Version caviardée

Réponses du Transporteur à la demande de renseignements numéro 1 de l'Association québécoise des consommateurs industriels d'électricité et du Conseil de l'industrie forestière du Québec (« AQCIE-CIFQ ») (Pacific Economics Group Research LLC « PEG »)

DEMANDE DE RENSEIGNEMENTS Nº 1 DE LA AQCIE-CIFQ (PEG) À HYDRO-QUÉBEC DANS SES ACTIVITÉS DE TRANSPORT D'ÉLECTRICITÉ (LE TRANSPORTEUR) RELATIVE À LA DEMANDE DU TRANSPORTEUR DE MODIFICATION DES TARIFS ET CONDITIONS DES SERVICES DE TRANSPORT POUR LES ANNEES 2021 ET 2022

ECONOMETRIC RESEARCH

1. Références : (i) Pièce B-0012, p. III-26;
(ii) Piece B-0012, p.VII-63

Préambule :

(i) « In 2018, Hydro One Sault Ste. Marie filed an application with the Ontario Energy Board to escalate transmission rates through an IRM. Hydro One proposed a revenue cap formulation and through its consultants Power System Engineering, Inc. ("PSE"), conducted a TFP study and an econometric benchmarking study that determined the S-factor. PEG also submitted a TFP study and an econometric benchmarking study ».

(ii) « Our econometric cost comparison analysis utilizes the results from the estimated total cost model to predict costs for each company ».

R-squared is a widely-used statistic that indicates the explanatory power of econometric models.

Demandes:

1.1 Please compare the R-squared values reported for the featured total cost benchmarking models of PSE in its study for Hydro One and of Brattle and PEG in this proceeding. How much lower is the R-squared in the Brattle model?,

Réponse :

R-square measures the proportion of the variance in the dependent variable explained by the model. Comparing R-squares from panel data estimators and OLS estimators is not meaningful, as the two are not directly comparable. In particular, the different estimators explain different components of the variance in dependent variables (e.g., variance around the average of the dependent variable for OLS versus the variance around the averages for individual companies for the fixed-effects panel data estimator). Nevertheless, PSE's Adjusted R-squared value from its OLS total cost model was 0.899. PEG's Adjusted Rbar squared value from its OLS model was 0.948. Brattle used panel estimators to control for utility specific, unobservable effects and used both the

fixed effects and random effects estimator. The R square within for the two fixed effects models were 0.441. The R-square overall for the two random effects models were 0.790 and 0.803 respectively.

1.2 Please provide commentary on any reasons why the R-squared value in the Brattle study is lower.

Réponse :

R-squares for panel and OLS estimators are not directly comparable. The fixed-effects estimator uses the time-demeaned data within the individual units to estimate the model's parameters (As noted above, the dependent variable variance explained is the variances around the average values of the dependent variable for the individual companies). The R squared within is interpreted as the amount of time variation in the unit's dependent variable (in this case a transmission utility's total costs) that is explained by the time variation in the unit's explanatory variable. Thus, it focuses on how well the explanatory variable's variation within one unit and across time explains the dependent variable's variation within the same unit over time. It is a different statistical concept than the adjusted R-squared from OLS, which as noted above explains each company's variation from the overall average variation in the dependent variable over time.

The quality of predictions from a regression model can be measured by examining the variance of the mean prediction from the model. For this, a statistic to use is the standard error of the regression—the Root Mean Square Error (RMSE). The RMSE is a measure of how close the predicted values are to the actual ones, with a lower RMSE being better, all else equal. For our fixed effects model, the Root Mean Square Error was 0.185, which is a low value suggesting a low regression standard error and accurate mean predictions.

ECONOMETRIC RESEARCH

2. Références : (i) Pièce B-0012, p.VII-62
(ii) Pièce B-0012, p. VII-63, Table 14

Préambule :

(i) « Table 14 presents the coefficient estimates for the final regression models. We use model (3) for our cost comparison analysis and model (2) for the output weights in our TFP model. Model (2) implies: a 1% increase in transmission line length, increases total real costs by

0.30%; a 1% increase in ratcheted peak demand, increases total real costs by 0.39%; a 1% increase in total energy output, increases total real costs by 0.05%, but is statistically insignificant ».

(ii) The parameter estimates for the scale variables in the featured benchmarking model 3 on Table 14 are 0.255 for km, 0.162 for MW, and 0.0522 for MWh.

Demandes :

2.1 What do these results seem to suggest about the importance of scale economies in the power transmission industry?

Réponse :

Our total cost models in Table 14 suggest increasing returns to scale.

2.2 Does model three imply that a 1% increase in km, MWh and capacity to produce a 0.4692% (0.255+0.161+0.0522) increase in predicted cost in the long run? Is that a reasonable result?

Réponse :

The fixed effects models produce approximately a 0.47% increase in expected costs. The random effects models produce approximately a 0.75% increases in expected costs. These results imply increasing returns to scale. Finding increasing returns to scale in electricity transmission is not surprising. There are very large fixed costs in the production function of electricity transmission that gives rise to economies of scale. Transmission is considered a natural monopoly by policymakers in North America and globally and direct point to point competition is considered wasteful. Our findings of economies of scale for transmission is consistent with the findings by Dismukes, Cope, Mesyanzhinov, "Capacity and economies of scale in electric power transmission", Utilities Policy (1998).

2.3 Please discuss why the fixed effects model implies much larger economies of scale than the random effects model.

Réponse :

From a statistical perspective, the difference is driven by the fact that the fixed-effect estimator uses OLS on the time de-meaned data, while the random effects estimator uses generalized least square for parameter estimates. As mentioned

in footnote 146 of the report, our cost benchmarking conclusions are robust to the use of the random effects estimator.

OUTPUT VARIABLES

3. Références : (i) Pièce B-0012, p. I-2;
(ii) Pièce B-0012, p. VII-60
(iii) Pièce B-0012, p. I-2; and Federal Energy Regulatory Commission, FERC Form 1
(iv) Pièce B-0012, p. VI-46

Préambule :

(i) « Our output measure [in the productivity study] consists of a cost-weighted average of peak demand and total miles of transmission lines—with 60% weight given to peak demand and 40% given to miles of transmission lines ».

(ii) « We use the same output metrics as we used in our TFP study with the exception that for peak demand we use ratcheted peak demand. Ratcheted peak demand for a given year is the maximum value of peak demand observed since the beginning of the study period up to that year. For example, the ratcheted peak demand for 1995 is the maximum of the peak demand for 1994 and 1995. Similarly, the ratcheted peak demand for 2014 is the maximum peak demand observed over the 1994-2014 period. We believe ratcheted peak demand is a more correct output variable for an econometric model of transmission costs than peak demand because an increase in peak demand in a given year may not necessarily result in capacity additions and additional costs. If the existing capacity is sufficient, an increase in peak demand may not require additional investments. On the other hand, it is more likely that an increase in ratcheted peak demand will require capacity additions and result in additional costs ».

(iii) Brattle «assembled a database of the costs, output and operating characteristics of U.S. electricity transmission companies using the FERC Form 1 data. »

(iv) « Companies report the total peak demand on their transmission system, if any. This metric, however, is only available from 2004, which would restrict the sample period for this study. We use an alternative definition of peak demand in the FERC data, which is available starting in 1994. This quantity is in megawatts (MW) of peak demand observed during a given year».

Demandes :

3.1 The productivity work in the report features peak demand. However, the econometric work features a *ratcheted* peak. If ratcheting was preferable for the econometric study, why was it not also preferable for the productivity study?

Réponse :

The output measures for a productivity study can be deflated revenues or physical units of output in a given year. Ratcheted peak demand does not correspond with the actual peak demand observed in a given year and thus is not consistent with the physical unit of output observed and produced in a given year, given the input services—i.e., capital, labor and MR&S services—in that year. In addition, using ratcheted peak demand constrains the output growth to be no lower than zero in any given year, even though physical peak demand units produced in a given year can show negative growth. Not permitting a physical output unit to show negative growth biases upward the output growth rate.

3.2 If peak demand is an output subindex in the productivity study, why is its 60% econometric weight based on a cost elasticity that was calculated using a *ratcheted* peak demand variable? What would the weight be if it were based on econometric work for peak demand instead of ratcheted peak?

Réponse :

We did not find the share weights sensitive to use of peak or ratcheted peak demand. Using peak demand in our econometric model would result in approximately a 50/50 weight.

3.3 Please recalculate the productivity trends using ratcheted peak demand and compare the results to those obtained using (unratcheted) peak demand.

