MEYRICK AND ASSOCIATES

Productivity Growth in New Zealand Gas Distribution Networks

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1 INTRODUCTION

The Commerce Commission is currently undertaking an inquiry to report on whether goods and services supplied by persons in markets directly related to either a natural gas transmission system or a natural gas distribution system or both should be controlled. The Commerce Commission (2003) indicated in its Draft Framework Paper that it intends to consider two approaches to determine whether prices for gas pipeline services are efficient. One of the approaches – the comparative benchmarking approach – involves comparing the prices with those of comparable services in other markets either that have workable competition or in which the prices are known or assumed to be efficient.

The Commission has engaged Meyrick and Associates to undertake an analysis of the rate of total factor productivity (TFP) growth in New Zealand's gas distribution networks. Changes in the structure of the distribution industry in recent years, particularly the splitting up of UnitedNetworks' gas distribution operations between Powerco and Vector, make it difficult to obtain consistent data through time. However, two companies – NGC Distribution and Wanganui Gas – have remained relatively stable in their structure since 1997. We have examined the operations of these two companies using data sourced from the section 70E notices which contain actual results for the period 1997 to 2003 and forecast results through to 2008. Closer examination of the data for Wanganui Gas revealed a number of apparent anomalies that it has not been possible to resolve in the time available. These mainly related to reported operating expenditure where there was, for instance, a 15 per cent fall in 2001 relative to 2000 [[redacted]]. Furthermore, as Wanganui Gas only accounts for around 3 per cent of gas throughput and 4 per cent of gas customers in New Zealand, we proceed by examining the productivity growth for NGC Distribution as an indicator of productivity growth likely to have occurred in the distribution industry as a whole.

For the 7 year period from 1997 to 2003 NGC Distribution's TFP increased at a relatively high trend annual rate of 2.8 per cent. [[redacted]]

In the following section of the report we briefly review the data and model used before presenting results in section 3.

2 DATA AND MODEL

NGC distributes gas to around 30 towns and cities in the North Island. Based on data for 2003, it is the third largest distributor in terms of customer connections which were estimated to be [[redacted]] residential customers and [[redacted]] other customers – and the second largest distributor measured in terms of gas supplied of 11,062 terajoules. NGC's distribution system comprises 2,739 kilometres of mains.

In 2003 NGC Distribution conveyed around one third of gas consumed in New Zealand and served just under one quarter of New Zealand's gas customers. The results for NGC Distribution are, thus, likely to provide a good indication of productivity growth occurring in the distribution industry as a whole.

The data used in this study are derived from the data supplied to the Commerce Commission by NGC Distribution in response to Section 70E notices. Some minor changes have been made to the Section 70E data to make it consistent with that used in the Commerce Commission's draft report. Specifically, the Commission adjusted the NGC [[redacted]] The Commission also adjusted the NGC operating and maintenance expenditure figures down for 2003, 2004 and 2005 to remove NGC's inquiry costs and adjusted the ODV figures for the period 1997 to 2008 in order to calculate revaluation gains for NGC's asset base.

In line with most earlier gas distribution studies, the distribution productivity analysis reported here contains two outputs and two inputs. A detailed discussion of measurement issues and output and input specification issues can be found in Meyrick and Associates (2004).

Output quantities

Throughput: The quantity of the distributor's throughput is measured by the number of terajoules of gas supplied.

Connections: Connection dependent and customer service activities are proxied by the distributor's total number of customers.

Output weights

To aggregate the two outputs into an aggregate output index we use the cost elasticity shares from the PEG (2001) translog cost function estimated for US gas distributors. This produces a throughput share of 14 per cent and a share for customer numbers of 86 per cent. The US information is used as there are insufficient observations available to undertake robust econometric estimation using New Zealand data.

Input quantities

Operating expenditure: The quantity of the distributor's operating expenses is proxied by its operating and maintenance expenditure (excluding all capital costs) to capture purchases of actual labour, materials and services used in operating the pipelines business. Information on current operating expenditure is converted to a (constant price) implicit quantity by deflating by the labour cost index for the electricity, gas and water sector. This price index is assumed to increase at 2 per cent per annum for the years 2004 to 2008, slightly higher than the current rate of inflation but in line with evidence of increasing wage pressures in the broader sector.

