to the ex ante measures, the ex post models had a number of desirable properties, including generating less volatility in capital service prices.

Ex post capital cost measures have also been used in TFP studies by respected government agencies and approved by leading regulators. For example, the US Bureau of Labor Statistics uses ex-post capital costs when developing TFP estimates. In one of the most meticulous and consequential X factor reviews ever (in terms of regulated revenue at stake), the US Federal Communications Commission (FCC) adopted an ex-post approach to capital cost measurement that was proposed by AT&T. The FCC found that "AT&T's residual earnings (i.e. ex post) method is a more accurate estimate of the contribution of capital to the production of output than the US Telephone Association's (ex ante) method of measuring rate of return, because AT&T's method measures the actual flow of funds to capital. In other words, the residual earnings method reflects actual payments to capital. We have decided to use AT&T's approach in our analysis of the record…"[47] This decision was especially significant since, up to that point, the FCC had reviewed and approved ex ante capital measures in TFP studies used to set X factors.

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[46] Harper, M., D. Berndt and D. Wood (1989), "Rates of Return and Capital Aggregation Using Alternative Rental Prices," in *Technology and Capital Formation* edited by D. Jorgensen and R. Landau, MIT Press, Cambridge MA.

[47] FCC (1997), *Price Cap Performance Review for the LECs,* CC Docket 94-1, FCC 97-159, p. 38.