Réponse :

The figure below recalculates the productivity trends when we use ratcheted peak demand instead of peak demand and hold all other factors or our study constant. Our base case results are displayed in Table 11 of our report.

Figure 1: Annual Growth of TFP Index – US Sample (Using Ratcheted Peak Demand)

Year [A]	Growth of Output Index [B]	Growth of Input Index [C]	Growth of TFP Index [D]	Growth of PFP (O&M) [E]	Growth of PFP (Capital) [F]
1995	3.33%	0.51%	2.82%	-0.14%	3.24%
1996	1.85%	0.22%	1.63%	0.97%	2.21%
1997	-1.09%	1.23%	-2.32%	-6.06%	-0.98%
1998	1.54%	1.75%	-0.20%	-4.62%	2.23%
1999	2.40%	-0.42%	2.82%	-8.24%	5.73%
2000	0.64%	-0.33%	0.97%	0.62%	1.02%
2001	0.85%	2.58%	-1.73%	-6.18%	0.55%
2002	1.58%	0.01%	1.57%	4.49%	0.91%
2003	1.36%	1.42%	-0.06%	-1.64%	0.22%
2004	0.87%	5.32%	-4.45%	-15.91%	0.01%
2005	2.12%	5.00%	-2.88%	-9.90%	2.39%
2006	2.42%	1.26%	1.16%	0.51%	1.10%
2007	1.00%	0.51%	0.49%	-0.47%	0.13%
2008	0.23%	2.61%	-2.39%	-7.86%	-0.64%
2009	0.08%	-0.45%	0.54%	5.21%	-0.57%
2010	0.68%	2.66%	-1.98%	-4.73%	-1.15%
2011	0.55%	0.09%	0.47%	-2.01%	0.63%
2012	1.07%	2.12%	-1.05%	-1.24%	-0.80%
2013	0.40%	3.71%	-3.31%	-4.98%	-2.55%
2014	0.81%	4.11%	-3.30%	-3.98%	-2.73%
2015	0.97%	2.95%	-1.98%	-1.98%	-2.24%
2016	0.33%	2.73%	-2.40%	-2.90%	-1.92%
2017	2.06%	1.65%	0.41%	1.07%	0.67%
2018	0.14%	2.13%	-2.00%	-2.60%	-1.44%
2019	0.87%	4.76%	-3.89%	-7.31%	-2.06%
1995 - 2019	***1.08%***	***1.92%***	***-0.84%***	***-3.20%***	***0.16%***
2000 - 2019	***0.95%***	***2.24%***	***-1.29%***	***-3.09%***	***-0.42%***
2002 - 2019	***0.98%***	***2.37%***	***-1.39%***	***-3.12%***	***-0.56%***
2005 - 2019	***0.92%***	***2.39%***	***-1.47%***	***-2.88%***	***-0.74%***
2010 - 2019	***0.79%***	***2.69%***	***-1.90%***	***-3.07%***	***-1.36%***

3.4 How does the cost performance of HQT change if a model using peak demand were used instead of ratcheted peak?

Réponse :

There is practically no change in our cost benchmarking results when using peak demand instead of ratcheted peak demand. The figure below shows our

total cost benchmarking when we use peak demand instead of ratcheted peak demand. For comparison, please see Table 15 in our report.

Figure 2: Total Cost Benchmarking Results for HQT – Peak Demand

Year	HQT	Full Sample of Utilities			HQT
	% Difference (Fixed Effects)	Mean % Difference (Fixed Effects)	Min % Difference (Fixed Effects)	Max % Difference (Fixed Effects)	HQT Percentile (Fixed Effects)
2001	5.1%	-4.1%	-61.9%	45.5%	25%
2002	2.9%	-4.4%	-78.8%	32.9%	31%
2003	2.4%	-4.7%	-81.1%	35.4%	29%
2004	1.2%	-2.8%	-65.6%	44.7%	38%
2005	4.8%	-3.3%	-57.2%	48.7%	23%
2006	7.9%	-4.1%	-37.6%	47.8%	19%
2007	5.5%	-4.2%	-34.0%	42.3%	17%
2008	-0.2%	-3.5%	-36.0%	50.0%	35%
2009	0.9%	-3.8%	-29.6%	38.8%	27%
2010	-2.6%	-4.4%	-33.5%	42.6%	36%
2011	-6.2%	-4.2%	-32.2%	47.2%	51%
2012	-8.1%	-4.0%	-29.7%	33.0%	69%
2013	-8.5%	-2.2%	-38.9%	48.2%	65%
2014	-7.6%	0.9%	-35.5%	89.1%	68%
2015	-9.4%	0.6%	-42.0%	56.1%	69%
2016	-6.3%	1.3%	-46.5%	47.5%	58%
2017	-5.5%	0.8%	-76.7%	45.9%	62%
2018	-4.4%	1.6%	-84.3%	47.2%	64%
2019	-4.4%	0.0%	-76.6%	47.7%	59%
2001 - 2019	***-1.7%***	***-2.3%***	***-51.5%***	***46.9%***	***49%***
2005 - 2019	***-2.9%***	***-1.9%***	***-46.0%***	***48.8%***	***56%***
2010 - 2019	***-6.3%***	***-1.0%***	***-49.6%***	***50.4%***	***64%***

3.5 Why couldn't Brattle have used the transmission peak in its econometric benchmarking study and monthly peak in its productivity study? Which peak load variable is more consistent with the peak data that HQT reports? Please reestimate the featured total cost benchmarking model and benchmark HQT using the alternative transmission variable.

Réponse :

Our econometric benchmarking study begins in 2001, transmission peak data begins in 2004. Thus, our sample would have been reduced by over 200 observations. Transmission peak and system peak are closely related and correlated and does not justify the loss in observations. Moreover, using the same data source in the productivity and benchmarking studies is beneficial for

comparative analysis as it eliminates any differences in results due to differences in data sources, methodology and reporting issues.

In addition, we note that PEG critiqued PSE's use of transmission peak demand in the 2018 Hydro One proceeding before the Ontario Energy Board stating that there were significant limitations in using the transmission peak data.

PEG has access to our files, data and model and is in a position to re-estimate the models with its preferred measure of peak demand.

CAPITAL COST

4. Références : (i) Pièce B-0012, p. I-3;
(ii) Pièce B-0012, p. IV-35
(iii) Piece B-0012, p. IV-33
(iv) Piece B-0012, p. IV-38-39
(v) Pièce B-0013

Préambule :

(i) « We find that our results are sensitive to certain assumptions that we make, including the period used for the analysis, the methodology used for capital services—*i.e. One-Hoss Shay* vs. *Geometric Decay*—the asset life assumption, the output measure used and the inclusion or exclusion of common costs—*i.e.*, Administrative and General ("A&G") expenses and General Plant ».

(ii) « Specifically, the capital quantity index is created by adding deflated gross additions and subtracting deflated gross retirements from the previous year's quantity index, where retirement assets are deflated by the index from the year when the assets came into service ».

(iii) « In order to measure capital quantity and the services that a unit of capital provides, one needs to make an assumption about how the flows of capital services change throughout the life of the asset—*i.e.*, how does the asset depreciate? Specifically, does the asset produce a relatively constant flow of capital services throughout its life—a methodology known as O*ne-Hoss Shay* depreciation. Alternatively, does the asset provide a flow of capital services that diminishes over time as the asset ages, and at what rate does that diminution occur—with one such methodology being the G*eometric Decay (Geometric Depreciation)*. ».

(iv) « The services provided by a unit of transmission capital corresponds to certain "functionalities" underlying the asset. For example, the functionality provided by towers and poles is to support, sustain and carry the overhead conductors and devices—*i.e.*, the transmission lines. Either the towers and poles provide this functionality or they do not, there really is no in-between. The functionality provided by towers and poles, therefore, are more consistent with *One-Hoss Shay*».

(v) «Document de soutien 1» of the Brattle Report.

Demandes :

4.1 Brattle's one hoss shay method requires data on the value of plant additions and retirements. The plant additions will have been put in service close to the time at which they are reported on FERC Form 1 and therefore assigning a price to the dollars of additions is reliable. However, it is not obvious how one can accurately determine the age of assets that are *retired*. Please discuss how much confidence one should have that the prices Brattle assigns to the dollars of retirements reflect the years when those assets were put in service.