Capital: The quantity of capital input is proxied by the kilometres of mains.

Input weights

The value of total costs is formed by summing the estimated value of operating expenditure and 12.5 per cent of total ODV. We follow Meyrick and Associates (2003) and NZIER (2001) in assuming a common depreciation rate of 4.5 per cent and an opportunity cost rate of 8 per cent for capital assets. Input weights were then formed from the share of the cost of each of the inputs in total cost.

2.1 Total factor productivity indexes

Total factor productivity indexes are one of the methods most commonly used to measure cost efficiency. A TFP index is generally defined as the ratio of an index of output growth divided by an index of input growth. Growth rates for individual outputs and inputs are weighted together using revenue and cost shares, respectively. In other words, the TFP index is essentially a weighted average of changes in output quantities relative to a weighted average of changes in input quantities. TFP indexes have a number of advantages including:

- indexing procedures are simple and robust;
- they can be implemented when there are only a small number of observations;
- the results are readily reproducible;
- they have a rigorous grounding in economic theory;
- the procedure imposes good disciplines regarding data consistency; and

- they maximise transparency in the early stages of analysis by making data errors and inconsistencies easier to spot than using some of the alternative techniques.

Mathematically, the TFP index is given by:

(1) $TFP = \Delta Q / \Delta I$

where ΔQ is the proportional change in the quantity of total output between the current period and the base period and ΔI is the corresponding proportional change in the quantity of total inputs.

To operationalise this concept we need a way to combine changes in diverse outputs and inputs into measures of change in total outputs and total inputs. Different index number methods take this weighted average change in different ways. Alternative index number methods can be evaluated by examining their economic properties or by assessing their performance relative to a number of axiomatic tests. The index number which performs best against these tests and which is being increasingly favoured by statistical agencies is the Fisher ideal index.

Mathematically, the Fisher ideal output index is given by:

(2) $Q_F^t = [(\sum_{i=1}^{m} P_i^B Y_i^t / \sum_{j=1}^{m} P_j^B Y_j^B)(\sum_{i=1}^{m} P_i^t Y_i^t / \sum_{j=1}^{m} P_j^t Y_j^B)]^{0.5}$

where: Q_F^t is the Fisher ideal output index for observation t;

P_i^B is the price of the ith output for the base observation;

Y_i^t is the quantity of the ith output for observation t;

P_i^t is the price of the ith output for observation t; and

Y_j^B is the quantity of the jth output for the base observation.

In this case we have three outputs (so $m = 3$) and seven years (so $t = 1, \ldots, 7$).

Similarly, the Fisher ideal input index is given by:

(3) $I_F^t = [(\sum_{i=1}^{n} W_i^B X_i^t / \sum_{j=1}^{n} W_j^B X_j^B)(\sum_{i=1}^{n} W_i^t X_i^t / \sum_{j=1}^{n} W_j^t X_j^B)]^{0.5}$

where: I_F^t is the Fisher ideal input index for observation t;

W_i^B is the price of the ith input for the base observation;

X_i^t is the quantity of the ith input for observation t;

W_i^t is the price of the ith input for observation t; and

X_j^B is the quantity of the jth input for the base observation.

In this case we have five inputs (so $n = 5$) and seven years (so $t = 1, \ldots, 7$).

The Fisher ideal TFP index is then given by:

(4) $TFP_F^t = Q_F^t / I_F^t$.

