Statistical Cost Research for HQT

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Introduction

The *Régie de l'énergie* has commissioned transmission ("Tx") productivity and benchmarking studies to use in Hydro-Québec Transmission's *formule d'indexation.*

The Brattle and PEG studies have markedly different results and methodological issues have emerged

This presentation

- provides an overview of the issues
- responds to controversial statements Brattle made in their November 29 reply comments

Plan of Presentation

Basic Principles of X Factor Research

Cost Exclusions

Sample

Benchmark Year

Benchmarking Issues

    Econometric Benchmarking

    Peak Demand

X Factor and Stretch Factor Recommendations

HQT Proposal to Suspend *MRI*

Basic Principles of X Factor Research

Negative Productivity Growth

Cost is a function of input prices, operating scale, other business conditions, and inefficiency.

Productivity indexes track the trend in cost that isn't due to input prices or operating scale

They therefore track the cost impact of changes in other business conditions as well as the change in inefficiency

Productivity growth can be negative due to external business conditions

Basic Principles of X Factor Research

Various established methods can be used in productivity research

In an X factor study, methods should be relevant to the design of a revenue cap index between *demandes tarifaires*

- Exclude costs that won't be addressed by the revenue cap index (e.g., pensions and benefits)
- Capital cost specifications should be sensitive to capex surges
- Use size-weighted averages of productivity trends when setting the X factor for a large company
- Productivity challenges facing sampled companies should be similar on balance to those that HQT will face in the next few years

An alternative paradigm, favored by some utility witnesses and accepted in Massachusetts, is that study should measure the true industry productivity trend

Cost Exclusions

PEG excluded 3 categories of power transmission *CNE* from the productivity and benchmarking research

FERC Accounts	**Name**
561.1-561.8	Dispatching etc.
565	Transmission of Electricity by Others
566	Miscellaneous Transmission Expenses

Rationale: Reported costs in these categories are sensitive to changes in structure of U.S. markets for power and transmission services which have little relevance to HQT's X factor and S factor

Cost Exclusions (cont'd)

Structural Change in U.S. Power Industry

U.S. electric utilities increasingly obtain power from resources that are not on their TX system and sell power off system

Not a matter of "make vs. buy" since transmission service territories are fixed

Many utilities have joined independent system operators ("ISOs")

- Utilities charge ISO for the use of their systems
- Utilities also take their transmission service from ISO
- ISO charges to utilities include costs of
  - ISO
  - Other Tx utilities
  - Utility's own Tx operations

Cost Exclusions (cont'd)

Why these exclusions matter

		Share of Tx *CNE*		Average Annual Growth Rate	
		Brattle	**PEG**	**Brattle**	**PEG**
Dispatching etc.	[a]	10.7%	15.5%	10.0%	
Tx by Others	[b]	34.9%	25.0%	11.3%	
Miscellaneous Tx	[c]	17.2%	15.4%	13.1%	
	[a+b+c]	62.8%	55.9%		8.32%
All other Tx *CNE*		37.2%	44.1%	5.1%	3.56%
All Tx *CNE*		100%	100%		

Tx by others is biggest problem by far

Including it in a Tx cost benchmarking study is akin to including purchased power in a generation benchmarking study

Hydro One witness Clearspring excludes Tx by Others from their study

Cost Exclusions (cont'd)

Utilities seem to have shifted ISO costs from one category to another idiosyncratically

e.g., from Tx by others expenses to miscellaneous Tx expenses or dispatch-related expenses

FERC directed transmitters to report some ISO costs as dispatch-related expenses starting in 2006

e.g., 561.4 Scheduling, System Control, and Dispatching;

561.8 Reliability Planning and Standards Development

Peak Load Variable

To Ratchet or Not to Ratchet

Transmission systems are designed to serve unusually high load

Actual loads reported on FERC Form 1 are rarely unusually high

Ratcheted peak is good proxy for unusually high load

Benchmark Year

Calculation of capital quantity begins in "benchmark year" by converting gross or net plant value to a capital quantity