Réponse :

The age of assets that are retired is dependent on the assumption made on the average service life for transmission, we assume 46 years. While some of the assets may be in service longer than the assumed average service life, and some less, that fact is not a deficiency in applying one hoss share, any more than it would be a deficiency of geometric decay that also assumes an average service life for its capital quantity index.

4.2 Please confirm that in Brattle's study, as in most productivity and benchmarking studies, it is customary to measure each year the quantity of plant additions associated with a *cohort of assets* with varied service lives and not the quantities of *individual* assets. Doesn't it make sense then to choose the method that best models the service flow of the *cohort*?

Réponse :

The term cohort of assets is not defined. We utilize different FERC accounts for transmission plant that consists of assets such as station equipment, towers and fixtures, overhead conductors to name a few, all with the same asset life assumption of 46 years. These FERC accounts are comprised by aggregating the individual assets into the specific FERC account. Thus, the characteristics of the individual asset that we described in our report pertain to the FERC accounts as a whole as well. Our example at the individual level was an illustrative example and not mean to pertain only to an individual asset.

4.3 Please prepare a table detailing the capital cost specification used in each of the productivity studies that Dr. Ros has prepared. If Dr. Ros used geometric decay in some or all of his telecommunications studies, doesn't the one hoss shay specification better reflect the service flow of individual telecommunications assets?

Réponse :

Jurisdiction	Sector	Capital specification
Régie (2021)	Electricity transmission	Gross Plant (One hoss shay)
Mexico (2015)	Telecommunications	Net Plant (Geometric)
Alberta, (2012)	Electricity and gas distribution	Gross Plant (One hoss shay)
Peru (2000, 2004)	Telecommunications	Net Plant (Geometric)

At the time of the studies, telecommunications assets included local distribution facilities (copper and fiber lines, poles, conduit, switching stations) and long-distance facilities (transmission lines). Many of these assets have the capital service characteristics exemplified by one hoss shay. Factors that led to selection of one hoss shay vs. geometric decay in the telecommunications studies were data availability, inflationary considerations and its effects on accounting data and precedence of previous Commission studies.

4.4 Please confirm that the cost of operating and maintaining transmission assets tends to rise as they age. Doesn't that suggest that their capital service quantity is diminishing?

Réponse :

While we have not undertaken a study to confirm the proposition and each company is different, in general it is not unreasonable to assume that O&M increases with age. That does not mean, however, that, by definition, capital service is diminishing. Under one hoss shay, as long as the asset is in service and has not "failed" the asset is generally providing the same capital service. O&M keeps the asset from failing, but the amount of capital service a transmission tower provides—as long as it is in service—is independent of the amount of O&M. An unanticipated reduction in next year's transmission O&M does not reduce next year's capital service. The capital service is the same whether O&M next year is $100 or whether O&M is reduced to $50 for budget reasons.

4.5 Which capital cost specification is used by the U.S. government in its sectoral productivity studies?

Réponse :

As per the description provided by the US BLS on multifactor productivity measures for capital inputs:

"Capital input is measured as "capital services" — the flow of services from the physical stock of capital. The stock of capital is measured using a "perpetual inventory method" as the sum of past investments adjusted for depreciation and retirements. Rental prices for each asset are estimated to value the stock of capital."[1]

4.6 Researchers using one hoss shay capital cost specifications sometimes encounter negative capital quantities. [redacted]

Réponse :

While this can happen under one hoss shay, it is not common. [redacted]

CAPITAL COST

5. Références :
(i) Pièce B-0012, p. IV-34
(ii) Pièce B-0012, p. VI-42
(iii) Pièce B-0012, p. VI-44

[1] US Bureau of Labor Statistics, FAQs on Multifactor Productivity: https://www.bls.gov/mfp/mprfaq.htm#5

Préambule :

(i) « The benchmark year refers to the first year for which capital information is available. For the U.S. sample of transmission companies, the first year of readily available data is 1988. For HQT, the first year with available data is 2001. We calculate the capital stock in the benchmark year by deflating the benchmark year plant in service by a weighted average capital price index. For the U.S. sample of utilities, we use the Handy-Whitman index to deflate the capital expenses. For HQT, we used a composite capital price index. The following is the benchmark year capital stock formula that we use in our study:

$$Benchmark\ Capital\ stock = \frac{Gross(or\ Net)\ Plant\ in\ service_{Benchmark\ year}}{\sum_{i=1}^{s}\left(i\ \times\left(\frac{P_{Benchmark-s+i}}{\sum_{i=1}^{s} i}\right)\right)} \qquad (18)$$

».

(ii) « Our primary data source for this study uses the processed FERC Form 1 data released by SNL Financial, a financial analytics company ».

(iii) « To carry out this study, we required transmission capital cost data from 1988 to 2019 and data for all other variables (summarized in Table 7) from 1994 to 2019. ».

Demandes :

5.1 Equation 18 provides the formulas used to calculate the benchmark capital stock. The numerator evidently differs depending on whether geometric decay or one hoss shay is being used. The denominator does not appear to depend upon which method is being used. Since prices have risen over time, it seems unlikely that the price at which *net* plant was acquired would be the same as that for *gross* plant because the more depreciated plant included in gross plant was acquired at lower prices. Please explain the mathematical reasoning for using the same deflation formula for both methods.

Réponse :

The denominator is a weighted average of Handy-Whitman price indices for previous years. These indices track the prices of new additions and as such can be used to adjust the gross plant in service measures provided by FERC, which are measures of the prices and quantities of plant at the time of purchase. Since we do not have data on the additions to plant prior to the benchmark year, the denominator serves to approximate the unavailable historical data. While the assets included in gross plant in service are actually acquired, net plant-in service (gross plant minus accumulated depreciation for that plant) was not acquired (as suggested by the question), i.e., there is no market for used plant (perhaps apart from selling the entire company). As such, there are no price indices for net plant that would allow the statement of a denominator such as in

Equation 18. Therefore, the Handy-Whitman indices at best approximates the unavailable "used plant" index.

5.2 If the denominators were actually different for gross and net plant, please provide each of the formulas.

Réponse :

See response to 5.1.

5.3 Does the gross plant in service reported by HQT in 2001 reflect the total gross amount of historical investment in plant and equipment still in service? Was there ever a time in the history of the company or predecessor entities when gross plant in service was restated at net plant value or some other alternative valuation?

Réponse :

The gross plant in service reported by HQT in 2001 reflects the gross plant in service as of that period. We do not have information regarding whether there was ever a time in the long history of the company or predecessor when gross plant in service was re-valued.

5.4 Please confirm that Brattle used 1988 as the benchmark year for the capital quantity index because that was one of the earliest years that was possible using SNL Financial plant value data. Please also confirm that an earlier benchmark year would have been more accurate but would have involved substantial incremental work.

Réponse :

We confirm the first point. Regarding the second point, any benchmark year is an approximation, and it is generally the case that more data since the benchmark year increases the precision of subsequent measures of the capital stock, but not necessarily its accuracy. Further, the added precision should be balanced by the added costs as obtaining earlier years for the benchmark requires a significant amount of resources and work hours. To the extent that an earlier benchmark year improves the measurement of capital stock, if the earlier data is limited to a subset of companies for which complete data are available, the earlier benchmark could come at the expense of not only the significant amount of work required, but also on having fewer companies to serve as benchmarks.

IMPACT OF STRUCTURAL CHANGE ON COST

6. Références : (i) Pièce B-0012, p. IV-33
(ii) Pièce B-0012, p. IV-13
(iii) Federal Energy Regulatory Commission, FERC Form 1
(iv) Pièce B-0012, p. VI-50

Préambule :

(i) « Labor and MR&S make up a utility's operations and maintenance (O&M) expenses. Labor expenses are readily available from the FERC Form 1 data and we calculate MR&S expenses from the same data. We obtain quantity indices for these two inputs by deflating their respective expenses by an appropriate input price index—a labor input price index and an MR&S input price index. We provide the data used and the details of this approach in Section VI ».

(ii) « The time horizon must be at least 15 years and allow the long-term growth of the industry to be measured and should be long enough to smooth out variations that could distort the measurement of long-term productivity growth in the power transmission industry or an alternative industry. Our TFP model measures TFP growth from 1994 to 2019, a period of twenty-five years and we provide TFP growth results for each year as well as for different periods ».

(iii) Brattle assembled a database of the costs, output and operating characteristics of U.S. electricity transmission companies using FERC Form 1 data.

(iv) « Table 10 below presents a summary of the annual growth rates for the three input quantities, input prices and the shares of the inputs. The fastest growing input quantity during the period was MR&S, averaging 5.58%, followed by capital at 0.93% and labor at 0.69% ».