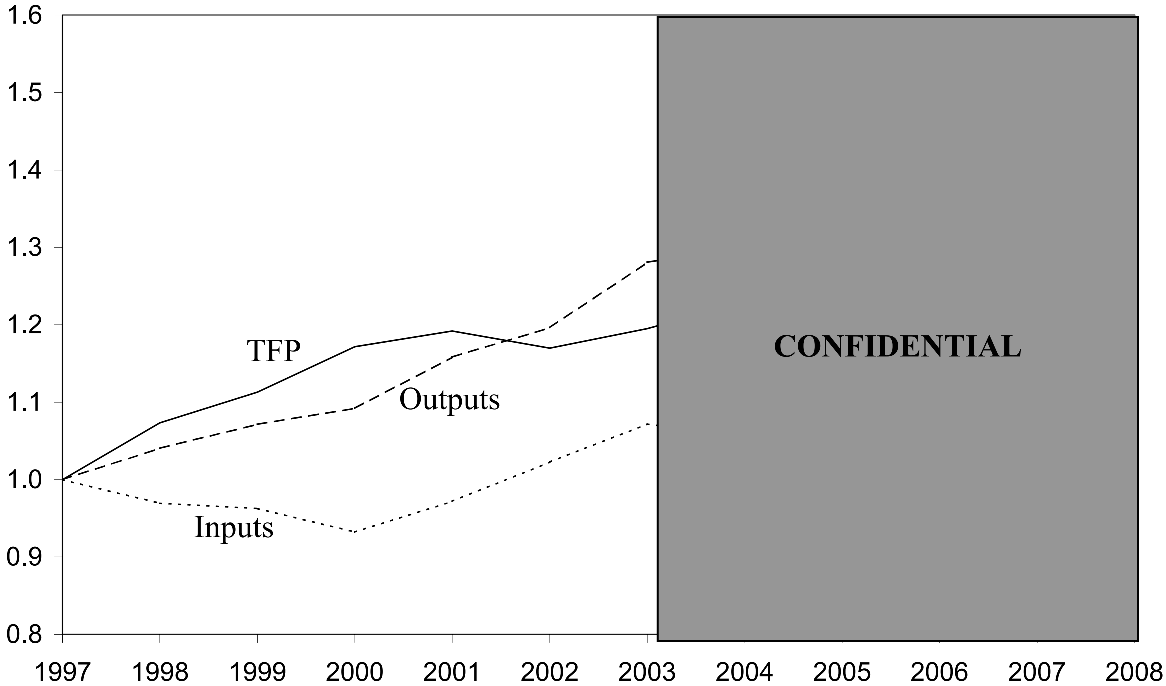
The Fisher index can be used in either the unchained form denoted above or in the chained form used in this study where weights are more closely matched to pair–wise comparisons of observations. Denoting the Fisher output index between observations i and j by $Q_F^{i,j}$, the chained Fisher index between observations 1 and t is given by:

(5) $Q_F^{1,t} = 1 \times Q_F^{1,2} \times Q_F^{2,3} \times .... \times Q_F^{t-1,t}$.

3 TIME–SERIES TFP RESULTS

TFP results for NGC Distribution are presented in figure 1 and table 1 using the chained Fisher indexing method and the 12 years of available actual and forecast data from 1997 to 2008.