Brattle's one hoss shay approach uses *gross* plant value

$$\textit{Gross Plant Value} = \textit{SUM Undepreciated Value of Additions}_{t\text{-}s}$$
$$= \textit{SUM Quantity Additions}_{t\text{-}s} \times \textit{Price}_{t\text{-}s}$$

Assuming equal quantity of additions [*A*] each year for *N* past years

$$\textit{Gross Plant Value} = \textit{SUM } A \times \textit{Price}_{t\text{-}s}$$
$$= A \times \textit{SUM Price}_{t}$$
$$= N \times [A \times \textit{SUM Price}_{t}]/N$$

$$\textit{Initial Capital Quantity}_{t} = N \times A = \textit{Gross Plant Value}_{t} \,/\, (\textit{SUM Price}_{t})/N$$
$$= \textit{Gross Plant Value}_{t} \,/\, \textit{simple price average}$$

Brattle doesn't use simple (arithmetic) average

Sample

PEG's sample is similar to that of Hydro One witness Clearspring

Expanding sample not a PEG research priority in Québec proceeding

- Doesn't usually matter much to results
- Regulators typically don't care much

PEG stands by exclusion of Pacific Gas and Electric due to recent severe wildfires

We routinely exclude companies with extreme start and end point data from productivity studies

Hydro One also excluded PG&E from its study

Capital Cost Specification

PEG and Brattle use different capital cost specifications

- PEG: geometric decay
- Brattle: one hoss shay

One hoss shay rationalized on grounds that service flow from Tx capital is constant until retirement --- like flow from a light bulb

However, service flow actually declines since

- *CNE* rises as transmission assets age
- Capital quantity calculations are made with TOTAL plant additions, which have varied service lives

Hyperbolic decay can model service flow more accurately

- Popular in sectoral productivity studies of government agencies

Capital Cost Specification

Geometric decay approach most widely used by far in X factor studies

- e.g., Ontario Energy Board

Several advantages

- Mathematically simple
- Capital quantity declines, like service flows do in real world
- Approximates impact of depreciation on cost in utility accounting
- In a productivity study, productivity growth slowed by a surge in capex
- In a benchmarking study, recognizes that providing good service with low-cost older plant is an accomplishment

Upgraded Brattle Productivity Results

If Régie prefers one hoss shay, PEG has provided "upgraded" productivity results using Brattle's data

PEG Improvement Using Brattle Working Papers	Multifactor	*CNE*	Capital
Original Brattle Results	-1.04%	-3.38%	0.05%
Improved Benchmark Year Capital Quantity	-0.72%	-3.38%	0.13%
Excluding Transmission by Others Expenses	-0.64%	-2.32%	-0.05%
Excluding Transmission by Others and Miscellaneous Expenses	-0.47%	-1.92%	-0.05%
Excluding Transmission by Others, Miscellaneous, and Dispatch-Related Transmission Expenses	-0.34%	-1.21%	-0.05%
All 3 *CNE* Exclusions and Improved Benchmark Year Capital Quantity	-0.11%	-1.21%	0.13%
All 3 *CNE* Exclusions, Improved Benchmark Year Capital Quantity, and Ratcheted Peak Demand	0.09%	-1.00%	0.34%

Note: Growth rates, full sample period (1995-2019)
Lowry, Mark N., C-AQCIE-CIFQ-0050, "PEG Commentary on Hydro-Québec's *MRI* Evidence," November 8, 2021, pp. 4, 33-35.

