Productivity Analysis of Electricity Distribution

Commerce Commission Workshop

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Workshop Outline

- Background
  - Where productivity measures fit within EDB regulation
  - What is TFP and partial productivity?
  - How do we measure productivity?
  - Previous productivity studies
- Output specification issues
  - Functional vs billed outputs
  - Proposed approaches
- *Morning tea*
- Input specification issues
  - Opex
  - Capital
  - Proposed approaches

BACKGROUND

Regulatory background

- NZ EDB regulation has moved from being purely productivity-based regime under the former thresholds regime to a high level building blocks approach for non-exempt EDBs
- Under building blocks, annual price caps are set to equate the present value of forecast costs with the present value of forecast revenue for each regulated EDB
- 17 out of the 29 NZ EDBs are currently non-exempt and subject to a default price-quality path under Part 4 of the Commerce Act
- Commerce Commission will reset the default price path for the non-exempt EDBs effective from 1 April 2015

Regulatory background (2)

- Reset will involve specifying maximum starting prices for each regulated EDB and a common ‘rate of change’ of those prices across all regulated EDBs
- Starting prices will be set to equate present value of forecast costs with present value of forecast revenue for each non–exempt EDB, subject to a common rate of change
- Rate of change must be based on the long–run average productivity improvement rate achieved by either or both of EDBs in New Zealand, and suppliers in other comparable countries, using appropriate productivity measures

Regulatory background (3)

- If starting prices are based on the current and projected profitability of each supplier, the rate of change will not affect the amount of revenue the individual EDB can expect to recover over the regulatory period.
- This is because starting prices for each regulated EDB would simply be adjusted to offset any alteration to the common rate of change to maintain the equality between the present value of expected revenues and the present value of expected costs for that EDB over the regulatory period.
- This means the regulatory outcome for each EDB is not affected by the measured long–run average productivity improvement rate used to set the rate of change of prices

Regulatory background (4)

- But the forecast partial opex and capital productivities can impact the level of forecast costs and therefore the present value of allowable revenue over the regulatory period for each EDB.
- In the case of opex, forecast opex is set using the following:
-

$$\text{operating expenditure}_t = \text{operating expenditure}_{t-1} \times$$

$$(1 + \Delta \text{ due to network scale effects}$$

$$- \Delta \text{ operating expenditure partial productivity}$$

$$+ \Delta \text{ input prices})$$

Total factor productivity

- TFP is the ratio of the quantity of total output produced to the quantity of total inputs used
- TFP growth between two periods is given by:

  $$\text{TFP Growth} = (Q_2/X_2)/(Q_1/X_1) = (Q_2/Q_1) / (X_2/X_1)$$

  where Q is total output, X is total input and 1,2 are years
- How do we form measures of total output and input quantities?
- We use index number methods which aggregate diverse output quantities (weighted by revenue or output cost shares) and input quantities (weighted by cost shares) into indexes
- A simple way of viewing TFP growth is as the ratio of the weighted average change in output quantities to the weighted average change in input quantities
- Requires values and quantities for all outputs and inputs

Partial productivity

- Partial productivity growth is the ratio of the weighted average change in output quantities to the change in the quantity of a particular input
- The key partial productivities in this instance are opex partial productivity and capital partial productivity

