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Price-Dual TFP Approach – Prepared by Frank Cronin, Expert Consultant to the PWU, for the OEB's PBR Working Group (EB-2010-0379)

Economic assessments of productivity can be derived from either quantities (physical) or prices (called price-dual or price-based). In the former case we base TFP calculations on the comparison between output and input quantities. Similarly, we can use prices to calculate TFP: output prices (e.g. rates) are compared with input prices (e.g. Input Price Index - "IPI") to estimate trends in productivity growth. Both approaches have been used by Canadian and US regulators.

What are the main advantages of the price dual?

The price-based TFP approach will provide supplementary analysis that can be used to assess the outcome of the quantity-based TFP analysis.

Given the significant data issues related to the quantity-based TFP approach that need to be dealt with, the price-based approach has a very notable advantage for the Ontario electricity distributors' TFP analysis: the amount of data required to implement the indirect approach (in particular capital data) is significantly less than that required for the physical approach (i.e., maybe 80 percent less data). Proper quantification of capital for the physical approach requires decades of capital stock (gross value of plant, accumulated depreciation, additions, retirements, and depreciation). The price-dual approach does not require the decades of capital data. Only IPI and rates data for the two end points are required to calculate the change in TFP over that period. Intermediate data would provide additional insights on the time path of TFP but are not required. Data for the period preceding the interval to be studied are not required to calculate a robust estimate. Thus the price-based approach would provide consistent, comprehensive assessments of Ontario LDCs' performance with substantially less data; and no data at all on physical capital inputs. (And this may have been the appeal for the CRTC and FCC.)

How do the mathematical basis of the quantity-based TFP and price-based TFP approach compare?

As PEG has shown, the two approaches are based on the same mathematical decomposition of the budget constraint (revenue = costs). However, the empirical calculations rely on different data; quantities in the quantity-based approach (PEG's slides) and prices for the price-dual approach (Frank Cronin's slides):

- Larry Kaufman, January 21, 2013 Presentation to PBR Working Group slides 10 and 11; and,
- Frank Cronin, Presentation to Woking Group, January 21, 2013 slides 13 and 14.

As PEG presents in equation (8) on slide 11 of their primer, the difference between the growth in input prices and the growth in rates is the growth in TFP. PEG's slides focus on the right hand

side of (8*); my slides focus on the left hand side of (8*). The two sides are identical as PEG has shown.

$$\dot{P} = \dot{W} - \dot{TFP} \qquad (8)$$ *or by rearranging terms*

$$\dot{W} - \dot{P} = \dot{TFP} \qquad (8^*)$$

$\dot{P}$ = growth in industry output price index

$\dot{W}$ = growth in industry input price index

$\dot{TFP}$ = industry total factor productivity trend

Let's see how we can use plausible data on rates and input prices. Let us assume that input prices rise more than output prices, specifically we assume $\dot{W}$ is 2 and $\dot{P}$ is 1. In this case, $\dot{TFP}$ is 1. What about the reverse when output prices rise more than input prices. Let's say, $\dot{W}$ is 1 and $\dot{P}$ is 2, then $\dot{TFP}$ is -1. These findings make perfect sense: when input prices rise more than output prices the firm must have improved its productivity to offset some of the rise in IPI. In our first case the firm would have offset half of the rise in the IPI by productivity improvements. In the opposite case where output prices rise more than input prices the firm would have experienced a fall or degradation in productivity which adds to the impact of the IPI on output prices. In the second case, the increase in rates exceeds the increase in the IPI by the fall in TFP.

How are the input prices and output prices determined?

Input prices are weighted indices. The weights are determined by the number of components included in the specification and the respective share of each cost component.

The output prices are the aggregated rate of the distributor.

What is the data and data source used to derive the input prices and the data and data source used to derive output prices?

The IPI is the basis for the change in input prices and the distributor's rates is the basis for the change in output prices.

Annual information collected by the OEB from the distributors is used to determine the weighting of the input price sub-indices. Additionally, Stats Canada produces some of the required information. The OEB calculated an IPI in 3rd G with no use of historical capital data. This could be reused or serve as the basis of another effort.

Rates information collected by the Board each year is used to derive the output prices.

What year do you suggest as the start point?

Any year since restructuring could theoretically be used as the starting point.

Are there disadvantages of the price-based approach compared to the physical approach?

If the framework is specified correctly and the empirical implementation is consistent with that specification, the price-based approach has no additional disadvantages compared to the physical approach.