Benchmarking Issues

Benchmarking results of PEG and Brattle differ markedly

However, implications *for S factor* aren't huge since both consultants use the conservative Ontario approach to setting X

	Brattle	**PEG**
Cost Efficiency Score		
Total Cost	-4%	67%
CNE	-41%	121%
Suggested Stretch Factor	[0.10-0.30]	0.60% + (0.1 to 0.3) adder

Interesting methodological issues arise

Benchmarking Issues (cont'd)

Econometric Issues

Brattle and PEG both used econometric benchmarking

Used by many regulators in ratemaking (e.g., Ontario, Britain, Australia)

Assume that the cost of utility *h* is a (linear) function of several business condition variables

$$Cost_h = \beta_0 + \beta_L \times Lines_h + \beta_P \times Peak_h + \ldots + error_h$$

The model parameters (β_0, β_L, …) estimated using historical data on utility operations

Model fitted with parameter estimates (b_0, b_L, …) produces a benchmark that can be compared to actual cost

$$Cost\ Benchmark_{HQT} = b_0 + b_L \times Lines_{HQT} + b_P \times Peak_{HQT} + \ldots$$

Econometric Issues (cont'd)

Brattle and PEG both estimated model parameters with "panel" data (multiple observations of each sampled company)

These parameters can be estimated using various estimation procedures ("estimators")

Using panel data, the most popular estimator for benchmarking is probably ordinary least squares ("pooled" OLS)

OLS also relatively simple and familiar to wider audience

To avoid controversy, PEG used pooled OLS estimator like Hydro One witness Clearspring

Econometric Issues (cont'd)

Brattle uses a different approach that they rationalize with concern about excluded relevant variables

e.g., Brattle cost models exclude forestation variable

Brattle's discussions of this problem is confusing

The problem of excluded relevant variables has several aspects

a) Estimates of the "slope" parameters (b_L , b_P, …) are biased if excluded relevant variables are correlated with included variables

   This problem can be measured by Hausman test

b) Econometric benchmark includes net cost impact of excluded relevant variables

   This problem *not* addressed by Hausman test

Econometric Issues (cont'd)

Brattle addresses issue (a) by estimating model parameters using fixed effects estimator. This is tantamount to adding company-specific "dummy variables" for all (but one) of the companies in the sample. For each utility *h*,

$$Cost_h = \beta_0 + \beta_L x\ Lines + \beta_P x\ Peak_2 + \beta_h x\ Dummy_h + error_h$$

The parameter estimate for β_h is a "unique constant term" that captures net impact on $Cost_h$ of

- Average net impact on cost of excluded relevant variables AND
- Average inefficiency of firm h during sample period

The slope parameters (b_L and b_P) are free of omitted variable bias but this comes at a price

- Variation in data *between* companies is ignored in parameter estimation --- *but this is most of the variation in the sample*

  >>> Parameter estimates less precise
- Most of Brattle's parameter estimates are not statistically significant

Econometric Issues (cont'd)

Fixed effects models can benchmark cost in three ways

1) *Benchmark* $Cost_{HQT} = b_0 + b_L \times Lines_{HQT} + b_{HQT} \times Peak_{HQT}$
2) *Benchmark* $Cost_h = b_0 + b_L \times Lines_{HQT} + b_{HQT} \times Peak_{HQT} + b_{HQT}$
3) *"Firm-specific time-invariant inefficiency"* $= b_{HQT}$

Brattle uses approach 2) on the grounds that b_{HQT} reflects average net impact of excluded relevant variables

But b_{HQT} *also reflects average inefficiency of HQT during sample period*

>>> Brattle's benchmarking results reflect how HQT's *current* inefficiency differs from its *average* inefficiency during sample period

>>> This explains why Brattle's benchmarking scores seem "reasonable" (not straying far from zero)

>>> It also explains why Brattle's benchmarking results are so "robust" to changes in the data and model specification

Sensitivity of *CNE* Benchmarking Results (2017-19) To Changes in Brattle's *CNE* data

	Fixed Effects	Pooled OLS
Original Brattle Data	-41.3%	45.5%
Remove Tx by Others Expenses	-32.1%	85.3%
Remove Bad Misc Tx Expenses	-33.2%	93.2%

Econometric Issues (cont'd)