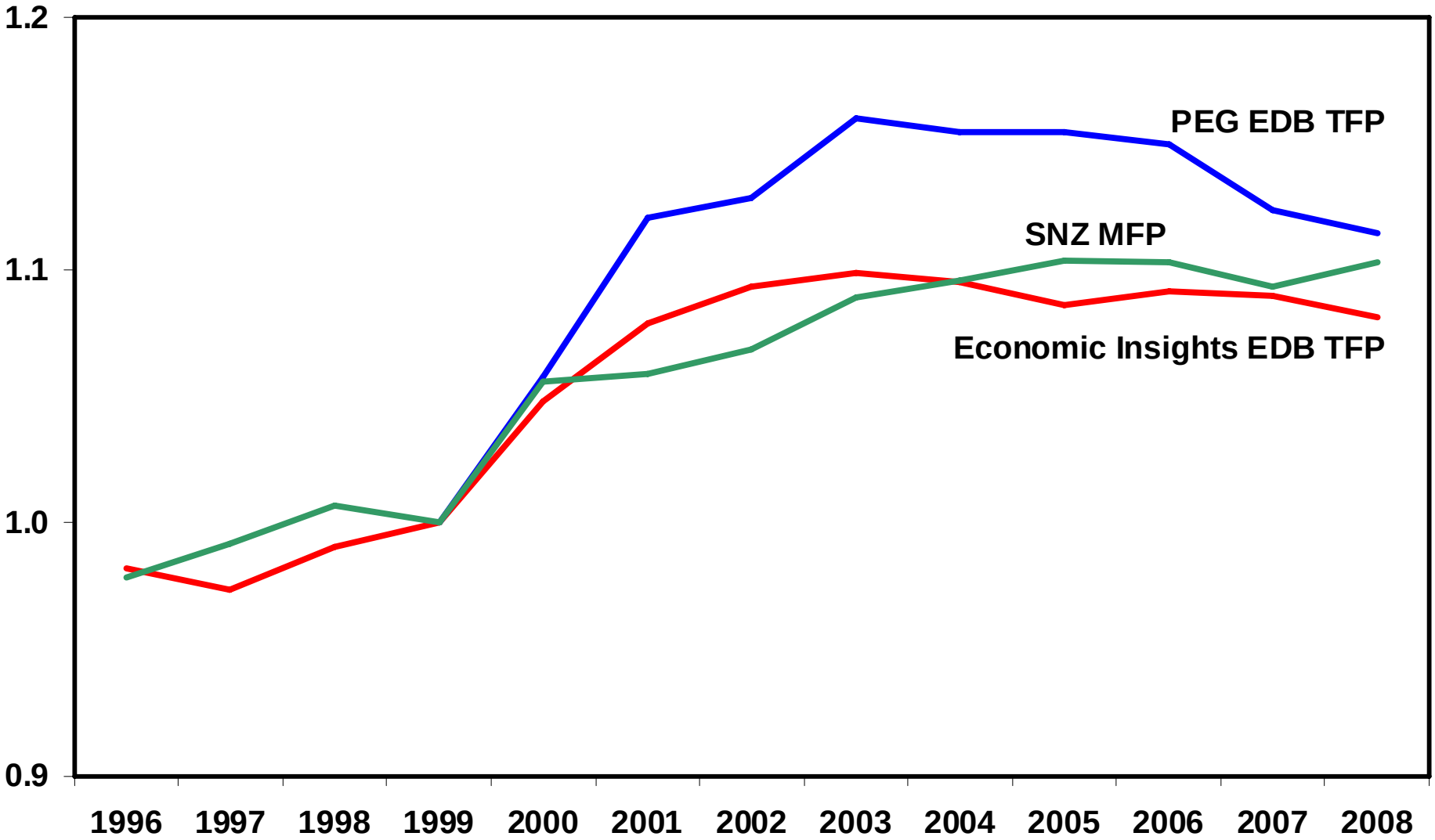
Key issues:

- How do we measure EDB outputs?
  - Is it what the EDB charges for or is it what it is expected to provide?
- How do we measure EDB inputs?
  - Main issue is how we measure the quantity of annual capital input?