Demandes :

6.1 What steps did Brattle undertake during its study to ascertain the effect of U.S. transmission industry structural change (e.g., the emergence of ISOs and RTOs) on the cost and productivity trends of sampled distributors?

Réponse :

The term structural change is ambiguous, open to interpretation and can mean different things to different professionals as is the term "emergence of ISOs and RTOs". We note that some ISOs/RTOs have been operation for a long period (e.g. PJM began in 1927 with three utilities, with more members following in the

1950s, 60s, and 80s) as have power pools which are the foundations of many present day ISO/RTOs.

In long run TFP studies in regulated industries—e.g., studies in electricity, natural gas and telecommunications spanning over 20 plus years—economic, regulatory and technological change is a normal feature of the industries and collectively drive long run TFP growth. Differentiating between "structural" vs. "non-structural" change would be a challenge as would be attempting to disentangle the impact on long run TFP growth, while holding all other factors constant. While of interest from an academic perspective, embarking on such an endeavor in this proceeding is not advisable. During our study we did not embark on such analyses.

6.2 Please discuss how changes in the transmission industry may have affected reported expenses of utilities in account 565 (transmission of electricity for others), accounts 561-561.8 (dispatching) and account 566 (miscellaneous transmission expenses).

Réponse :

Account 565 is incorrectly defined in the question. It is not transmission of electricity for others, it is transmission of electricity by others. Account 561-561.8 is incorrectly labelled as "dispatching" in the question when in fact only accounts 561.1- 561.4 have dispatching descriptions in the accounts, the rest generally include non-dispatching functions such as reliability, planning and standards (561.5), transmission service studies (561.6), generation interconnection studies (561.7), reliability planning and standards developments services (561.8). Moreover, the description of "dispatching" accounts 561.1 - 561.4 reveal many unambiguous transmission-specific functions.

The term "changes in the transmission industry" is not defined, ambiguous and open to interpretation and the question calls for speculation. In general, the FERC Uniform System of Accounts (USOA) is a time-tested and well-understood regulatory accounting system that has been in place since the mid-20th century in the U.S. and has been adopted by regulators in other parts of the world. Many of the transmission O&M accounts have been in place for a long period as well, providing industry participants with a long history of cost accounting experience and institutional expertise amid the significant evolution of the industry since its inception. The regulatory accounts of the USOA identify the costs of providing transmission services and is the basis for cost of service regulation that the FERC and states utilize for transmission revenue requirements and rates. The FERC periodically issues orders to review and revise its USOA taking into account "Commission's ratemaking policies, past Commission actions, industry trends and external factors (e.g., economic,

environmental, and technological changes, and mandates from other regulatory bodies.")[2]

The long period of FERC accounting experience encompasses the many evolving industry structures—from one based upon vertically-integrated utilities that would interconnect and engage in limited wholesale transactions to one based upon more formal wholesale competition requirements emanating from the 1978 Public Utilities Regulatory Policies Act (PURPA), to the 1996 FERC Order 888 on transmission open access and non-discriminatory rules leading to the creation of the Open Access Transmission Tariff (OATT) and its periodic reforms, to the continued evolution of organized wholesale power markets through ISOs/RTOs.

Perfection in the underlying database is not a requirement for a TFP study which focuses on growth rates and some amount of measurement error is standard in econometric analysis and, when part of the dependent variable, presents no challenge in estimation.

6.3 Which transmission O&M accounts, if any, were excluded from the O&M expenses used in the study? Please provide the rationale any excluded accounts.

Réponse :

We excluded none. We used all transmission O&M accounts in our study, because they are transmission O&M expenses. See response to OC 9.2 for list of the accounts.

6.4 If account 565 was included, please explain the rationale for its inclusion.

Réponse :

Account 565 is listed under FERC Transmission O&M accounts. The FERC and transmission companies utilize account 565 as an O&M expense in the transmission companies' Annual Transmission Revenue Requirement ("ATTR").[3] **FERC's definition of the account is: "This account shall include amounts payable to others for the transmission of the utility's electricity over transmission facilities owned by others." [emphasis added]. The FERC has provided guidance to the industry on this account and what should be included in it and has stated that recovery of payments for transmission by others is allowed "only when the facilities are used either on a day-to-day basis to**

[2] See, https://www.ferc.gov/enforcement-legal/enforcement/accounting-matters.

[3] *See*, Nebraska Public Power District v. Tri-State Generation and Transmission Association, Inc., Southwest Power Pool, Inc., Docket No. EL 18-194-000, issued December 20, 2018.

transmit power and energy for tariff customers, or when they form part of the pertinent company's integrated transmission system."[4] [emphasis added]. Thus, expenses included in account 565 represent legitimate transmission expenses incurred to provide service for tariff customers. These are relevant transmission O&M expenses to include in a transmission TFP and cost benchmarking study.

6.5 Please discuss why the reliance of sampled utilities on transmission by others may have increased during the sample period.

Réponse :

See response to question 6.2.

6.6 Could the inclusion of transmission by other expenses explain why the quantity of materials, rents, and services grew far more rapidly than the quantities of labor or capital, and the rapid decline in O&M productivity?

Réponse :

See response to question 6.8 below for our productivity results when transmission of electricity by others is removed from the analysis.

6.7 Did you include the cost of HQT's transmission by others in your benchmarking study. If yes, were these as large, relative to other O&M expenses, as those of the U.S. transmitters in the sample?

Réponse :

For the U.S., transmission of electricity by others represents approximately 35% of total transmission O&M expenses for our sample (see the Table below), with variation within companies as some companies exhibited a low, single-digit percent while others higher than the average. For HQT, the account labeled "transmission purchases" represents 3% of total transmission O&M expenses

Year	Account 565: Transmission of Electricity By Others Share of O&M	Accounts 566: Miscellaneous Transmission Expenses Share of O&M	Accounts 561.1-561.8 Share of O&M	All other (residual) transmission expenses
Average	34.87%	17.18%	10.74%	36.46%

[4] *See*, *N.Y. State Elec & Gas Corp*, Opinion No. 447, 92 FERC ¶ 61,169, at 61,584 (2000), *order on reh'g*, Opinion No. 447-A, 100 FERC ¶ 61,021, *reh'g denied*, Opinion No. 447-B, 101 FERC ¶ 61,037 (2002), *order on reh'g*, Opinion No. 447-C, 103 FERC ¶ 61,321, at P 8 (2003) (emphasis added))

and is captured in the "Other" expenses category and not directly under transmission O&M. Our benchmarking study results and conclusions are robust to the inclusion or exclusion of HQT's transmission purchases.

6.8 Please recalculate the productivity trends and benchmarking results excluding this cost item.

Réponse :

Excluding costs related to transmission by others—and maintaining the output shares at 60% peak and 40% transmission—results in in higher (less negative) TFP growth for the 1995 – 2019 period. The table below summarizes the average TFP growth after excluding this cost item.

Figure 3: Annual Growth of TFP Index – US Sample (excluding Tx by others)

Year [A]	Growth of Output Index [B]	Growth of Input Index [C]	Growth of TFP Index [D]	Growth of PFP (O&M) [E]	Growth of PFP (Capital) [F]
1995 - 2019	***0.89%***	***1.53%***	***-0.64%***	***-2.32%***	***-0.05%***
2000 - 2019	***0.75%***	***1.90%***	***-1.15%***	***-2.55%***	***-0.64%***
2002 - 2019	***0.80%***	***2.14%***	***-1.34%***	***-2.95%***	***-0.75%***
2005 - 2019	***0.71%***	***2.09%***	***-1.39%***	***-2.63%***	***-0.97%***
2010 - 2019	***0.74%***	***2.44%***	***-1.70%***	***-1.99%***	***-1.43%***

Since the exclusion of costs related to transmission by others (from O&M expenses) affects total costs used in the benchmarking regression analysis, such a change affects the weights applied for the TFP study for the US sample as well as makes the energy output significant. These weights differ from those presented in the Brattle report. The new weights for peak demand, transmission

line length and energy output are 44%, 42% and 14%, respectively. The table below summarizes the productivity trends based on the new output weights.

