Illustrative Analysis – Supplementary TFP Analysis including Price Dual TFP, and Impact of Reliability and Line Losses on TFP

Frank Cronin
Expert Consultant
to the
Power Workers' Union

All reported findings are preliminary.

February 21, 2013

Overview

- Illustrative analyses are provided on:
  - ➢ Employing price-dual TFP analysis as supplementary analysis to quantity-based TFP analysis:
    - Using data for the period 2006-2011, a price-dual TFP for Ontario LDCs is estimated and compared with quantity-based TFP
  - ➢ Incorporating distribution line losses and reliability performance/customer value in TFP analysis

Price Dual TFP

Quantity-Based TFP v Price-Dual TFP Analysis

- The quantity-based TFP methodology is very data intensive and extensive,
  - Needs a very substantial list of data for each LDC (e.g., stock, additions, retirements, deprecation, contributed capital, outputs, inputs, prices)
  - Needs capital data for decades; 10 years or more of operating data

- It appears that the 4th Generation
  - Will not have available for its analytical work a substantial amount of the needed data i.e. capital additions, retirements, and depreciation from 1989 – 1998
  - Data limited to 1989-1998; and 2002-2011

- Gaps in data may result in substantial errors in estimates of capital, total costs, TFP growth, and efficiency for individual LDCs and in aggregate TFP growth estimates

- All data available to estimate a price-dual TFP

- Supplement quantity-based TFP analysis with price-dual TFP analysis

Price Dual TFP - Supplemental Analysis to Quantity-based TFP Estimates

- 1st Generation data updated with 1998-2011 data to estimate quantity-based (fixed weight and Tornquist)TFP using 4 decades of capital data and a decade of operating data
- Using data for the period 2006-2011, a price-dual TFP for Ontario LDCs is estimated and compared with a quantity-based TFP.
- Chart 1 presents the percentage changes over 2007-2011

Chart 1

TFP Growth Estimates

using Alternative Methodologies and Weights

	Price-dual	Quantity-based	
		Fixed Weight	Tornquist
2007-2011	-2.0%	-2.3%	-2.4%

Price Dual TFP - Supplemental Analysis to Quantity-based TFP Estimates

- The resulting TFP estimates are quite similar.
  - The price-dual TFP estimate is -2.0 percent per year
  - Both estimates of the quantity-based TFP are similar
    - The fixed weight estimate of -2.3 percent
    - The variable (Tornquist) weight estimate of -2.4 percent

Price-Dual TFP

- Recall from Larry's Primer that TFP is equivalent to the difference between distribution input prices and output prices (rates)

- Below we have reproduced one equation from the January 25 note prepared by Frank Cronin
  http://www.ontarioenergyboard.ca/OEB/Industry/Regulatory%20Proceedings/Policy%20Initiatives%20and%20Consultations/Renewed%20Regulatory%20Framework/Measuring%20Performance%20of%20Electricity%20Distributors#updates

- Equation (8*) states that the difference in the annual rate of change input prices **($\dot{W}$)** and output prices **($\dot{P}$)** is the annual rate of change in total factor productivity **($T\dot{F}P$)**.

$$(\dot{W}) - (\dot{P}) = T\dot{F}P \quad (8^*)$$

- Using the capital data covering the period 1972 to 2011 other operating input data for 2006 to 2011 including rates data.

Price-dual TFP – IPI

- The derivation of the IPI is according to the OEB Staff report and appendix, 1999. This material was the basis of the Board's 2000 Decision on TFP:
  http://www.ontarioenergyboard.ca/documents/cases/RP-1999-0034/ppp1.html
  http://www.ontarioenergyboard.ca/documents/cases/RP-1999-0034/ppp2.html

- IPI derivation is also described in a 2002 backgrounder on the IPI posted on the OEB's website.

- See also the 3rd Generation 2008 Staff report on the IPI:
  http://www.ontarioenergyboard.ca/documents/cases/EB-2007-0673/IRM_Staff_Paper_20080228.pdf

Price-dual TFP – Output Prices

- The change in output price is calculated on an individual LDC basis
- The change in output price for an LDC is derived from the aggregate rate change which is calculated using monthly distribution billing data
- For each LDC a monthly distribution bill is calculated for the relevant customer classes by applying rates and charges, as set out in the Board's approved rate schedules, to the typical usage for the customer classes; e.g.:
  - Residential: 800 kWh per month
  - GS < 50 kW: 2,500 kWh per month
  - GS > 50 and Large Use: based on actual usage per customer (i.e. kW-month per customer) using data provided in the most recent cost of service applications.
- Board's approved rate schedules can be accessed at:

  http://www.ontarioenergyboard.ca/OEB/Industry/Regulatory+Proceedings/Applications+Before+the+Board/Electricity+Distribution+Rates