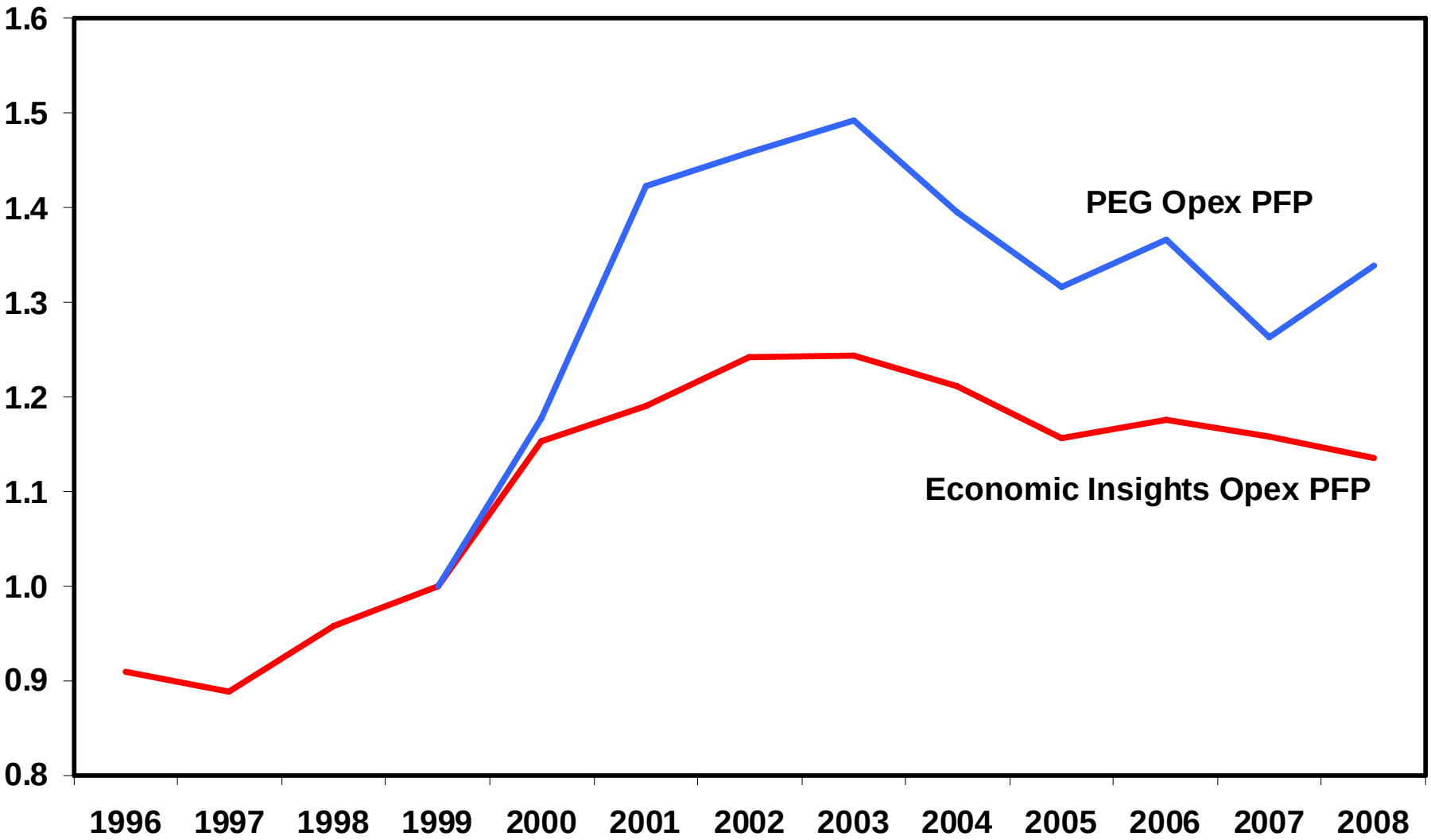
Previous productivity studies

- Recent resets of the default price path have been based on the results of studies undertaken in 2009 by Economic Insights (for the Commission) and Pacific Economics Group (for the ENA)
- Despite using different approaches and specifications both studies produced similar electricity distribution industry productivity results
- Economic Insights found an annual TFP growth rate of just over 1 per cent for the 13 years to 2008, around the same as for the economy as a whole over the same period
- PEG found an annual TFP growth rate of 1.2 per cent for the 10 years to 2008
- Based on these findings the Commission set an X factor of 0 per cent (leading to a rate of change of CPI-0 per cent)
- 0 per cent also assumed for opex partial productivity growth

Previous productivity studies (2)



Previous productivity studies (3)



Economic Insights (2009) EDB TFP specification

3 outputs:

- throughput in GWh
- customer numbers
- system capacity based on MVA*kms

Outputs were output cost share weighted

4 inputs

- opex
- overhead lines in MVA–kms
- underground lines in MVA–kms
- transformers in KVA and other capital

Inputs weights formed using exogenous capital cost

PEG (2009) EDB TFP specification

3 outputs:

- customer numbers
- throughput in GWh
- peak demand as measured by the non–coincident peak in GW

Outputs were revenue share weighted

2 inputs:

- opex
- capital (measured by constant price depreciated asset value)

Inputs weights formed using endogenous capital cost

OUTPUTS

Output coverage

- Outputs in a TFP study should cover the main things the EDB produces which are valued by customers
- In a competitive market the prices charged by a firm will reflect its costs of producing key dimensions valued by customers
- This makes it easy to identify and measure a firm's output
- But in a natural monopoly there may be a divergence between what firms charge for, what their main cost drivers are and what their customers (and regulators) value
- This makes it harder both to identify and to measure a network business's outputs that should be included in TFP measures

Billed vs functional outputs (1)

- Billed outputs are those items an EDB actually charges customers for
- EDB charging practices have typically evolved on an ease of implementation basis rather than on a network cost-reflective basis
- High proportion of charges are often on energy throughput but throughput is a minor driver of EDB costs
- Dimensions that customers value such as availability of supply, reliability, speedy restoration after any interruption are not explicitly charged for but may be significant cost drivers
- Functional outputs are all those services EDBs provide to customers which are valued by customers (of which billed outputs are a subset)

Billed vs functional outputs (2)

- Under building blocks the revenue requirement is set based on the EDB being expected to meet a range of performance standards and other deliverables
- Prices then have to be consistent with broad regulatory pricing principles
- In the case of building blocks, it will be important to measure output in a way that is broadly consistent with the output dimensions implicit in the setting of EDB revenue requirements
- These output dimensions may be different to the outputs the EDB charges its customers for
- Points to functional rather than billed outputs specification in building blocks but sensitivity analysis is important

Billed outputs

- Energy delivered
  - Bulk of charges but little impact on costs
  - Proxy for load?
  - Road analogy
- Customer numbers
  - Proxy for fixed output components
  - Need to disaggregate?
- Demand-based outputs
  - Industrial customers usually charged on basis of actual peak demand or reserved capacity
  - Data available but not easily aggregated
  - System proxies problematic

Other functional outputs

- System capacity
  - Captures capacity to deliver (road analogy)
  - Line capacity or line and transformer capacity?
  - How can DSM and embedded generation be allowed for?
- Peak demand
  - Important cost driver but customers see reliability at peak as relevant output
  - Volatility and incentive effects
- Reliability
  - Important to customers
  - Some practical issues to be resolved
  - Should other aspects of service quality be included?