Figure 4: Annual Growth of TFP Index – US Sample (excluding Tx by others)

Year [A]	Growth of Output Index [B]	Growth of Input Index [C]	Growth of TFP Index [D]	Growth of PFP (O&M) [E]	Growth of PFP (Capital) [F]
1995 - 2019	***0.74%***	***1.52%***	***-0.78%***	***-2.44%***	***-0.20%***
2000 - 2019	***0.58%***	***1.90%***	***-1.32%***	***-2.72%***	***-0.81%***
2002 - 2019	***0.69%***	***2.13%***	***-1.44%***	***-3.04%***	***-0.85%***
2005 - 2019	***0.57%***	***2.09%***	***-1.52%***	***-2.79%***	***-1.10%***
2010 - 2019	***0.69%***	***2.44%***	***-1.75%***	***-2.05%***	***-1.47%***

The revised results for HQT's total cost performance, presented below, indicate that predicted costs remain very close to HQT's actual costs. The same is true for the O&M cost benchmarking – the long run cost difference for HQT, while slightly worse than that presented in the Brattle report, lies in the +/-10% band.

Therefore, our conclusions on cost benchmarking are robust to the exclusion of this cost item.

Figure 5: HQT Total Cost Benchmarking Results – Excluding Transmission by others

	HQT	Full Sample of Utilities			
Year	% Difference (Fixed Effects)	Mean % Difference (Fixed Effects)	Min % Difference (Fixed Effects)	Max % Difference (Fixed Effects)	HQT Percentile (Fixed Effects)
2001 - 2019	***-1.1%***	***-1.9%***	***-45.7%***	***39.8%***	***43%***
2005 - 2019	***-0.4%***	***-1.2%***	***-44.2%***	***42.0%***	***44%***
2010 - 2019	***-2.3%***	***-0.1%***	***-44.6%***	***40.1%***	***59%***

Figure 6: HQT O&M Cost Benchmarking Results – Excluding Transmission by others

	HQT	Full Sample of Utilities			
Year	% Difference (Fixed Effects)	Mean % Difference (Fixed Effects)	Min % Difference (Fixed Effects)	Max % Difference (Fixed Effects)	HQT Percentile (Fixed Effects)
2001 - 2019	***-5.4%***	***-5.8%***	***-104.3%***	***99.2%***	***41%***
2005 - 2019	***-14.5%***	***-3.8%***	***-101.5%***	***93.4%***	***80%***
2010 - 2019	***-26.8%***	***-4.5%***	***-122.8%***	***82.4%***	***93%***

6.9 How do the average trends in transmission by others, dispatching expenses, and miscellaneous transmission expenses compare to the trend in the other (residual) transmission O&M expenses?

Réponse :

The Table below provides the average long-run growth rate for the respective O&M expense items listed in FERC Form 1.

Year	Account 565: Transmission of Electricity By Others	Accounts 566: Miscellaneous Transmission Expenses	Accounts 561.1-561.8	All other (residual) transmission O&M expenses
Average	11.26%	13.13%	10.02%	5.12%

7. Référence : (i) Pièce B-0012, p.VI-51

Préambule :

(i) Brattle's study « Does not include a share of A&G expenses nor a share of the general plant in transmission capital expenses ».

Demande :

7.1 Please explain why it is reasonable that the alternative results that Brattle calculated including A&G and general plant should cause such radical differences in productivity results. What is the average A&G cost used in this alternative analysis as a percentage of the Transmission O&M included? What is the average General Plant capital cost used in this alternative analysis as a percentage of the Transmission capital cost?

Réponse :

The difference in overall TFP growth when A&G and general plant are included—in proportion to total O&M and total plant—compared to when they are not included is that it increases TFP growth by 72 basis point, from -1.04% to -0.32%, see Table 12 in our report. The difference in PFP O&M when A&G and general plant are included is that PFP O&M decreases from -3.38% to -3.49%, a decrease of 11 basis points, see response to Régie 12.2.

The average A&G cost used as a percentage of transmission O&M is approximately 14%. For the general plant, the percentage allocation for general plant is calculated based on the approach provided in Brattle's report, using FERC Form 1 data on transmission plant and total electric plant. The US sample average for the percentage of allocable general plant is approximately 18%.

As to the reasonableness of these results, please see our discussion on this topic in our report in Section VI. D. There is not an economically optimally way to allocate common costs by looking at the supply-side only, and other common cost allocators can produce materially different results. We reaffirm our recommendation not to include common costs in the studies.

7.2 Please report the average trend in the O&M productivity of sampled transmitters when A&G expenses are included.

Réponse :

1 **See response above and response to Régie 12.2.**

INPUT PRICE INDEXES

8. Références : (i) Pièce B-0012, p.VI-48;
(ii) Pièce B-0012, p. VI-49;
(iii) Pièce B-0012, p. IV-36;
(iv) Pièce B-0012, p. VII-56;
(v) Pièce B-0012, p. VII-59
(vi) Pièces B-0013 et B-0019

Préambule :

(i) « We define the quantity index for labor as the ratio of the total wages paid and a labor price index—*i.e.*, we calculated deflated wages. For the labor price index, we use data from the Occupational Employment Statistics ("OES"), which measures the average wage for all occupations. The OES is an annual report published by the Bureau of Labor Statistics at the state level for a range of industries in the U.S. We use the mean 2019 wage level for the *Electric Generation, Distribution and Transmission Industry* ».

(ii) « Similar to labor quantity, we obtain the MR&S quantity index by deflating MR&S expenses by a price index. For the U.S. sample, we use the Gross Domestic Product Price Index (GDP-PI), adjusted for the GDP-PI from the base year, to determine MR&S quantity ».

(iii) « With respect to the "price" of capital—*i.e.*, the opportunity cost/rental price of owning a unit of capital—*One-Hoss Shay* implies a certain rental price formula. With *One-Hoss Shay*, the asset provides the same amount of services each year over the life of the asset. Therefore, the annual payments are constant, apart from the effect of inflation in the purchase price of new assets. In order to justify the purchase of the new asset, the discounted sum of the annual payments—adjusted for asset inflation—would equal the purchase price. Specifically, the "rental" price of capital is:

$$P_t = \left(\frac{1-k-uz}{1-u}\right) \times \frac{(r-i)}{(1+r)} \times \left[1-\left(\frac{1+i}{1+r}\right)^s\right]^{-1} \times HW_{t-1} \qquad (20)$$

».

(iv) « With respect to HQT O&M costs, unlike FERC Form 1, HQT tracks the employee headcount for transmission services in terms of full-time equivalent ("FTE") of employees. We use this variable as a direct measure of the labor quantity for HQT. For the labor price, we calculate it as the ratio of the total payroll expenses to the FTE for a given year. We exclude pension and benefits from the definition of total payroll and we exclude capitalized labor from the definition of labor because these expenses are included in the company's capital expenses ».

(v) « Econometric analysis involves a dependent variable that is the variable that is being "explained" in the model—in our case total costs—and a set of independent variables, the variables that are the "explanatory" variables. The dependent variable is a variable that we estimate a relationship for, whose value depends on a set of external variables. The independent variables help define the relationship and form the basis on which we model the dependent variable ».

(vi) Price levels vary for different regions of the U.S. [redacted]

Demandes :

8.1 For each of the labor, MR&S, and capital price indexes used in the econometric work, please explain whether and how differences between the price *levels* of sampled U.S. transmitters were captured in the input price indexes. Did these indexes satisfactorily reflect differences in local price levels?

Réponse :

For MR&S price levels, we use GDP-PI for gross domestic product, like PEG does, as published by the US BEA. For labor level we use mean wage level estimates for 2019 published in the Occupational Employment Statistics (OES) by the US BLS. [redacted] We also use the Employment Cost Index (ECI) for private industry workers in the utilities industry to derive wage levels for other years. For capital, we use the price levels implicit in the Handy Whitman, which are available and differ based at the regional level – South Atlantic, Pacific, Plateau, South Central, North Atlantic and North Central.

The data used in this study reflect the granularity at which they are available. For TFP analysis, growth rates are relevant. For econometric cost benchmarking, any measurement error in the price levels shows up in measurement error for the dependent variable, which is not a major concern in an econometric model and does not result in biased parameters.

8.2 How did the study deal with differences in the prices faced by HQT and the sampled US companies, which are expressed in different currencies?

Réponse :

The input price indices used for HQT are described in Brattle's report. The indices were obtained from either publicly available Canadian government sources or from information provided by HQT. For the cost benchmarking study, we convert HQT's cost data, which were originally in Canadian dollars, to US dollars using Purchasing Power Parity exchange rates

8.3 Why was an *endogenous* labor price used for HQT and an *exogenous* price used for U.S. companies? If the actual labor cost data for a company is used to calculate the labor price that is used in the benchmarking work, then is it the case that how much the company pays it employees is not being benchmarked?