Price-dual TFP - Output Prices

- The following rates and charges were used in determining LDC's monthly distribution bill:
  - Monthly Service Charge, excluding the component related to the smart meter cost
  - Volumetric Rate (i.e. $/kWh or S/kW)
  - Lost Revenue Adjustment Mechanism (LRAM) and Shared Savings Mechanism (SSM) Recovery Rate riders

Price-dual TFP - Output Prices

- The annual rate change for each customer class is derived from the distribution bill change
- LDC's aggregate rate change is calculated by the summation of customer class rate changes apportioned by their respective revenue requirement shares obtained from the LDC's recent COS application
- The change in the output price for the composite of LDCs included in the analysis is the summation of the LDC aggregate rate changes apportioned by the respective LDC distribution revenue share
- Output prices were calculated for 13 Ontario distributors whose revenue requirement collectively make up 80% of the distribution sector

Price Dual TFP - Supplemental Analysis to Quantity-based TFP Estimates

- 1st Generation PBR quantity-based TFP Methodology:
  - Described in "Productivity And Price Performance For Electricity Distributors in Ontario" on OEB website at http://www.ontarioenergyboard.ca/documents/cases/RP-1999-0034/ppp1.html
- 1st Generation PBR quantity-based TFP Data - collected capital data from distributors for 1972 to 1997:
  - additions,
  - retirements,
  - depreciation,
  - gross stock,
  - accumulated depreciation, and
  - contributed capital

TFP Estimates with Reliability/Customer Valuation

- Willingness to Pay (WTP) and Willingness to Accept Compensation (WTA):
  - Researchers, regulators, and utilities in North America and in Europe have used WTP/WTA studies for decades
  - For electricity distributors, these survey-based analyses gauge the value that different classes of customers place on service improvements, degradations, number of outages, length of outages, time of outage, etc.
- Ofgem and NVE have both employed WTP and/or WTA for a decade to value service not supplied and gauge the efficiency of O&M and capital
- The Board conducted a WTP and WTA study (Pollara Study) in 2010
- We have employed these results as inputs to an adjusted TFP estimate

TFP Estimates with Reliability/Customer Valuation

- Pollara study for OEB and Ofgem provide similar estimates of service valuations
- Pollara finds **42 %** of residential customers would pay for improvement:
  - $16.20 per bill or $192.40 per year;
  - Gives overall average across all Ontario customers of **$82**
- Ofgem finds **46 %** of residential customers would pay for improvement:
  - WTP per customer is **$93** (for 1 hr. improvement in 2002);
  - Business customers value such an improvement at 7% to 10% of their distribution bill, or $8,888 across all classes

TFP Estimates with Reliability/Customer Valuation

- Pollara finds Ontario customers place a high value on service reliability
  - **57 %** would not be willing to accept compensation in return for degraded service; for those willing, bill must decrease by $27.9/month to accept increase in unplanned outages
  - Average LDC residential monthly service charge is $28.4 - equivalent to customer value placed on service degradation
- Standard treatment of output is LDC-centric; customers place no value on line
- Reliability-adjusted TFP more accurately reflect LDCs' performance from perspective of rate-payer and not just number of new connections, megawatts supplied, or peak demand
- Incorporation of customer valued service changes can have significant affect on calculated growth/decline in average annual TFP

TFP Estimates with Reliability/Customer Valuations

- Ontario customers put higher value on preventing degradation than on improving service
- Residential customers value degradation at a minimum of **$27.85/month,** quite close to the average distribution monthly bill of **$28.38/month** (2009)
- In adjusting TFP for reliability, reported changes in service reliability were used together with the Pollara WTP and WTA for improvements and degradations, respectively,
- These “customer valued” improvements/decrements were then equally weighted with changes in the quantity of LDCs’ outputs

TFP Estimates with Reliability/Customer Valuation

- Consider 4 examples of TFP estimates adjusted for changes in reliability

Chart 2

TFP Growth Estimates: 2002 – 2011

Adjusted for Changes in Reliability[a]

Utility A		Utility B		Utility C		Utility D	
w/out	**w/**	**w/out**	**w/**	**w/out**	**w/**	**w/out**	**w/**
-0.2	**-3.4**	**-0.6**	**-0.9**	**-0.3**	**-1.9**	**0.2**	**-3.1**