What we plan to look at

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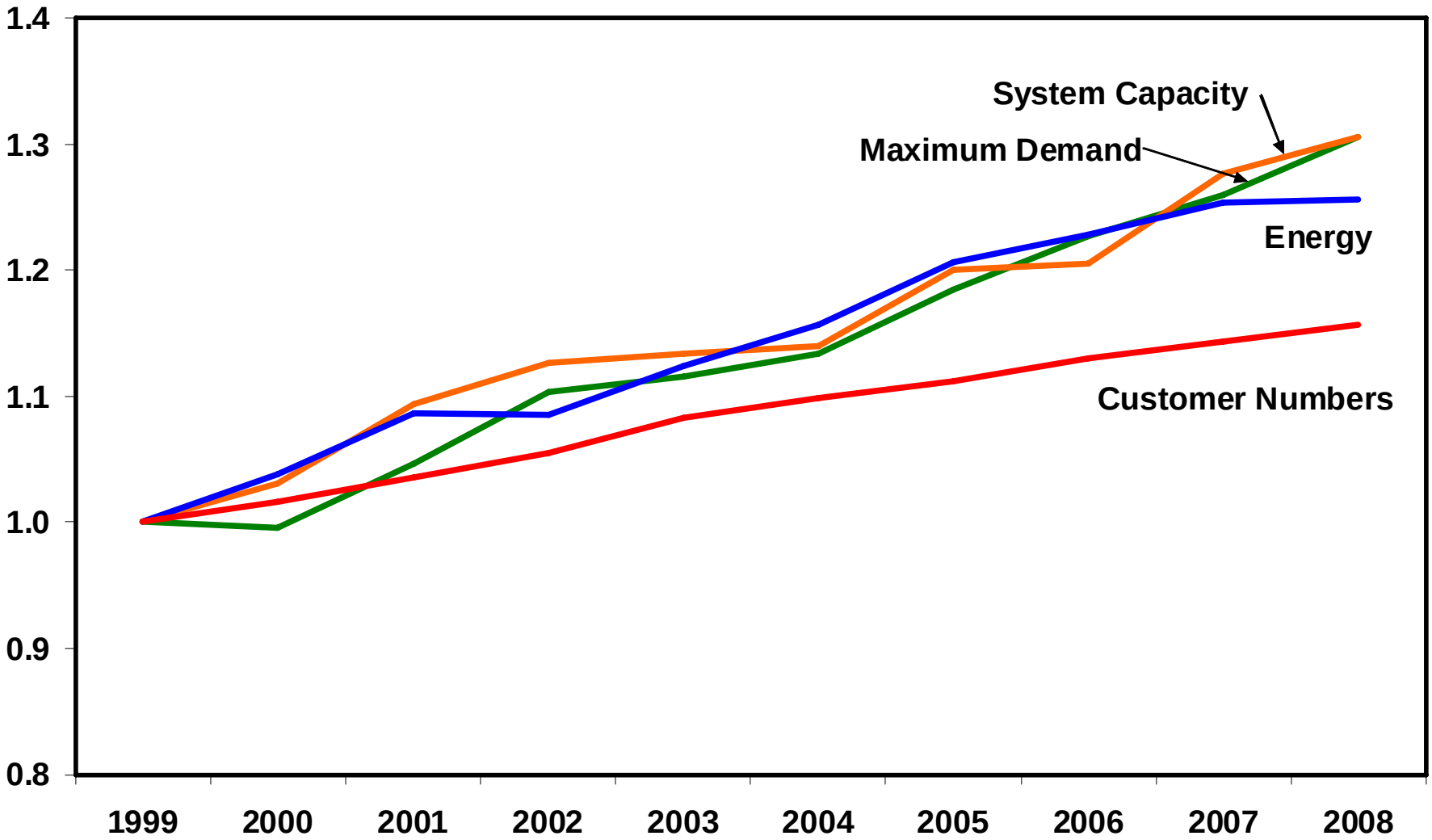
1) Functional Outputs

Quantity	Value	Price
Customers (No)	Revenue * Cost share	Value / Customers
Capacity (kVA*kms)	Revenue * Cost share	Value / kVA*kms
Throughput (GWh)	Revenue * Cost share	Value / GWh

2) Billed outputs

Quantity	Value	Price
Customers (No)	Revenue	Value / Customers
Max demand (MW)	Revenue	Value / MVA
Throughput (GWh)	Revenue	Value / GWh

Output quantities from 2009 studies



Issues for discussion

- Availability of information on billed output quantities and revenues and ability to aggregate into a usable form
- Is system maximum demand a reasonable proxy for the sum of maximum demands for customers that are charged on that basis?
- Have revenue shares changed significantly in the past decade?
- Should system capacity take account of both transformer and line/cable capacity?
- Is it reasonable to include throughput as an EDB output?
- Should reliability be included? If so, how?
- Other questions/issues?

INPUTS

Different types of inputs

- Opex (labour, materials and services) and capital (lines, cables and transformers)
- Different treatment of these inputs required in productivity studies
- Obtaining price and quantity of non-durable opex inputs is relatively straightforward
- But obtaining accurate annual cost and annual input quantity of durable capital inputs is more challenging
- Capital service flow is the quantity of capital inputs' contribution to production each year
- Annual user cost is cost of using capital inputs each year

Opex coverage

- Separate data on labour, materials and services generally not available
- Given extent of contracting out, generally use aggregate opex
- Diverse composition requires deflating opex by a price index to derive the quantity of opex inputs indirectly
- Need uniform treatment of asset refurbishment and allocation of corporate overheads
- Have previously used scaled up Direct line costs per kilometre and Indirect line costs per customer to ensure only current nondurable input use is included
- Propose to roll this forward using change in opex from new IDD after 2008

