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The Potential Benefits of Hilmer and Related Reforms: Electricity Supply

by

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Abstract

This article examines the macroeconomic impact of the elimination of x-inefficiency in the Australian electricity supply industry using a computable general equilibrium (CGE) model of the Australian economy. Data envelopment analysis and a stochastic production frontier model are applied to measure x-inefficiency in the electricity industry. It is assumed that microeconomic reform will eliminate this x-inefficiency. The potential increase in total factor productivity resulting from microeconomic reform is introduced into the CGE model as a Hicksian-neutral factor-augmenting technological change. Two alternative labour market assumptions are utilised in measuring the macroeconomic benefits of the microeconomic reform. The results suggest that even under the most pessimistic labour market assumptions, the potential benefits of microeconomic reform in an industry such as electricity will not be trivial. It therefore follows that the impact of microeconomic reform on economic growth could be substantial, particularly if the Australian labour market is more flexible than hitherto assumed.

Keywords: microeconomic reform, x-inefficiency, data envelopment analysis, stochastic production frontier, computable general equilibrium, natural rate of unemployment.

J.E.L Classification number: D24

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1. Introduction

In a recent article Quiggin (1997) challenged the results of the Industry Commission's study of the growth and revenue implications of Hilmer[1] and related reforms. He suggested that the Industry Commission (1995) had overestimated the potential productivity gains resulting from the reforms. He also criticised their use of the computable general equilibrium model, ORANI[2] to estimate the dominant flow-on effects of microeconomic reform. As a result of his criticisms of the methodology of the Industry Commission and others[3] Quiggin concluded that the dominant flow-on effects of microeconomic reform would be negative because some of the workers displaced by the reforms would leave the labour force.

In this paper an attempt is made to measure the effects of microeconomic reform of the electricity industry taking into account Quiggin's criticisms of previous studies. In the following four sections the extent of x-inefficiency in the Australian electricity industry is measured utilising two established methodologies, data envelopment analysis and the estimation of the stochastic production frontier. Quiggin (1997)

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[1] Hilmer, Rayner and Taperell (1993).

[2] Dixon, Parmenter, Sutton and Vincent (1982).

[3] Bureau of Industry Economics (1990), Business Council of Australia (1994), Filmer and Dao (1994).

criticised the first methodology as leading to overly optimistic estimates of potential productivity gains and recommended the use of the second methodology. In this paper the estimates of x-inefficiency yielded by both methodologies for the Australian and other electricity supply industries are compared. In the following section, alternative labour market assumptions are used with a computable general equilibrium model to provide estimates of the effects on the Australian economy of the elimination of x-inefficiency in the electricity supply industry as a result of microeconomic reform. These estimates are compared to estimates yielded by the closure suggested by Quiggin (1997) in which some of the workers displaced from the electricity industry are presumed to leave the workforce permanently. The final section 7 provides a summary with conclusions resulting from the study.

2. Estimating x-inefficiency

Leibenstien and Maital (1992) acknowledge two techniques for measuring the extent of x-inefficiency. The first technique, called stochastic production frontier (SPF), is a parametric technique involving the specification and estimation of a stochastic production frontier model.[4] The second technique called data envelopment analysis (DEA) involves using non-parametric mathematical programming[5] to construct a piecewise surface as an estimate of the best-practice production frontier. Both techniques utilise the estimated production frontiers to derive estimates of x-inefficiency.

[4] Aigner, Lovell and Schmidt (1977).
[5] Charnes, Cooper and Rhodes (1978).

Quiggin (1997) along with other econometricians have suggested that, being non-parametric, DEA fails to take account of stochastic elements in the data, such as errors in the measurement of variables and confounding enterprise specific factors. Accordingly these have favoured the application of SPF models to measure x-inefficiency. However, SPF models are subject to problems in specifying the underlying production function and the nature of the non-stochastic error that DEA avoids. In the next two sections a DEA model and a general specification of the SPF model are outlined. These models are applied to measure x-inefficiency in the Australian electricity supply industry in Section 5.

3. Data Envelopment Analysis

The estimation of technical efficiency as a problem in mathematical programming has been called data envelopment analysis (DEA). DEA is usually attributed to Charnes, Cooper and Rhodes (1978) although others had applied mathematical programming techniques to input-based efficiency measurement in the late 1960s and early 1970s. A major recent development has been the decomposition of technical efficiency by Fare, Grosskopf and Lovell (1985). This allows the elimination of technical inefficiency due to uncontrollable factors, such as scale and input congestion.