Figure 1: **NGC Distribution output, input and TFP indexes, 1997–2008**

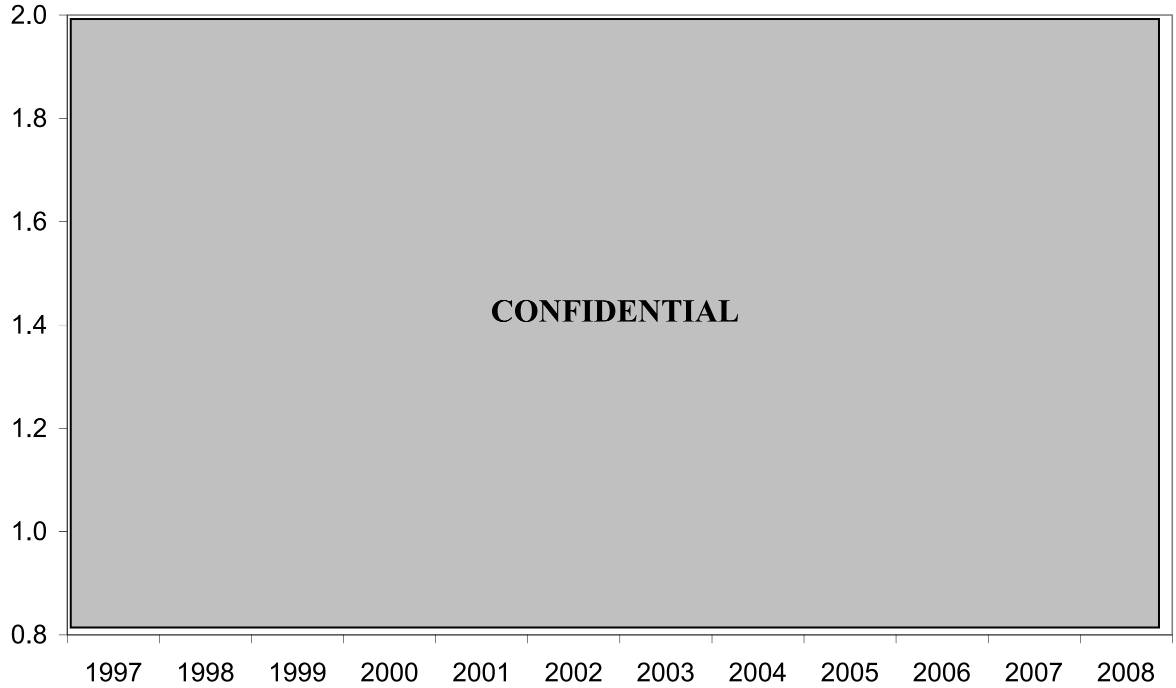


Source: Meyrick and Associates gas utility database.

[[redacted]] Input quantities initially declined between 1997 and 2000 before increasing through to 2003 and then levelling off. This pattern is driven primarily by changes in operating expenditure. NGC Distribution's kilometres of main increased by 17 per cent between 1997 and 2003 and are forecast to [[redacted]] NGC Distribution's customer density increased from 18.5 customers per kilometre in 1997 to 20.4 customers per kilometre in 2003. It is forecast to [[redacted]]

The TFP index increased by nearly 20 per cent between 1997 and 2001. The TFP index then decreased by 2 per cent in 2002 due to the combined effects of increased operating expenditure and an increase in the number of kilometres of main. [[redacted]] For the 7 year period from 1997 to 2003 NGC Distribution's TFP increased at a relatively high trend annual rate of 2.8 per cent. [[redacted]]

Figure 2: **NGC Distribution partial productivity indexes, 1997–2008**



Source: Meyrick and Associates gas utility database

In figure 2 and table 1 we present the TFP index and the two partial productivity indexes – the output quantity index divided by the relevant input quantity index – for NGC Distribution. [[redacted]

[redacted]] As would be expected in a capital intensive industry with long–lived assets, the partial productivity of capital is less volatile than that for operating expenditure.

Table 1: **NGC Distribution TFP and partial productivity indexes, 1997–2008**

	Quantity indexes			Partial productivities	
	Outputs	Inputs	TFP	OpEx	Capital
1997	1.000	1.000	1.000	[redacted]	[redacted]
1998	1.040	0.969	1.073	[redacted]	[redacted]
1999	1.071	0.963	1.113	[redacted]	[redacted]
2000	1.092	0.932	1.172	[redacted]	[redacted]
2001	1.158	0.972	1.192	[redacted]	[redacted]
2002	1.196	1.023	1.170	[redacted]	[redacted]
2003	1.281	1.072	1.195	[redacted]	[redacted]
2004	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2005	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2006	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2007	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2008	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Source: Meyrick and Associates gas utility database

APPENDIX 1: GAS UTILITIES DATABASE

Table A1: **NGC Distribution's outputs and inputs, 1997–2008**

Year	*Revenue $NZ mil*	*Throughput Terajoules*	*Customer Numbers*	*O&M $NZ mil*	*ODV $NZ mil*	*Capital kms*
1997	[redacted]	9,053	43,342	[redacted]	97.3	2,338
1998	[redacted]	8,519	45,834	[redacted]	97.6	2,428
1999	[redacted]	8,192	47,727	[redacted]	96.1	2,454
2000	[redacted]	8,769	48,270	[redacted]	108.5	2,479
2001	[redacted]	10,164	50,452	[redacted]	108.2	2,533
2002	[redacted]	10,236	52,318	[redacted]	115.6	2,639
2003	[redacted]	11,062	55,938	[redacted]	127.0	2,739
2004	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2005	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2006	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2007	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2008	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Source: Meyrick and Associates gas utility database

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