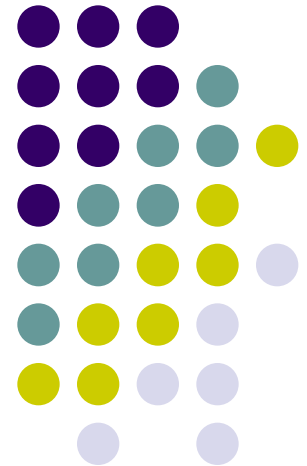


Empirical Analysis

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Toronto, Ontario
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Pacific Economics Group, LLC
Economic and Litigation Consulting

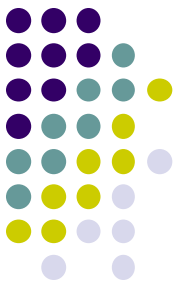


Introduction

Benchmarking under the Board's renewed regulatory framework (RRF)

- Building on current approach with further empirical work on the electricity distribution sector, including total cost benchmarking; an Ontario TFP study; and input price trend research
- Empirical work will inform rate-adjustment mechanisms under 4th Gen IR and the Annual IR Index, and may inform review of Custom IR applications
- Benchmarking will continue to be used to assess distributor performance and publication will inform the public and facilitate comparisons



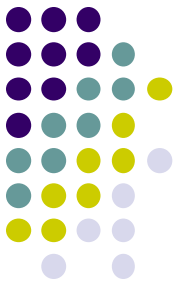


Introduction (Con't)

Pacific Economics Group (PEG) is, amongst other things, providing expert advice to Board Staff on the development and implementation of benchmarking models, including the calibration of the key parameters of rate adjustment formulas, including:

- Designing a more Ontario-specific inflation factor
- Resetting the productivity factor (the main effort is to estimate a long-run Ontario total factor productivity (TFP) trend)
- Developing and implementing total cost benchmarking models





Introduction (Con't)

In December 2012, PEG wrote a concept paper addressing our forthcoming empirical analysis

This presentation reviews the main issues discussed in the Concept Paper



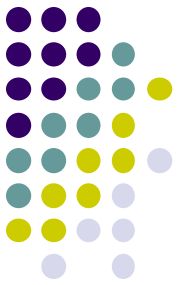
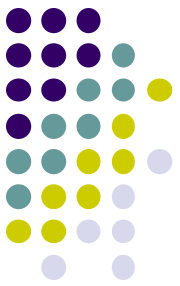


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Review of 3rd Gen IR

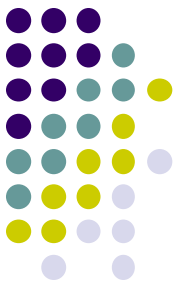
The rate adjustment formula in 3rd Gen IR had three main components:

1. An inflation factor
2. An X factor equal to:
 - a. An industry-wide productivity factor
 - b. A company-specific productivity stretch factor

Inflation factor: GDP-IPI

>>> measure of input price inflation for industry considered but rejected, in part because of concerns over volatility in measured inflation





Review of 3rd Gen IR (Con't)

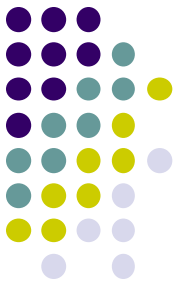
X-Factor: Industry-wide productivity factor

- US electricity distribution industry used as proxy for Ontario
- US distributors' average TFP growth 1988-2006 = 0.72% was Board's approved productivity factor

X-Factor: Company-specific productivity stretch factor

- Three efficiency cohorts, based on two benchmarking studies of OM&A cost
 - Statistically superior on econometrics and top third unit cost
>> stretch factor = 0.2%
 - Statistically inferior on econometrics and bottom third unit cost
>> stretch factor = 0.6%
 - All others
>> stretch factor = 0.4%





Review of 3rd Gen IR (Con't)

PEG's 3rd Gen IR productivity factor and stretch factor recommendations constrained by lack of Ontario-specific data (especially historical capital data)





Data Sources for Empirical Analysis

Ontario-specific data posted on the Board's website by Board staff

- Main data source: RRR filings 2002-2011

To obtain longer time series, Board staff has also posted:

- Ontario MUDBANK data on capital 1989-1998
- Data on low voltage charges paid by some distributors to Hydro One

Board staff working on gathering for posting:

- Pre-2002 data on Hydro One's distribution system
- Smart meter capital additions data