Following Fare, Grosskopf and Lovell (1985), the input oriented measure of technical efficiency of a supplier k is calculated as the solution (TE_k) to the following mathematical programming problem:

$$\text{Choose } z \text{ to minimise } \lambda \qquad (1)$$
$$\text{s.t.} \quad y^k \leq Yz$$

$$\mathbf{X}z \leq \lambda x^{k}$$
$$lz = 1$$
$$z \in R_{+} \quad \text{and}$$
$$TE_{k} = \text{minimum value of } \lambda.$$

y^k represents the output of supplier k. x^k is a vector of supplier k's inputs with elements x_j^k (j=1,…,M). *Y* is a (1xN) vector of the outputs of all suppliers with elements y^i (i=1,…N). **X** is a (MxN) matrix of the inputs of all suppliers with elements x_j^i. *z* is a (Nx1) vector of weights z_i to be determined. λ is a scalar value denoting the proportional reduction in all inputs, holding the relative factor proportions and output constant.

The minimum value of λ that satisfies the mathematical programming problem (i.e. TE_k) is called the Farrell radial measure of technical efficiency.[6] This represents the proportional reduction in inputs that can be achieved through the adoption of the best practices of the suppliers in the sample.

A best practice supplier who is operating on the production frontier will have technical efficiency score (TE_k) of unity. This means that this particular supplier has zero technical or x-inefficiency. In other words, given the existing data on outputs and inputs of suppliers, it is not possible to construct a more efficient benchmark supplier using the mathematical programming formulation outlined above.

A supplier who is operating off the production frontier will have a technical efficiency score (TE_k) of less than unity. This means that the particular supplier is technically or x-inefficient and can reduce inputs by at least (1- TE_k)*100 per cent by adopting the practices of relevant best practice suppliers. [7] The relevant best practice suppliers are those suppliers for which $z_i>0$. The proportional contribution of a particular best practice supplier i to the best practice benchmark of supplier k is calculated as the ratio $z_i y^i / Yz$.

The output of the application of DEA for each supplier is therefore a measure of the suppliers x-inefficiency and identification of the members of the best practice reference set and their contribution to the suppliers best practice benchmark. In DEA each supplier will have a unique best practice benchmark corresponding to its particular input-output configuration. In normal business practice x-inefficient suppliers would be encouraged to form benchmarking partnerships and to adopt the best practices of the relevant best practice suppliers. In this way the x-inefficiency would be eliminated. In the present circumstances it is assumed that the introduction of competitive pressures into hitherto monopoly markets would promote the adoption of best practices and, hence, the elimination of any controllable x-inefficiency.

4. Stochastic Production Frontier

The estimation of a stochastic production frontier (SPF) is attributed to Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977). They independently proposed the estimation of a production function where the error is separated into a stochastic component (v_i) to account for measurement error, weather, strikes and other random factors and a one-sided systematic component (u_i) measuring x-inefficiency,

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[6] Farrell (1957).

[7] The existence of slack in respect of some (not all) inputs means that these inputs might be reduced even further at best practice.

i.e. the proportional departure from the best practice frontier. The general stochastic production frontier model is defined as follows:

$$y^i = f(x^i ;\beta) \exp(v_i - u_i) \quad , \qquad i = 1,\ldots,N. \tag{2}$$

β is the (Mx1) vector of production function coefficients so that $f(x^i ;\beta)$ is the stochastic production frontier and $\exp(-u_i)$ is the technical efficiency term..

u_i are assumed non-negative and to be independently and identically distributed as the truncated normal distribution $N(\mu,\sigma^2)$. According to Stevenson (1980), this is a more general specification of x-inefficiency than the conventional half-normal distribution centred on mode $\mu = 0$. v_i is assumed to be independently and identically distributed as the normal distribution $N(0, \sigma_v^2)$.