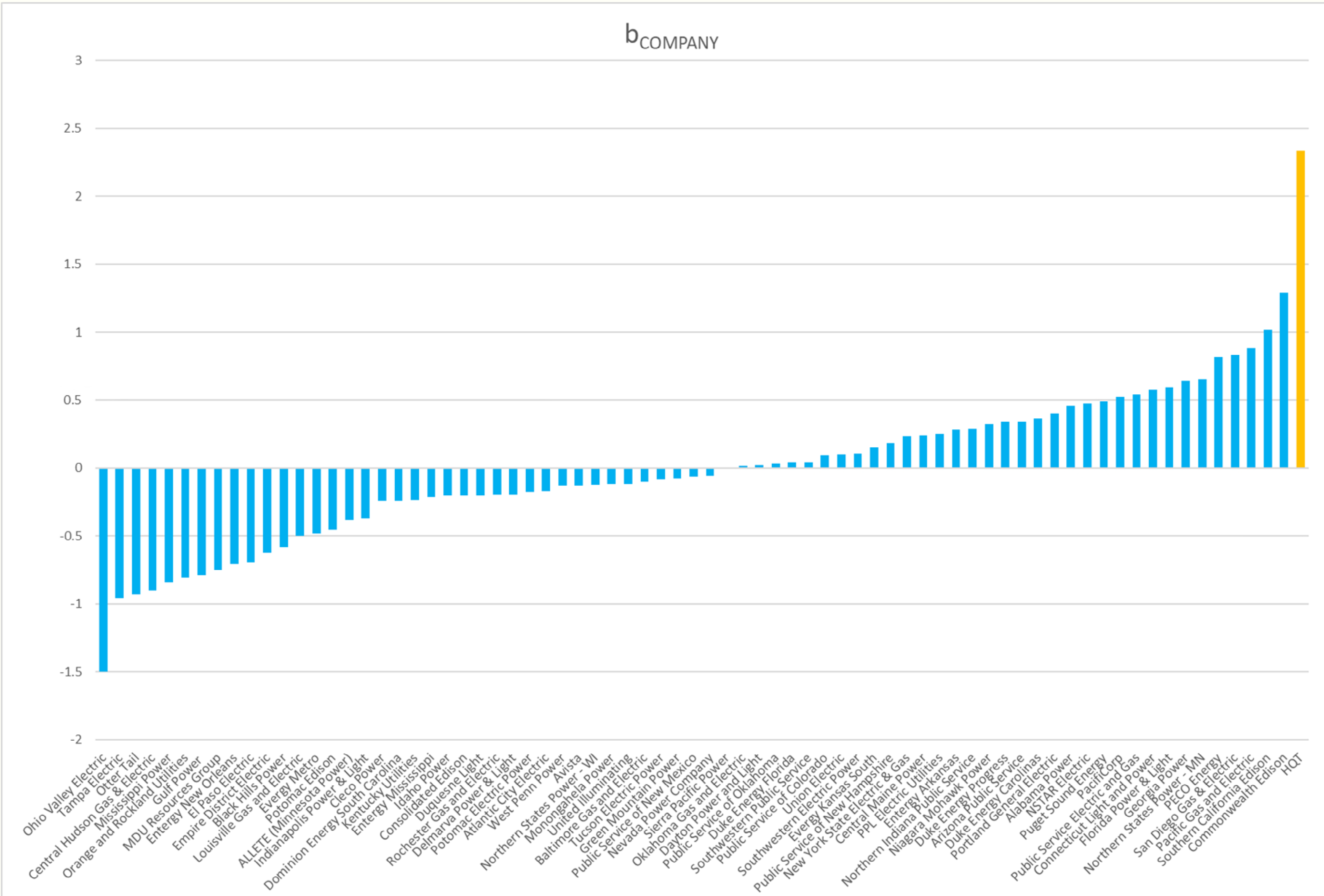
When fixed effects results are used to benchmark HQT (from 2001-2019) using approach 1) very different results obtain