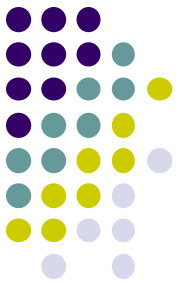
The Inflation Factor

The Board will adopt a more industry-specific inflation factor for 4th Gen IR and the Annual IR Index to better reflect the inflation in input prices experienced by electricity distributors

Inflation is a weighted average in input price *subindexes*:

$$\begin{aligned} \text{e.g. inflation} = & 0.20 \times \text{growth PLabor} + \\ & 0.20 \times \text{growth POther O\&M} + \\ & 0.60 \times \text{growth Pcapital} \end{aligned}$$





The Inflation Factor (Con't)

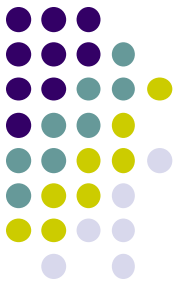
Board criteria for the inflation factor:

- to use data that is readily available from public and objective sources
- inflation in labour prices to be indexed by an appropriate generic and off-the-shelf labour price index
- to the extent practicable, inflation in non-labour prices should be indexed by Ontario distribution industry-specific indices

Issues for Working Group:

- What are the best choices for the subindexes?
- Because of concerns with volatility in industry-specific inflation factors in 3rd Gen IR, options to mitigate volatility will be explored (e.g., measured inflation factor could be a three-year moving average of overall input price index)





The Productivity Factor

Total Factor Productivity (TFP) Basics

TFP = Output Quantity/Input Quantity

TFP Growth = Changes in Output Quantity minus Changes in Input Quantity

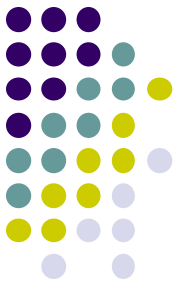
Two approaches

- Output quantity and input quantity often measured with indexing methods

Index-based TFP estimates also develop estimates of industry input price measures

- TFP can also be estimated econometrically





The Productivity Factor (Con't)

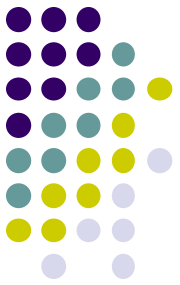
Basics (Con't)

Indexing methods compute measures of comprehensive *output quantities* (Y) and *input quantities* (X)

Change in TFP (Δ TFP) is then computed as

$$\Delta\text{TFP} = \Delta Y - \Delta X$$





The Productivity Factor (Con't)

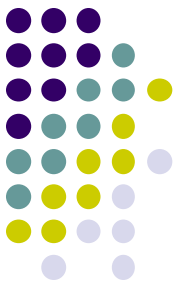
Output quantity is a weighted average of:

- Customer numbers
- kWh deliveries
- kW demand

Revenue shares should theoretically be used to weight output quantity subindexes but are not available in Ontario

Cost elasticity shares are a feasible alternative for output weights and were also used in 3rd Gen IR





The Productivity Factor (Con't)

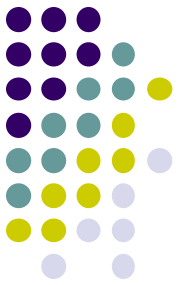
Input quantity is a weighted average of:

- OM&A inputs
- Capital inputs

Changes in OM&A input quantity can be measured as changes in OM&A expenditure minus the change in the OM&A input price subindex

>> input price indices constructed at same time as TFP indexes





The Productivity Factor (Con't)

Capital input quantity begins with a “benchmark” capital year

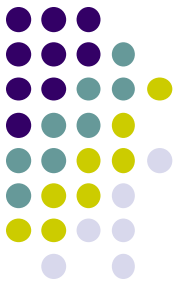
- Should be as distant from present as possible
- Rationale for use of MUDBANK data

Perpetual inventory equation used to update capital quantity index

$$XK_t = (1-d) \cdot XK_t + \frac{VI_t}{WKA_t}$$

Where XK_t = Capital quantity in year t





The Productivity Factor (Con't)

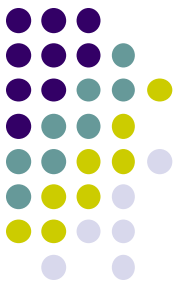
Measuring capital input quantity requires:

- A benchmark capital year
- Measures of capital additions VI_t in each year
- A measure of the economic depreciation rate d
- An index of distributor plant asset prices WKA_t
>>> Also used for input price index

Issue for Working Group:

- Appropriate values for economic depreciation rate and distribution plant asset price index will be examined





The Productivity Factor (Con't)

Also must develop estimates of total capital costs, equal to product of capital input quantity and capital service price index

$$CK_t = WKS_t \cdot XK_{t-1}$$

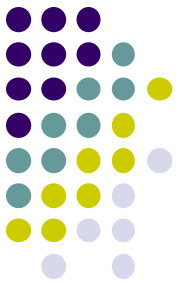
$$WKS_t = r_t WKA_{t-1} + d \cdot WKA_t - (WKA_t - WKA_{t-1})$$

Where r_t is a measure of the rate of return on capital assets

Issue for Working Group:

- Appropriate values for rate of return will be examined





The Productivity Factor (Con't)

Index-based approaches to TFP measurement

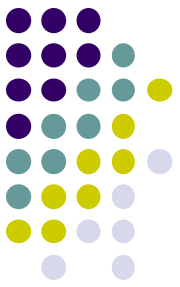
Pros

- Relatively simple
- Requires less cross sectional data
- Relies on well established techniques
- Relatively well understood and transparent

Cons

- Will not necessarily yield reliable estimates of future TFP trends if
 - Business conditions in future differ from the past
 - Requires relatively extensive time series data, usually at least 10 years
- >>> Board used 18-year trend in 3rd Gen IR





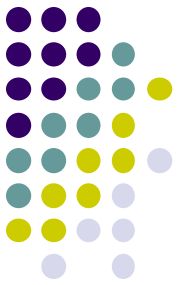
The Productivity Factor (Con't)

Econometric techniques can also be used to decompose TFP growth into its various components

- Time trend/technological change
- Realization of economies of scale
- Changes in business conditions
- Changes in customer density
- Changes in undergrounding

Estimated impact of various “TFP drivers” can be used to project TFP growth going forward given estimates of expected changes in business conditions





The Productivity Factor (Con't)

Econometric approaches to TFP measurement

Pros

- Can reflect diversity in distributor business conditions
- Can capture differences in future business conditions compared with past
- Does not require as extensive time series data

Cons

- More complex
 - More cross sectional data typically required
 - Techniques and results less well understood
- >>> however, we will be doing econometrics anyway for benchmarking analyses used for stretch factors

Issue for Working Group:

- Merits of econometric estimates of TFP growth will be examined





Total Cost Benchmarking

PEG will develop two total cost benchmarking models

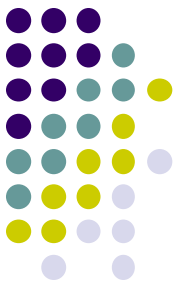
- Econometric
- Unit cost

In both cases, PEG will update benchmarking models previously developed, and applied in 3 Gen IR, but will include capital as well as OM&A costs in analyses

>>> Capital costs to be added will be identical to those developed and used in our estimates of TFP trends for Ontario electricity distributors

Stretch factor assignments under 4th Gen IR to continue to be based on assessments from the two benchmarking models





Total Cost Benchmarking (Con't)

Econometric benchmarking to be based on statistical relationship between a distributor's total costs and:

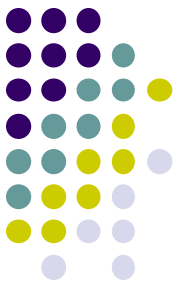
- outputs
- input prices
- other business condition variables beyond company control

Will estimate econometric model, generate expected cost predictions and confidence intervals for each distributor's specific conditions, then compare these to each distributor's total costs

Issue for Working Group:

- Choices of business condition variables will be examined
>>> discuss current variables and explore potential new





Total Cost Benchmarking (Con't)

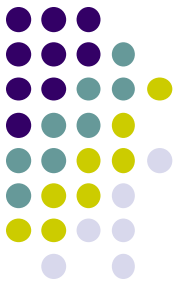
Unit cost benchmarking to be based on a comparison of each distributor's unit cost (*i.e.* its total distribution cost divided by an index of output quantity) and the average unit cost of distributors in its designated peer group

- Currently there are eleven peer groups, plus Hydro One (which has no Ontario peers)

Issues for Working Group:

- Potential modifications of the peer groups
- Whether other performance measures provided under the RRF should be examined when establishing stretch factor values





Next Steps for PEG

Finalize dataset

>>> final dataset will be as transparent and 'user friendly' as possible, released at same time as our empirical analysis

Begin Working Group meetings

Incorporate stakeholder input into our analysis

Release final report in April 2013