Following Jondrow, Lovell, Materov and Schmidt (1982) the expectation of u_i , conditional on $e_i = (v_i - u_i)$, is used to predict u_i . Battese and Coelli (1988) calculate the technical efficiency of individual suppliers as follows:

$$TE_k = \exp[E(-u_k)| e_k]$$

$$= \{[1-\Phi(\sigma_A - \gamma e_k/\sigma_A)]/[1-\Phi(\gamma e_k/\sigma_A)]\}\exp(\gamma e_k + \sigma^2_A/2) \tag{4}$$

where $\Phi(.)$ is the distribution function of a standard normal random variable,

and $\gamma = \sigma^2 / \sigma_s^2$

$\sigma_S^2 = \sigma^2 + \sigma_v^2$

$\sigma_A = \{\gamma(1-\gamma)\sigma_S^2\}^{1/2}$

The translogarithmic function is adopted as the most general functional form for the stochastic production frontier, ie:

$$\ln(y^i) = \beta_0 + \sum_{j=1}^{M} \beta_j \ln(x_j^i) + \tfrac{1}{2}\sum_{r=1}^{M}\sum_{s=1}^{M} \beta_{rs}[\ln(x_r^i)\ln(x_s^i)] + (v_i - u_i) \tag{5}$$

where $\beta_{rs} = \beta_{sr}$ (r,s = 1,..,M).

5. Data and estimation

The DEA results are based on a model with one output, electricity generated (GWh), and three inputs, hydro-capacity (MW), thermal capacity (MW) and the number of full-time employees. The SPF results are based on a model with one output, electricity generated, and two inputs, total generating capacity (K) and the number of full-time employees (L).[8] The data for 111 electricity suppliers, including the seven Australian suppliers, was obtained from Electricity Association Services Ltd (1996), Electricity Supply Association of Australia Limited (1996), Annual Report of China Light and Power Company, Limited (1994) and Heidarian and Wu (1994).

The data relates to different years for different suppliers. The World Bank data on developing country suppliers covered the period 1987 to 1991. However in many cases a complete set of data on inputs and outputs was only available for 1988. The data on developed countries covered the period 1994 to 1995. The Australian data related to the fiscal year 1994-95. This data is aggregated and summarised in Table 1.[9]

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[8] A three input SPF model is inapplicable as a small number of the suppliers did not have any hydro generating capacity.
[9] Data on the individual suppliers is described in Whiteman (1997).

Table 1
Summary of international data on electricity suppliers[10]

	Number of suppliers	*Hydro-capacity (%)*	*Productivity (GWh per employee)*	*Capacity factor[11] (%)*
Canada	4	60	7.2	54
Baby tiger economies	4	24	0.8	48
Asian tiger economies	4	10	5.8	58
Japan	3	17	5.1	47
Europe	15	22	2.6	46
United States	3	13	4.9	48
Australia	7	20	3.8	48
Developing economies	69	38	0.4	47
Israel & South Africa	2	5	4.4	51
All suppliers	111	28	1.1	48

Table 2
Parameter Estimates for the Translog Stochastic Production Frontier with truncated normal x-inefficiency

Coefficient	*Associated parameter*	*Value of coefficient*	*t-ratio*
β_0	constant	1.649	3.033
β_K	$\ln(x^i_K)$	0.882	10.989
β_L	$\ln(x^i_L)$	0.046	0.415
β_{KK}	$[\ln(x^i_K)]^2$	0.008	0.770
β_{LL}	$[\ln(x^i_L)]^2$	-0.004	-1.755
β_{KL}	$[\ln(x^i_K) \ln(x^i_L)]$	0.003	0.135
γ		1.000	2134348.100
μ		-2.145	-1.410
Log-liklihood function		-0.99	

[10] Developing economies are identified by Heidarian and Wu (1994). The Baby Tiger economies are Thailand, Philippines, Malaysia and Indonesia. The Asian Tiger economies are Hong Kong, South Korea, Singapore and Taiwan.
[11] This ratio measures the extent to which a supplier utilises installed capacity. It is calculated as follows: [(Gross output in MWh)/(installed capacity in MW x 8760 hours) x 100].

The parameters of the SPF model, summarised in Table 2, were estimated by the method of maximum liklihood and calculated using the computer program FRONTIER Version 4.1.[12] The program also supplies estimates of x-inefficiency u_i for individual suppliers. The estimated value and significance of γ suggests that there is very little stochastic error and consequently that DEA should provide relatively accurate estimates of x-inefficiency. The DEA estimates were obtained using the Solver facility of Microsoft Excel.