Réponse :

The labor prices and quantities were developed primarily in the context of TFP. For US companies the quantity, which is not available is estimated by dividing expenditures by a price index. For HQT, quantity is available, so price is estimated by dividing expenditures by the measured quantity. Further, endogenous and exogenous distinctions are beside the point, as the calculations we use do not involve a supply-demand regression system with labor price and quantity perhaps jointly determined, but simply ways to approximate one unavailable variable. For US companies, labor quantity is expenditure divided by price and for HQT, the average wage is expenditures divided by workers. Along the same lines, input prices are not explanatory variables in either our or PEG models, but rather are combined to be part of total expenditures, which in turn are deflated by the overall price index and used as the dependent variable. Thus, any measurement error in the price levels shows up in measurement error for the dependent variable, which is not a major concern in an econometric model and does not result in biased parameters.

8.4 Is it the case that the labor price used for HQT cannot be considered part of a set of "external" explanatory variables?

Réponse :

The question is not clear. Input prices are not among the explanatory variables.

8.5 Is the P used in equation 19 the same as the P defined in equation 20?

Réponse :

No. The P used in equation 19 is the capital price index by region (Handy Whitman) while the P in equation 20 is the capital rental price for a company (the opportunity cost of capital).

EXPERIENCE OF THE BRATTLE TEAM

9. Référence : (i) Pièce B-0012, p. Appendix 85-86

Préambule :

(i) « Dr. Ros has worked on dozens of TFP studies involving electricity, gas and telecommunications ».

PEG seeks to better understand the experience of Dr. Ros and the Brattle team when it comes to conducting energy utility productivity and benchmarking studies.

Demandes :

9.1 Please provide CVs for all of the named authors.

Réponse :

CVs are filed for Dr. Ros and Mr. Shetty under HQT-05 Document 2.4

9.2 How many productivity studies of energy utilities have been undertaken by the named authors? How many of these addressed power transmission? Please list the energy utility studies in the public domain and provide copies of these studies.

Réponse :

This will be Dr. Ros' second productivity study of an energy utility. His first involved a TFP study of U.S. electricity distribution companies for use in a price cap proceeding in Alberta, Canada in 2010-2012, applicable to electricity and gas distribution companies. The study was commissioned by the Alberta Utilities Commission (AUC) and co-authored with Dr. Jeff Makholm from NERA. PEG

submitted evidence in that proceeding and should be familiar with the study and its location.

Mr. Shetty is a recent graduate of the University of Wisconsin Madison and this is his first productivity study of an energy utility.

9.3 How many cost benchmarking studies of energy utilities have been undertaken by the named authors? How many of these addressed power transmission? Please list the energy utility studies in the public domain and provide copies of these studies. How many of these benchmarking studies used multinational data?

Réponse :

While Dr. Ros has published econometric benchmarking studies in the telecommunications industry, see response to 13.9 below, this is Dr. Ros and Mr. Shetty's first econometric cost benchmarking study of an energy utility.

ECONOMETRIC RESEARCH

10. Reférence : (i) Pièces B-0013 et B-0019

Préambule :

[redacted]

[redacted]

Demande :

10.1 Please provide the final values for all of the business condition (explanatory) variables that Brattle used in its econometric models.

Réponse :

The attachment HQT-5_Document_2.3_Document de soutient 8_Brattle Regression Dataset.xlsx contains the final dataset used by Brattle to conduct the econometric benchmarking analysis. It includes all the scale variables and the business conditioning variables that are used in the regression analysis.

10.2 Please provide a brief description of the [redacted] including its source. If this index is from Statistics Canada, please provide the table number containing this data. If the index was constructed by HQT or Brattle, please also provide the calculations underlying this index.

Réponse :

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

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- [redacted]
- [redacted]
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- [redacted]
  - [redacted]
  - [redacted]

ECONOMETRIC RESEARCH

11. Références : (i) Pièce B-0012, p. VII-61.
(ii) Pièce B-0019

Préambule :

(i) Brattle states that « panel data estimation does not require an observation for a given company for every single year ».

(ii) In the R code provided for Controls Processing, observations with missing values are summarily removed.

Demandes :

11.1 Please confirm that this statement is only true if the missing observations are not missing due to some related reason, and that failing to analyze the reason for the missing data could introduce material bias into the model.

Réponse :

The missing values that are dropped from our econometric model relates to some of the observations of the business conditioning variables which we use as independent variables in our regressions. For some of the business conditioning variables the data source we used was not SNL but rather form 1 data downloaded from the FERC's website. For these variables we downloaded the data, processed the relevant raw data, and included the data in our econometric dataset. Processing the raw FERC data revealed some data deficiencies, including missing observations. In econometric analysis, missing data can impact the sample selection process and under certain conditions could bias the panel data estimates. When missing data on the independent data are the issue, as in our case, under the Gauss-Markov assumptions the sample can be chosen based on the independent variables without causing major statistical problems. In addition, the data deficiencies and missing observations from the raw FERC data do not appear to be non-random or systematic. Missing data could introduce bias when sample selection is based on the dependent variable, such as excluding a unique company from the sample and using the model to make predictions on the excluded company.

11.2 Did Brattle do an investigation of any patterns in the missing values? If so, please provide a summary.

Réponse :

See response above.

ECONOMETRIC RESEARCH

12. Référence : (i) Pièce B-0012, p. VII-63-70.
(ii) Pièce B-0019

Préambule :

(i) Brattle presents parameter estimates and relevant benchmarking model statistics in the report.

(ii) Brattle provides code for replicating the models which estimates each model twice – once without HQT in the sample and once with HQT in the sample.

Demande :

12.1 Please report full benchmarking results for HQT using the sample that excluded HQT.

Réponse :

We use the fixed-effects model for cost benchmarking HQT vis-à-vis the U.S. sample of transmission companies. The fixed effects model estimates a unique constant term for each firm in our sample, including HQT and utilizes it for prediction. It is common to refer to this unique constant term as the unobserved heterogeneity of each firm in our sample, including HQT. The unobserved heterogeneity represents all those unobserved, time-invariant factors that affect transmission costs and that differ across firms and is a crucial part of cost benchmarking. The fixed effects model controls for the unobserved heterogeneity and uses each firm's constant term for the cost benchmarking. It is not mechanically possible, nor would it be meaningful from a cost benchmarking perspective, to exclude HQT from the fixed-effects model. Doing so would bias the cost benchmarking analysis.

ECONOMETRIC ESTIMATION PROCEDURE

13 Référence : (i) Pièce B-0012, p. VII-61.

Préambule :

(i) « We consider two common estimators to deal with panel dataset—the fixed effects (“FE”) estimator and random effects (“RE”) estimator. FE assumes that the unobservable company-specific variables are related to one or more of the model’s independent variables and failure to control for them could bias the parameter estimates. Therefore, it removes the unobserved effect from the error term prior to model estimation using a data transformation process.145 During this process, other independent variables that are constant over time are also removed meaning that the FE estimation cannot estimate the impact of variables that remain constant over time. The benefit, however, of FE is that it controls for company-specific factors that are not observable but that remain constant over time. One key example is the geographic territory, climate and the difficulty or ease of providing transmission services. RE is a reasonable alternative to FE when a researcher is able to explicitly control for all potential independent variables and has a good reason to think that any unobservable variable is not correlated with any of the model’s independent variables. An advantage of the RE estimator is that it allows for the estimation of variables that remain constant over time ».

Brattle states in footnote 146 that: « The FE estimator thus removes and controls for all unobservable company effects that remain constant over time, ensuring the remaining coefficients are not biased».

Brattle indicates they used a Hausman test to determine whether an RE or an FE estimator is appropriate.