[a] **w/out** means TFP not adjusted for reliability**; w/** means TFP adjusted for reliability

TFP Estimates with Reliability/Customer Valuation

- Used the Pollara study's service valuations along with reported reliability
- "Customer-valued" changes to service have been included with distributors' output
- Including the customer-valued changes in service can significantly affect the LDC's observed TFP
  - for 3 of the LDCs, the change in annual average TFP is significant: ranging from -1.6 % to -3.3 %
  - For 1 of the LDCs, the change in annual average TFP is moderate, equaling -0.3 %
- Reliability-adjusted TFP more accurately reflects LDCs' performance from the perspective of the rate-payer

TFP Estimates with Line Losses

- Line Losses are a substantial share of distribution costs
- Line Losses vary substantially among seemingly similar LDCs
- Line Losses vary greatly over time depending on regulatory incentives and prices of electricity
- The impact of incorporating losses in TFP analysis can have a significant impact on the reported TFP estimates

TFP Estimates with Line Losses

- Let's look at two large urban LDCs (i.e. Utility A and Utility B) for an illustration of cost shares and costs per customer

- Chart 3 shows data on cost shares (i.e., capital, OM&A, and line losses), total costs per customer, and line loss cost per customer

TFP Estimates with Line Losses

Chart 3

2005

	Input Cost Shares			Costs per Customer	
	Capital	OM&A	Line Losses	Total	Line Losses
Utility A	48.7%	36.5%	14.8%	$380.8	$56.4
Utility B	41.9%	36.2%	21.8%	$633.6	$138.3

TFP Estimates with Line Losses

According to Chart 3,

- Utility A and Utility B have the same share of OM&A but markedly different capital and line loss shares
- The difference in total cost share attributed to line losses is:
  - 14.8% (Utility A) v 21.8% (Utility B)
- Utility A is benefitting substantially from a loss factor which is 28% lower than Utility B….
  - 2.1% (Utility A) v 2.9% (Utility B)

TFP Estimates with Line Losses

- Given the high price of power in 2005 (0.1013 per kWh), the substantially lower loss factor for Utility A translates into about $80 savings per customer

- Note the urban LDCs in Chart 3 also have markedly different costs per customer:
  - $634 v $381 in total costs and
  - $138 v $56 in line loss costs

TFP Estimates with Line Losses

- Chart 4 shows line loss data for three Ontario utilities over the 1988 to 2011 period

Chart 4

	Utility A		Utility B		Utility C		kWh Price
1988	3.7		4.8	$91	3.7		0.0411
1997	2.3		3.1		2.3	$55	0.0581
2005	2.1	$56	2.9	$138	2.9	$119	0.1013
2009	3.3		3.1		3.8	$116	0.0830
2010	3.5	$66	3.0		3.5		0.0861
2011	3.3		3.2		3.5		0.0935

TFP Estimates with Line Losses

- LDC line loss management can materially impact TFP performance

- Improvements: As shown in Chart 5, Utility A has improved line loss performance in all three periods examined over the 1988- 2011 span
  - In the 1988-1997 period, TFP inclusive of losses increases from 0.6 percent per year to 1.0 per year
  - In the 1993-1997 period, TFP inclusive of losses increases from 2.1 per year to 3.7 per year
  - In the 2000-2011 period, TFP inclusive of losses increases from 0.3 per year to 0.6 per year

TFP Estimates with Line Losses

Chart 5

3-Factor and 4-Factor Total Factor Productivity by Period

Utility A

	3-Factor	4-Factor	(with Line Losses)
1988-1997	0.6	1.0	(improved losses)
1993-1997	2.1	3.7	(improved losses)
2000-2011	0.3	0.6	(improved losses)

TFP Estimates with Line Losses

- Improvements and degradation: As seen in Chart 6, Utility B shows improvement in the 1988-1997 period but degradation post 2000
  - In the 1988-1997 period, TFP inclusive of losses increases from -1.3 per year to -0.9 per year
  - In the 1993-1997 period, TFP inclusive of losses increases from 1.6 per year to 1.9 per year
  - In the 2000-2011 period, TFP inclusive of losses decreases from 1.9 per year to 1.2 per year

TFP Estimates with Line Losses

Chart 6

3-Factor and 4-Factor Total Factor Productivity by Period

Utility B

	3-Factor	4-Factor (with line losses)	
1988-1997	-1.3	-0.9	(improved losses)
1993-1997	1.6	1.9	(improved losses)
2000-2011	1.9	1.2	(degraded losses)