Table 3
Alternative estimates of x-inefficiency of electricity suppliers

	DEA Model (%)	*SPF Model (%)*
Canada	4.06	12.89
Baby tiger economies	21.61	15.32
Asian tiger economies	3.00	4.20
Japan	14.46	27.54
Europe	9.98	30.79
United States	16.36	18.16
Australia	19.15	16.02
Developing economies	16.28	21.53
Israel & South Africa	0.57	19.05
All suppliers	11.77	23.48
NSW	25.62	23.76
VIC	12.81	7.30
QLD	15.91	8.17
SA	19.99	23.07
WA	9.39	13.79
TAS	27.21	26.31
NT	29.85	29.35

Estimates of x-efficiency from the DEA and SPF models are summarised in Table 3. It is notable that, on average, the DEA estimates of x-inefficiency are about half of the

[12] Coelli (1996)

size of the SPF estimates. This would contradict conventional wisdom that suggests that the DEA estimates of x-inefficiency would be larger because the methodology fails to eliminate stochastic sources of error.[13] In the case of Australia as a whole, the SPF estimate of x-inefficiency is 3 percentage points lower than the corresponding DEA estimate. Estimates from both methodologies for New South Wales, South Australia, Tasmania and the Northern Territory are likewise relatively close. In the case of Victoria and Queensland, the DEA estimates are well above the SPF estimates of x-inefficiency while in the case of Western Australia the opposite applies.

Table 4

Best-practice benchmarks for Australian Electricity Suppliers

Supplier	*Benchmark suppliers*	*Contribution to benchmark (%)*	*Hydro capacity (%)*	*Capacity Factor (%)*	*Labour productivity (GWh)*	*Sales per million customers (MWh)*
NSW			19.3	45.8	3.3	18.6
	Hydro-Quebec	2	93.1	54.9	7.4	42.0
	Taiwan Power	97	17.7	61.7	5.7	11.6
	China	1	34.4	65.5	0.3	na
VIC			20.6	53.6	4.9	16.4
	Hydro-Quebec	3	93.1	54.9	7.4	42.0
	Taiwan Power	96	17.7	61.7	5.7	11.6
QLD			9.2	52.4	4.2	18.8
	Korea Electric	81	6.9	62.5	6.2	11.1
	Taiwan Power	18	17.7	61.7	5.7	11.6
	China	1	34.4	65.5	0.3	na
SA			0.0	41.4	2.9	13.2
	PG Singapore	78	0.0	51.3	7.6	21.3
	St Lucia	1	0.0	54.0	0.5	4.1
	Zimbabwe	21	0.0	53.5	1.3	31.2
WA			0.1	47.0	3.3	15.2
	PG Singapore	77	0.0	51.3	7.6	21.3
	Korea Electric	1	6.9	62.5	6.2	11.1
	Zimbabwe	21	0.0	53.5	1.3	31.2
TAS			90.2	39.6	5.1	33.5
	Oslo Energi	2	99.6	42.7	18.3	26.4
	Hydro Quebec	94	93.1	54.9	7.4	42.0
	TransAlta	3	13.0	55.2	15.2	81.8
NT			0.0	36.0	2.6	20.3
	PG Singapore	93	0.0	51.3	7.6	21.3
	St Lucia	7	0.0	54.0	0.5	4.1

[13] In his example Quiggin (1997) suggests that potentially half of the variance of the OLS error term and consequently half of the DEA estimate of x-inefficiency could be due to measurement errors and other enterprise specific factors. The estimated value of γ above suggests that virtually all of the variance of the error can be attributed to the non-stochastic x-inefficiency component of the error term.

In view of the closeness of the estimates for Australia and the evidence of no significant stochastic error, the DEA estimate of 19.15 per cent x-inefficiency for Australian electricity suppliers is adopted for the purposes of this study. The DEA result implies that Australian suppliers can eliminate this x-inefficiency by adopting the practices of their relevant best-practice benchmark suppliers.