Demandes :

13.1 Why were these the only estimators considered?

Réponse :

We estimate our benchmark models utilizing a panel data set. Our data set has observations for the same 74 transmission companies over the period 1994-2019. This is a rich data set that can be exploited in ways that would not be possible had we not had data on the same companies over time but instead had data on different transmission utilities over time, the latter type of data set being known as pooled cross-sectional data. Fixed effects and random effects estimators are panel data estimators and it is best practice in econometrics and not in any way controversial to utilize panel data estimators with panel data. A fundamental strength of panel data estimators is its ability to obtain consistent estimators in the presence of omitted variables. Omitted variable bias is a common challenge in econometric modelling because no matter how well specified a model is, it is unlikely that all observable variables have been included. More important, there are factors that are not possible to include in an

econometric regression because the variable is unobservable to the researcher—i.e., it may not be feasible to measure—or due to the resources that would be required to accurately and objectively measure the variable, e.g., intangible factors such as quality of management and workers. These are all factors that vary among our sample of 74 utilities and that likely have direct impacts on transmission costs. Not using a panel data estimator for the panel data at hand and instead utilizing pooled OLS is a mistake, as it is not using the proper tool for the job at hand, as reflected in the result of the Hausman test discussed in response to 13.11 below. The RE estimator is preferred to pooled OLS when the researcher fails to reject the null hypothesis of no correlation between the unobserved effects and the regressors.

13.2 Please comment on whether using FE in econometric benchmarking essentially benchmarks each company against its own average costs during the sample period, rather than against the other companies in the sample, and whether this undermines the purpose of a benchmarking exercise.

Réponse :

No, the observation in the questions is incorrect. The FE is ideal for benchmarking HQT to the U.S. sample of transmission companies. As discussed in response to 12.1, the fixed effects model estimates a unique constant term for each firm in our sample, including HQT. These constant terms are used for prediction. The unique constant term is, by definition, the unobserved heterogeneity that represents all those unobserved, time-invariant factors that affect transmission costs and that differ across firms and is a crucial part of cost benchmarking. Ignoring this heterogeneity in a benchmarking exercise is a mistake and biases the results, as demonstrated through the Hausman test result in our sample. Moreover, while the FE estimator uses the panel-level variable's deviation from the panel-level means to estimate the parameters, the estimated slope coefficients are not unique to each company. The model produces overall slope coefficients estimated from all the transmission companies in our sample and makes predictions based on those common coefficients and the unique utility-specific constant term.

13.3 Please confirm that, in econometric research, the precision of parameter estimates is increased to the extent that the variables have a wide range of values in the sample. Please also confirm that, in econometric cost research, FE greatly reduces the range of values. Is this a reason why parameter estimates in the random effects models have greater statistical significance?

Réponse :

The standard error of a parameter is due to three factors—the variation in the independent variable, the standard error of the regression and the linear relationships among the independent variables. Holding the other factors constant, as the variation in the independent variable increases, so does its precision.

The FE estimator is consistent under both the null hypothesis of no correlation between the unobserved heterogeneity and the regressors and the alternative. Under the alternative, pooled OLS is biased and inconsistent and does not accurately depict the relationships between the dependent and time-varying independent variables. The RE estimator is consistent only under the null hypothesis of no correlation between the unobserved heterogeneity and the regressors. The RE is a more efficient estimator as it does not estimate the fixed effects separately which increases the degrees of freedom and lowers the standard error of the regression, holding all other factors constant. As mentioned in 13.1 above, the RE estimator is preferred to pooled OLS when the researcher fails to reject the null hypothesis of no correlation between the unobserved effects and the regressors.

13.4 Please explain why FE is not preferable for estimating the cost elasticities used in the productivity research but is preferable for evaluating HQT's performance.

Réponse :

The Hausman test failed to reject the null hypothesis of no correlation between the unobserved heterogeneity and the regressors, thus suggesting that FE is the preferred model. For cost benchmarking, our main interest is in the significance of the model as a whole, and less on the individual parameters. That, plus the result of the Hausman test, led us to select the FE for cost benchmarking. We note, as stated in our report, that our cost benchmarking conclusions are robust to the RE model. For the cost elasticities, we used some judgement in selecting the RE coefficients. For cost elasticities our main interest is in the parameters of the output variables, as we use the output parameters to determine the shares in the productivity study. Under FE only the transmission length output was significantly different than zero thus implying the use of only transmission length as an output in our productivity study. We note that use of the FE for estimating the cost elasticities in the productivity research would have lowered TFP growth modestly.

13.5 Was a sensitivity analysis performed for other estimator choices and model specifications?

Réponse :

Sensitivity analysis that we performed prior to filing our report consisted of the FE and RE models to the specifications adopted as well as with specifications that included squared output and interaction terms, as discussed in the report.

13.6 In view of your answers to the preceding questions, does Brattle believe that FE is preferable to RE in econometric cost benchmarking unless ALL potential independent variables are controlled for and the researcher has good reason to think that ANY unobservable variables are not correlated with the model's independent variables?

Réponse :

The use of FE or RE is case specific, guided by the underlying economic theory of the model, the availability of data on the independent variables, the importance of unobservable variables that cannot be measured—or would be too costly to measure—and their relationship with the observed independent data, as well as statistical tests testing null hypothesis of no correlation between unobserved company-specific factors and the independent variables. The FE estimator is consistent under both the null hypothesis of no correlation between the unobserved heterogeneity and the regressors and the alternative. The RE estimator is consistent only under the null hypothesis of no correlation between the unobserved heterogeneity and the regressors. Both the FE and RE are preferable to pooled OLS for panel data. The RE uses feasible generalized least squares and is a more efficient estimator as it does not estimate the fixed effects separately which increases the degrees of freedom and lowers the standard error of the regression. There is thus a tradeoff involved between the two that is important to consider for the research objective at hand. In addition, although not a concern in our case, a researcher may have a preference for RE, e.g., based on a trade-off of the amount of bias and precision and can live with some amount of bias in the estimate if an important independent variable for the research project involves a variable that does not vary over time, such as gender, as gender would be absorbed in the unit-specific constant term in FE.

13.7 Please provide full benchmarking results for HQT using the random effects versions of the models.

Réponse :

Please see response to Régie 13.5.4.

13.8 Brattle seems to indicate that the choice between FE and RE does not matter if the conclusions reached are similar. If the RE model does not control for important unobservable time-invariant variables, could the models' similar results instead be an indication of model misspecification resulting in biased estimates?

Réponse :

No. We re-iterate, the FE estimator is consistent under both the null hypothesis of no correlation between the unobserved heterogeneity and the regressors and the alternative. The RE estimator is consistent only under the null hypothesis of no correlation between the unobserved heterogeneity and the regressors. The RE uses feasible generalized least squares and is a more efficient estimator as it does not estimate the fixed effects separately which increases the degrees of freedom and lowers the standard error of the regression. What this means in practice is that under the null hypothesis of no correlation between the unobserved heterogeneity and the regressors, the FE and RE coefficient should be similar to each other. Evidence that they are not similar means that the unobserved heterogeneity and the regressors are correlated, thus use of RE is not appropriate. We obtained a p-value of 0.0005 on the Chi-squared statistic of the Hausman test, safely rejecting the null hypothesis of the Hausman test that the differences in coefficients between the two estimators are not systematic. Finally, while it is possible that not including difficult (or impossible) to attain explanatory variables could result in biased estimates, the alternative method—OLS, which controls for none of the unobservable time-invariant variable—would introduce even more bias.

13.9 Are fixed-effects models widely used in econometric benchmarking studies?

Réponse :

The term "widely used" is subjective and being responsive to this question would require a thorough review of the literature on econometric benchmarking, a review that PEG is able to undertake if it is so inclined. While we have not performed a literature search on the topic, we believe fixed-effect is well suited for econometric benchmarking and the literature would reflect it. As an example, Dr. Ros has used fixed-effects models for econometric benchmarking in previous research. Specifically, Dr. Ros co-authored a paper with Professor Jerry A. Hausman using fixed-effect models to benchmark and predict telecommunications prices in a sample of developing economies, see Jerry A. Hausman and Agustin J. Ros (2013) "An econometric assessment of telecommunications prices and consumer surplus in Mexico using panel data," *Journal of Regulatory Economics* 43:3. The econometric approach used in the

Hausman and Ros paper is similar to the approach used for HQT cost benchmarking.

13.10 Since the FE models have low statistical power and the interpretation of the coefficients for slow-moving variables is complicated, how can the predictions based on that model be relied upon?

Réponse :

The terms "low statistical power" and "slow-moving variables" are unclear in the question. See response to 13.6 and 13.8 for why FE models result in consistent and unbiased parameter estimates and thus the predications based on the model can be relied upon.

13.11 Please provide the Hausman test results.

Réponse :

On performing the Hausman test, the Chi-squared statistic comes out to be 26.09, which translates to a p-value of 0.0005. This lets us safely reject the null hypothesis that the differences in coefficients between the two estimators are not systematic.

13.12 Please confirm that the Hausman test indicated that the utility-specific errors are correlated with the regressors.