Opex price index

- Around 60% of opex is typically made up of labour costs
- Remainder covers operational, office and professional services and consumables
- EDB-specific price indexes generally not available
- Use SNZ economy-wide or broad EGWW sectoral price indexes instead
- Use Labour price index for labour price (and price for all of opex in previous studies)
- Could use Producer price index for non-labour component of opex

Opex specification

Quantity	Cost	Price
Nominal opex / Weighted average price index	Opex (scaled up from Direct and Indirect costs and rolled forward using total opex after 2008)	Weighted average of an SNZ labour price index producer price index

Advantages

- Uses readily available data
- Unlikely to be any practical alternatives

Limitations

- Dependent on changes in SNZ price indexes accurately reflecting changes in opex prices faced by all EDBs
- Assumes all EDBs face the same levels of opex component prices
- Assumes the same range of opex coverage and functions for all EDBs

Capital input quantities

- Capital service flow is not directly observable – have to use proxy measures instead
- No proxy measure will be perfect – all have pros and cons
- Best proxy measure will depend on:
  - Physical depreciation profile of constituent assets
  - Robustness of the data used to form the proxy – the more accurate the better and the fewer assumptions that have to be made, the better

Physical depreciation profiles

- Important to distinguish between physical and financial regulatory depreciation
- Asset physical 'carrying capacities' can have one of four different physical depreciation profiles:
  - one hoss shay (no reduction in carrying capacity throughout the asset's life)
  - hyperbolic (small decline in early years, larger decline in later years of the asset's life)
  - straight–line (ie equal absolute reduction each year of the asset's life), or
  - geometric (equal percentage decline over lifetime, ie bigger absolute falls in early years and smaller absolute falls in later years)

EDB asset physical depreciation

- EDB assets subject to little physical deterioration over their lifetime provided they are properly maintained
- Failure rates may be higher towards the end of asset life leading to Weibull distribution of asset ages
- But service flow relatively constant over the asset's life meaning one hoss shay depreciation is closest
- Can approximate service flow under one hoss shay by using physical measures (eg MVA-kms) or gross capital stock in constant prices
- Using constant price depreciated asset value proxies assumes depreciation profile other than one hoss shay
- If the decay of the asset over time is overestimated by the proxy then productivity growth will also be overestimated

Annual user cost of capital

- Annual user cost of capital consists of:
  - depreciation
  - plus opportunity cost
  - minus capital gains
- Equivalent building block concepts are return of capital (depreciation less inflation allowance) and the return on capital (opportunity cost)
- Building blocks also implicitly includes concept of ex-ante financial capital maintenance based on RAB and WACC
- Preferable to have (approximate) consistency between the ways annual capital costs are calculated in building blocks and productivity measurement

Alternative capital specifications (1)

Physical proxies

Quantity	Annual user cost	Price
O/H MVA-kms	Return of & on O/H capital	O/H AUC/MVA-kms
U/G MVA-kms	Return of & on U/G capital	U/G AUC/MVA-kms
Transformers & other KVA	Return of & on Trf & other capital	Trf & other AUC/KVA

Advantages

- Reflects individual component carrying capacities
- Uses the most robust data available and captures actual asset lives
- Approximates productive capital stock used by leading statistical agencies for aggregate structures
- Ensures broad consistency with building blocks calculations

Limitations

- Small amount of extra data required

Alternative capital specifications (2)

Depreciated asset value proxy

Quantity	Annual user cost	Price
Constant price depreciated asset value	Revenue minus opex	AUC/Const price depreciated RAB