The relevant best-practice benchmark suppliers, their characteristics, and their contributions to the best-practice benchmark of the Australian suppliers are outlined in Table 4. It is evident that Taiwan Power is a good benchmark for NSW and Victoria in terms of both labour and capital productivity. Korea Electric is the main benchmark for Queensland while Powergrid Singapore is the main benchmark for South Australia, Western Australia and the Northern Territory. Hydro-Quebec is the main benchmark for Tasmania. In terms of input mixes (i.e. the proportion of hydro-capacity), these main benchmark suppliers do appear to approximate the input mixes of their prospective Australian benchmark partners. [14]

6. General equilibrium effects of eliminating x-inefficiency

It is assumed that the competitive reforms currently being undertaken within the Australian electricity supply industry will lead to the elimination of x-inefficiency. The reduction of x-inefficiency is equivalent to a Hicksian neutral factor augmenting technical change. The impact is to increase the productivity of all factors of

[14] Quiggin (1997) suggests that previous studies have failed to take proper account of differences in factor input mix and of differences in sales per customer. In particular he challenges the use of a Canadian electricity company serving a few very large industrial customers as a best practice benchmark for labour productivity. In the present study, TransAlta Utilities of Alberta , Canada probably falls into this category. However as can be seen in Table 4, TransAlta only makes a very small contribution to the best-practice benchmark of Tasmania.

production in the electricity industry equally and thereby to reduce the cost of electricity for all other industries and consumers. The resulting reduction in the cost of electricity would be expected to have a stimulatory impact throughout the economy.[15] The impact of this stimulus on GDP growth will depend on government fiscal policy and the flexibility of the labour and capital markets.

The Industry Commission (1995) assumes that the unemployment rate is unaffected by the elimination of x-inefficiency in the electricity industry and that the stimulus translates into higher real wages. In its sensitivity analyses however, the Commission does acknowledge the possibility that the stimulus could result in reductions in unemployment rate by up to 2.25 percentage points.[16] Quiggin (1997) points out that the Commission fails to take account of workers displaced from the electricity industry because of the increased productivity of labour. He suggests that 35 per cent of these workers will leave the labour force permanently.

The Industry Commission also assumes that capital is flexible in the long run and can adjust in response to any stimulus arising from lower electricity costs. The rate of return to capital is assumed constant.

In the Industry Commission's underlying assumptions, real aggregate government expenditure and tax revenue is held constant and monetary policy is accommodating so that there is no change in the rate of inflation as a result of microeconomic reform. Quiggin has challenged the assumption that tax rates and real government expenditure

[15] On average electricity constitutes about 6 per cent of industry intermediate inputs.

do not change. As Quiggin observes, the Industry Commission (1995, p. 50) accepts that their assumption is 'highly artificial' and that the revenue gains from microeconomic reform are more likely to be used 'to increase government spending, reduce tax rates, retire debt or some combination of the three'.

In the present study the direct and general equilibrium effects of a reduction in x-inefficiency in the electricity supply industry of 19.15 per cent is investigated using a version of the Monash multisectoral, computable general equilibrium (CGE) model of the Australian economy in comparative static mode.[17] The standard structural macroeconomic closure is employed in which government expenditure and tax revenues are allowed to vary as a result of the microeconomic shock.

Two experiments are conducted with different labour market assumptions. In both experiments capital stock is assumed flexible. In the first experiment the favoured labour market assumption of the Industry Commission (1995, p. 63) as modified by Quiggin (1997) is adopted. In this experiment a natural rate of unemployment of 8.5 per cent is assumed.[18] However the Commission's assumed growth in aggregate employment is reduced by 35 per cent of the number of displaced electricity workers who are presumed to leave the labour market. In the second experiment, the favoured labour market assumption of the Industry Commission (1995, p. 63) is adopted. In this

[16] The Industry Commission (1995, p.62) here assumes that the Hilmer process reduces the natural rate of unemployment from 7.25 to 6.25 per cent.
[17] Adams, Dixon, McDonald, Meagher and Parmenter (1994).
[18] Under this assumption, the Industry Commission (1995, p. 50, 63) allows for the Hilmer and related reforms to result in an increase in the participation rate. Hence, while employment grows by 0.39 per cent, the unemployment rate remains at 8.5 per cent in the second experiment. In the first experiment, following Quiggin (1997), this employment growth is reduced by 0.06 percentage points to 0.33 per cent, i.e. to cover the withdrawal of 35 percent of the displaced electricity workers from the labour force.

experiment a natural rate of unemployment of 8.5 per cent is assumed with aggregate employment growing to offset an increase in the participation rate.