	Benchmarking Results Using Brattle's Fixed Effects Estimates	
	Approach (1)	Approach (2)
CNE	-8.5%	180%
Capital Cost	-1.1%	300%
Total Cost	-1.7%	234%

\>>> The radically different benchmarking results Brattle obtains are chiefly due to the way they use fixed effects parameter estimates to fashion benchmarks

Correcting for omitted variable bias does not forestall bad benchmarking results for HQT

"Unique Constant Term" for Utilities in Brattle Sample



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Econometric Issues (cont'd)

Literature Review

Brattle reviewed benchmarking literature and claims that it supports the use of fixed effects

The cited articles did consider fixed effects estimators

However

- They do NOT support Brattle's use of approach (2)
- Most articles consider a use of fixed effects that is more in the spirit of approach (3)

Benchmarking Issues (cont'd)

Peak Load Variable

Two sources of peak load data reported on FERC Form 1

- Monthly peak load
- Tx peak load

Monthly peak load makes more sense for productivity study because it is available for more years

However, Tx peak load is more relevant for benchmarking

Benchmarking Issues (cont'd)

Other Issues

Brattle's models are less sophisticated than PEG's

- Labor and capital price indexes used in benchmarking are improperly levelized
- Fewer relevant variables (e.g., forestation)
- Inflexible functional form excludes quadratic and interaction terms

PEG's X Factor Recommendation

Use of productivity research to set X factor is complicated by several considerations

- Were productivity growth challenges facing sampled US distributors similar on balance to those that HQT will face in near future?
- Is Régie interested in a "pure" measure of productivity (a la Brattle) or a ratemaking-relevant measure (a la PEG)?
- Would HQT be eligible for supplemental capital revenue? If not, this argues for a lower X factor.

PEG's X Factor Recommendation

PEG Recommendations

If X applies only to *CNE* revenue, PEG's research suggests

X = -0.68% = *CNE* productivity trend for full sample period

Régie may also wish to consider…

-1.00% = Upgraded *CNE* productivity growth using Brattle's full sample period.

0.00% = X factor typically chosen by Ontario Energy Board

0.57% = Current X factor for the Company's *CNE*

0.80% = *CNE* productivity trend of Australian power transmitters (2006-2020)[fn]

[fn] Australian Energy Regulator (2021), "Annual Benchmarking Report Electricity Transmission Network Service Providers", p. 12.

PEG Recommendations (cont'd)

If X applies to capital as well as *CNE r*evenue, PEG's research suggests that

X = -0.62% = multifactor productivity trend for full sample period

Régie may also wish to consider…

X = 0.00% = X factor typically chosen by Ontario Energy Board

X = 0.19% = Upgraded Brattle multifactor productivity trend for full sample period

Stretch Factor

Stretch factor should reflect expected difference between HQT and industry *Productivity*^{CNE} growth

Difference will be larger

- The less efficient is HQT
- The greater is incentive power of the *MRI* compared to that of the regulatory systems of productivity sample utilities

Incentive to contain *CNE* is fairly strong under the Company's *MRI*

- Multiyear rate plan
- Revenue cap index
- Perverse incentive to raise capex to lower *CNE*

U.S. utilities operate under formula rate plans and return on equity premiums that weaken cost containment incentives

Stretch Factor (cont'd)

Benchmarking evidence suggests that excluded relevant variables are serious concern when benchmarking HQT

However, Brattle's solution to problem is unacceptable.

Best available evidence suggests a base stretch factor of 0.60%.

To this should be added a 0.10% adder for weak incentives in the US if X is based on long-run industry trend.

About Dr. Lowry

MRI practitioner since 1989

Pioneered use of statistical cost research in North American energy utility regulation

50 + energy utility productivity studies (including 3 for power transmission)

40+ statistical benchmarking studies (including 4 for power transmission)

Active in most Canadian *MRI* proceedings

Longtime advisor to Ontario Energy Board

Works for mix of utilities, regulators, and consumer advocates

Several published articles on *MRIs* and statistical benchmarking