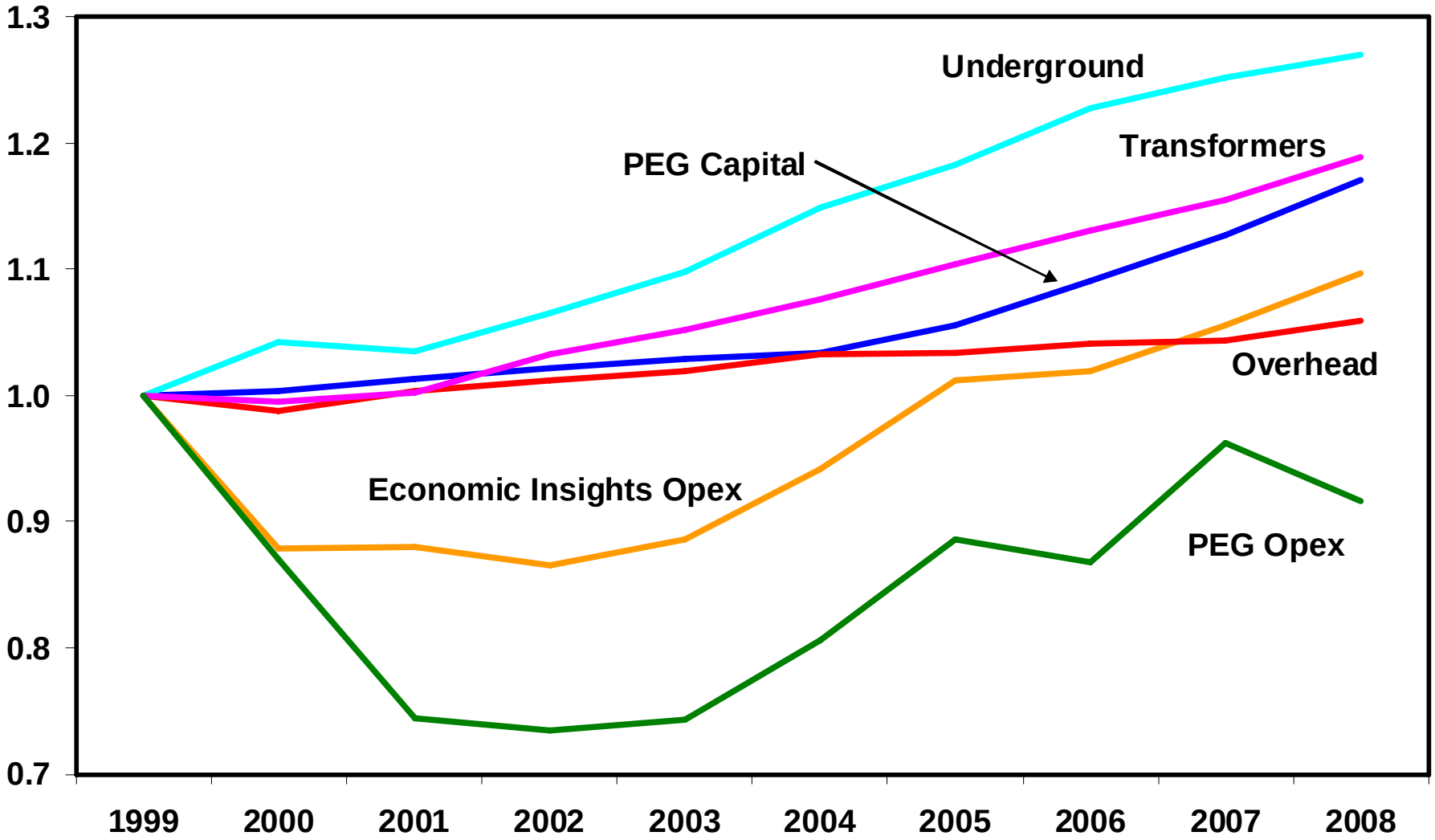
Advantages

- Easy to implement
- Uses existing regulatory data

Limitations

- Unlikely to reflect carrying capacities of assets
- Dependent on accuracy and consistency of initial capital base values
- Assumes consistency of RAB treatment over time and across EDBs
- May not capture actual asset lives
- Dependent on SNZ CGPI accurately capturing prices paid by EDBs
- Unlikely to be consistent with financial capital maintenance

Input quantities from 2009 studies



Issues for discussion

- Is scaling up Direct and Indirect costs from the old IDD and rolling forward using total opex from new IDD the best way to form the measure of annual nondurable input use?
- How representative are the high level price indexes of the price changes EDBs actually face?
- Which profile most accurately reflects the depreciation of EDB physical capital ‘carrying capacity’?
- Which data source – financial or physical – gives the most robust reflection of EDB capital annual input quantities?
- How important is it for the capital weight used to reflect the true cost of capital rather than the realised cost?
- Other questions/issues?