Table 5
Impact of Hilmer reforms on electricity supply industry

Experiment	*1*	*2*
Aggregate employment assumption (%)	*0.33**	*0.39***
Capital productivity (%)	23.57	23.57
Labour productivity (%)	23.84	23.84
Price of electricity (%)	-9.63	-9.63
Capital (%)	-18.57	-18.53
Employment (%)	-18.75	-18.71
Electricity supply (%)	0.65	0.69

* As for experiment 2 but with 35 per cent of displaced electricity workers leaving the labour force.
** Industry Commission (1997, p.63) , (unemployment rate 8.5%).

Elimination of x-inefficiency in the electricity supply industry is equivalent to a Hicks neutral factor augmenting technical change. Accordingly, the results for electricity summarised in Table 5 show labour and capital productivity in the electricity industry increasing by about the same rate, 24 per cent. The direct impact of the reforms, therefore, is to reduce capital and labour inputs in the electricity industry by 19 per cent. As the effective cost of inputs fall, the price of electricity to other industries is reduced by about 10 per cent.[19] The impact of this fall in the price of electricity on other industries is summarised in Table 6.

Activity is directed away from the relatively less electricity using agricultural and agricultural based industries towards the more electricity intensive mining, manufacturing and service industries. The mining industry is the major benefactor of

[19] The Industry Commission (1995,p.20) assume that competitive pressures improve labour and capital productivity in a non-neutral manner by 50 and 4 per cent respectively. Electricity prices to manufacturing, mining and services are assumed to reduce by between 26 to 29 per cent.

reform of the electricity industry. This is because electricity accounts for about 11 per cent of the intermediate inputs in mining compared to about 6 per cent for most other industries. Hence the fall in the cost of electricity generates a relatively large fall in the foreign currency price of Australian minerals.[20]

Table 6
Estimated impact of electricity reforms on industry output

Experiment	*1*	*2*
Aggregate employment assumption (%)	*0.33**	*0.39***
Broadacre farming	-0.21	-0.19
Intensive farming	0.16	0.21
Mining coal and ores	1.93	2.00
Mining other	0.29	0.35
Food and fibre	0.02	0.02
Food other	0.25	0.29
TCF	0.26	0.31
Wood	0.59	0.66
Paper	0.46	0.51
Chemicals	0.50	0.56
Non-metallic products	0.60	0.67
Metal products	-0.10	-0.04
Transport equipment	0.61	0.67
Other machinery	0.29	0.35
Other manufacturing	0.38	0.44
Electricity	0.65	0.69
Gas	0.75	0.81
Water	0.65	0.71
Construction	0.72	0.78
Wholesale and retail trade	0.44	0.50
Transport	0.75	0.81
Communication	0.65	0.72
Finance	0.61	0.67
Dwellings	0.75	0.83
Public administration	0.58	0.64
Community Services	0.57	0.64
Recreational Services	0.53	0.59

* As for experiment 2 but with 35 per cent of displaced electricity workers leaving the labour force.
** Industry Commission (1997, p.63) , (unemployment rate 8.5%).

[20] Quiggin (1997,p. 260) attributes the expansion of mining relative to other sectors to very high elasticities of supply and demand for minerals. In the Monash model the export demand elasticity for minerals has a relatively small absolute value (-12.3 compared to -20 for most other industries) and the supply elasticities tend to be smaller or the same as for other industries.

Table 7
Macroeconomic effects of electricity reform (%)

Experiment	*1*	*2*
Aggregate employment assumption (%)	*0.33**	*0.39***
Real GDP	0.58	0.64
Real consumption	0.58	0.64
Real investment	0.58	0.64
Real government spending	0.59	0.65
Export volume	0.49	0.56
Import volume	0.49	0.54
Terms of trade	-0.00	-0.01
Real wage	0.58	0.51
Aggregate capital stock excluding electricity capital	0.74	0.81
Exchange rate	-0.01	-0.02

* As for experiment 2 but with 35 per cent of displaced electricity workers leaving the labour force.