Réponse :

The Hausman test rejected the hypothesis that the differences in coefficients are not systematic. This means that the RE treatment of including the utility-specific errors in the overall error term will result in inconsistent parameter estimates, as would using OLS to estimate the parameters.

13.13 Did the version of the Hausman test Brattle used assume homoskedasticity of the error terms?

Réponse :

We employed a version of the Hausman test that is robust to heteroscedasticity using the xtoverid function in Stata. This test also confirms the use of fixed effects over random effects as a preferred estimator.

13.14 Were other statistical tests – such as the Wooldridge, Breusch-Pagan, or related tests – performed for heteroskedasticity, autocorrelation, and/or alternative model specification? If so, please provide the results.

Réponse :

As is common practice in applied work, robust standard errors are assumed to be preferred and we used clustered standard errors that are robust to heteroskedasticity and autocorrelation. The use of clustered standard errors robust to heteroscedasticity and autocorrelation do not affect the parameter estimates.

13.15 Should Hausman test results be the sole basis for deciding whether to use the FE estimator in benchmarking?

Réponse :

See response to 13.6.

ECONOMETRIC RESEARCH

14. Références : (i) Pièce B-0012, p. VII-63-70.
(ii) Pièce B-0019

Préambule :

Brattle reports econometric parameter estimates for total cost, capital cost, and CNE models using various estimation procedures and samples. In all of these models the business condition variables are the same.

Demandes :

14.1 Please comment on the pros and cons of the variables being identical in the 3 models, and whether the low R-squared value and large number of insignificant variables for the CNE model suggests that it may not be suitable for benchmarking purposes due to potential model misspecification and/or omitted variable issues.

Réponse :

See response to 1.1 where we discuss why comparing R-squares from panel data estimators and OLS estimators is not meaningful, as the two are not directly comparable. All three models that we use for benchmarking are highly significant with p-levels < 0.01. Economic theory and available data guide model specification and lead to the same specification for all three models as the regressors affect total, capital and O&M costs. The use of FE controls for and accounts for omitted variable, estimates the unit-specific unobserved heterogeneity, results in consistent parameters and when used to predict costs for benchmarking results in good predictions. Moreover, as mentioned in response 1.1 for our fixed effects model, the Root Mean Square Error was 0.185, which is a low value suggesting a low regression standard error and accurate mean predictions.

14.2 Brattle clustered the model standard errors by company. Please discuss the pros and cons of company-level clustering. Specifically, discuss whether by company-level clustering Brattle posits that each company's errors are independent and not systematically correlated with any another company's – so the error terms for companies in the same ISO or state would be completely unrelated.

Réponse :

The use of clustered standard errors that are robust to heteroscedasticity and autocorrelation does not affect the parameter estimates, and thus does not affect our cost benchmarking results. Clustering on the panel variables produces a consistent Variance-Covariance matrix of the estimators when disturbances are not identically distributed over the panels or there is serial correlation in ε_{it}. Thus, the use of clustered standard errors posits that the variance of the error term is not constant across our 74 companies with one plausible reason being company size. It also posits that there is a relationship between the value of the error term in one period and the value in the next. For our sample, it is a plausible assumption that within a company, the error in one period is related to the error in the next period.

14.3 Please comment on how selecting an inappropriate level of standard error clustering could affect the statistical significance tests for the variables.

Réponse :

The term "inappropriate level of standard error clustering" is ambiguous and unclear. In general, robust standard errors do not affect the parameter estimates of our cost benchmarking model and thus do not affect our cost benchmarking result. The use of robust standard errors can increase or decrease the precision and statistical significance of the parameter estimates, depending on the data at hand. It is common practice in applied work to utilize robust standard errors.

ECONOMETRIC RESEARCH

15. Référence : (i) Pièce B-0012, p. VII-62

Préambule :

(i) « The regression specification we employ uses a logarithmic functional form. In this model, we express the dependent variable and the three output metrics in natural logarithms, which is common practice in econometric literature… We also tested specifications that included quadratic forms (squared terms) of the output metrics, as well as interactions but these did not yield conclusive results. ».

Demandes :

15.1 How should an econometric researcher decide whether to include second-order terms in an econometric cost model?

Réponse :

Whether to include second-order terms in a model is a model specification question. Specifying the appropriate model is a challenging part of econometrics that utilizes good econometric practice and overall judgement taking into account the relevant research objective. In this particular case, including or not including second-order terms is guided by the researcher's judgement about the general relationship between an independent variable and the dependent variable and whether that relationship is linear (or linear in the natural logarithms of the dependent and independent variables) or non-linear—*i.e.*, whether the relationship changes with changing values of the independent variable, such as including the square value of the independent variable or

interacting it with other independent variables. It is also reasonable to compare models with and without the second-order terms in model specification.

15.2 In what sense were the results sufficiently inclusive for Brattle to decide not to include second order terms in their models?

Réponse :

The first order output variables in our translog models were not significant which was a weakness compared to our models with specifications that did not include the squared and the interaction terms. We also found that our cost benchmarking results were robust to model specification including second order terms. Moreover, the use of second order terms (and interaction effects) complicates the calculation of the cost shares in the productivity study, as the translog specification means that cost elasticities are not constant and need to be evaluated for different values of the variables in order to derive the output shares.

STRETCH FACTORS

16. Référence : (i) Pièce B-0012, p. I-23

Préambule :

(i) « When initially moving from rate-of-return regulation to PBR, the change in regulatory structure can lead to efficiency gains by the regulated firm. The stretch factor provides customers with a “first cut” of the share of the increased productivity growth due to the initial incentive effects of PBR. Thus, a stretch factor should be more common in “first generation” PBR plans than in subsequent generation plans ».

Demandes :

16.1 Please comment on the propriety of statistical benchmarking and stretch factors in later plans.

Réponse :

Please see section III.D of our report for a discussion on the use of benchmarking for setting the stretch factor which applies to initial as well as later plans.

16.2 Do firms in competitive markets all have efficient operations or does their operating efficiency vary?

Réponse :

As discussed in our report in section III.D., there are reasons why firms in competitive markets are unable to operate on the production possibilities frontier, including X-inefficiencies.

16.3 Does continued benchmarking strengthen utility performance incentives?

Réponse :

The increased performance incentives from PBR are a function primarily of the duration of the plan and whether there is incorporation of earnings sharing. As stated by the Alberta Utilities Commission with respect to the stretch factor, for which benchmarking is intended to help determine, cited in our report III-27:

"Finally, the Commission agrees with the parties who argued that while the size of a stretch factor affects a company's earnings, it has no influence on the incentives for the company to reduce costs. Similar to a discussion in Section 6.1 of this decision, the Commission considers that PBR plans derive their incentives from the decoupling of a company's revenues from its costs as well as from the length of time between rate cases and not from the magnitude of the X factor (to which the stretch factor contributes)."

STRETCH FACTORS

17. Référence : Pièce B-0012, p. I-24

Préambule :

(i) « The sample of companies used for the TFP study is also relevant. If the sample consists of companies that are operating under a PBR plan, then the measured productivity growth already contains some of the effects of the stretch factor. In contrast, a TFP study sample that includes only companies under rate-of-return regulation would not capture this effect. Our sample of U.S. transmission companies are under cost-of-service regulation by the FERC. Many of those companies are under "formula rates" meaning that the companies' rates are frequently aligned with underlying costs and there is less ability to take advantage of regulatory lag. At the same time, the FERC also provides incentives to transmission companies, most in the form of premiums on return on equity for meeting certain public policy objectives ».

Demandes :

17.1 Isn't the ROE premium discussed above fairly widely applied to transmitter capital expenditures by the FERC? Doesn't this materially weaken transmitter capex containment incentives?

Réponse :

The term "fairly widely applied" is subjective and being responsive to this question would require a thorough review of relevant FERC decisions, a review that PEG is able to undertake if it is so inclined. Moreover, it is not obvious how a policy that increases the return on equity in exchange for meeting policy objectives "materially weakens capex containment incentives" as any effects are likely to be small and of second order relative to cost of service and formula rates in general.

17.2 If a TFP study sample that includes companies operating under multiyear rate plans to that extent *reduces* the appropriate stretch factor, doesn't a sample with numerous companies operating under formula rates and premium allowed rates of return on equity to that extent *increase* the appropriate stretch factor?

Réponse :

It would not be unreasonable for a PBR plan to have a lower stretch factor for a plan that was derived from a TFP sample of companies operating under multiyear PBR plans compared to a TFP sample of companies operating under formula rates.