** Industry Commission (1997, p.63) , (unemployment rate 8.5%).

The macroeconomic effects of the two experiments are summarised in table 7. The results are similar in spite of the difference in labour market assumptions. As a result of the elimination of x-inefficiency in the electricity industry, real GDP increases by 0.6 per cent. The direct impact on real GDP of the increase in total factor productivity in the electricity industry is 0.4 per cent.[21] In both cases, therefore, the dominant flow-on effects of the x-inefficiency reducing microeconomic reform are positive even though in the first experiment, as in Quiggin (1997), some electricity workers are permanently displaced from the workforce.[22]

7. Summary and conclusions

[21] The direct impact on GDP growth is calculated as the product of electricity's share of GDP by the total factor productivity change, (i.e, 0.02027*19.15 = 0.39).

[22] Under similar labour market assumptions as experiment 1, Quiggin (1997, p.257) estimates a total impact on real GDP of 0.08 per cent and a direct impact of 0.10 per cent for reforms in electricity, gas and water. Thus he argues that the dominant flow-on effects of microeconomic reform will be negative because of the permanent displacement of some of the electricity workers from the workforce. The Industry Commission (1995,p.51) estimates a total impact on real GDP of 1.39 per cent for electricity and gas under the labour market assumptions of experiment 2.

The objective of this paper has been to examine the effects of microeconomic reform of the electricity industry taking into account the criticisms of Quiggin (1997) of previous attempts to measure the potential benefits of microeconomic reform, notably by the Industry Commission (1995). As a result of his criticisms Quiggin (1997, p 270) concluded that, ”The direct gains from the entire program of microeconomic reform are likely to be no more than 1 per cent of GDP and these may be partially offset by resulting increases in unemployment”.

The effect of microeconomic reform has been interpreted as resulting in the elimination of x-inefficiency, thereby increasing total factor productivity in the electricity industry. In the present paper the criticisms of Quiggin have been taken into account in estimating the potential benefits of microeconomic reform of the electricity industry. In the first place x-inefficiency in the electricity industry has been estimated utilising both data envelopment analysis (DEA) and the estimation of a stochastic production frontier. The results suggested that, for Australia, there was little difference in the estimates yielded by both methodologies. The results for the stochastic production frontier indicated the presence of little stochastic error and hence that DEA was an appropriate methodology in the circumstances. Secondly the best-practice benchmarks yielded by DEA did not involve the unrealistic comparisons referred to by Quiggin (1997).

The DEA results indicated x-inefficiency of 19 per cent in the Australian electricity industry. The impact of the elimination of this x-inefficiency was measured using the Monash computable general equilibrium model. The direct impact of the improvement in total factor productivity arising from the elimination of x-inefficiency in the electricity industry is equivalent to a 0.39 per cent increase in GDP. Two experiments were conducted corresponding to the Quiggin (1997) and Industry Commission (1995) labour market assumptions.

In the first experiment following Quiggin (1997), 35 per cent of workers displaced from the electricity industry by the improvement in labour productivity are assumed to leave the labour market thereby increasing the current unemployment rate. Under this labour market assumption, the total economy wide benefit is estimated as equivalent to 0.58 per cent of real GDP. This implies that the flow on effects resulting from increasing employment and capital stock is equivalent to 0.19 per cent of real GDP.

In the second experiment following the Industry Commission (1995) a natural rate of unemployment of 8.5 per cent was assumed. The results implied an economy wide benefit equivalent to 0.64 per cent of real GDP. This implies that the additional labour market adjustment effects identified by Quiggin (1997) would reduce the economy wide benefit by the equivalent of 0.06 percent of real GDP.

These results show that the potential benefits of microeconomic reform in an industry such as electricity are not trivial. Even if there is no labour market flexibility and significant adjustment costs are incurred, the benefits of microeconomic reform are positive. These experiments have been carried out on the assumption of a natural unemployment rate around 8.5 per cent. This implies an extremely pessimistic view regarding the flexibility of the Australian labour market and the ability of the currently unemployed to take up the employment opportunities offered by lower electricity prices. It also presumes that labour through its unions will selfishly appropriate most of the gains of microeconomic reforms such as those occurring in the electricity industry through demanding and achieving higher real wages.

If the Australian labour market is more flexible than hitherto assumed then the benefits of microeconomic reform could be substantial. A more optimistic view of the labour market would concede that a proportion of the currently unemployed, at least, are available for work and that the currently employed are willing to forgo some (not necessarily all) of the benefits of microeconomic reform.

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