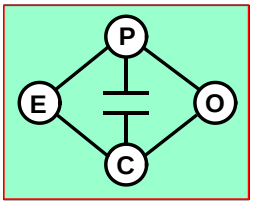

Transmission Pricing Methodology: issues and proposal

Submission by Electric Power Optimization Centre

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Executive Summary

1. In a previous submission (March 1, 2013), EPOC claimed that the beneficiary-pays proposal provided incentives for suppliers to change their offer strategies to increase prices on infra-marginal tranches and in some circumstances to increase prices on supra-marginal bids. Under current wholesale market arrangements the proposal provides incentives for consumers who bid a demand curve to change their bid strategies to decrease prices on dispatched tranches. Such incentives bias the cost allocation towards some agents (without the ability to bid strategically) whose share of benefits will be overstated (e.g. wind and non-bidding demand).

2. EPOC's claims were made based on some preliminary experiments using supply-function equilibrium models. Although EPOC stands by the claims in (1), recent work shows that the incentives are not as strong as previously thought.

3. EPOC also claimed that the incentives to bid strategically have the potential to decrease the efficiency of dispatch as agents offer approximate pay-as-bid strategies, which lead to mixing over a set of offers that have different prices. Our more recent models provide less support for this assertion.

Introduction

The Electricity Authority has proposed a beneficiary pays scheme for allocating costs of transmission assets. This entails the estimation of the benefits of an asset accruing to different agents by running the dispatch software (SPD) both with and without the asset. Despite the apparent elegance and simplicity of this proposal, it provides some incentives to alter offer behaviour.

A previous submission by EPOC (March 1, 2013) provided some analysis of the incentives provided by imposing taxes on supplier profits. This analysis has been improved in the companion paper "*Supply function equilibrium with taxed benefits*", which accompanies this submission as an appendix.

Upgrading the line capacity in a two-node network

In the companion paper, we have performed an analysis of the 2012 beneficiaries-pay transmission pricing methodology in the context of a two-node network with an upgraded transmission line, as depicted in Figure 1.

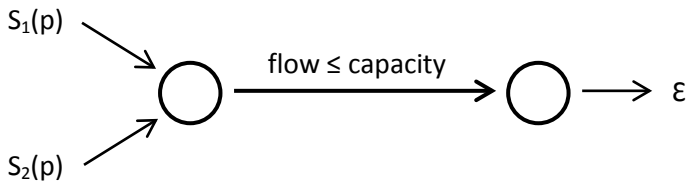

Figure 1: Two-node Network

We have performed a sensitivity analysis which looks at the effect of altering three of the parameters of the model: the tax rate; the maximum demand level; and the size of the line upgrade. These are not intended to be representative of a New Zealand market, but simply serve to illustrate the effects on optimal equilibrium behaviour that emerge from different parameter choices. The results of the analysis are presented in Table 1, below.

In all the models we assume a marginal cost for both supplies of 1.

We first considered a **baseline** scenario, with a price cap of 6[1], a demand level uniformly distributed between 0 and 10, a line capacity that has been upgraded from 2 to 8, and a tax-rate of 25% of benefits. Note that, in this model, the benefits that are taxed are the differences in perceived profits (infra-marginal rents) for generators, or consumer welfare, before and after a transmission capacity upgrade.

[1] The price cap here might indicate the short-run marginal cost of an expensive thermal plant of last resort, or a value of lost load at which involuntary load reduction occurs. It is introduced so as to yield a unique SFE. For details the reader is referred to the companion paper.

In Table 1, ‘S’ and ‘St’ correspond to different generator offer behaviour, with ‘S’ assuming that generators do not alter their bids to account for the tax, and ‘St’ being the equilibrium behaviour taking the tax into account. If we look at the baseline scenario, we see that generators, by changing their offer strategy (while competing in a duopoly setting), are able to increase their collective post-tax profit by 0.681, whereas pre-tax consumer welfare drops by 0.318. However, for a fixed tax-rate, the amount of tax paid by consumers also decreases due to the generators’ strategic behaviour. As the tax rate rises, the firms alter their bids further to minimize the tax they must pay, further reducing consumer surplus.

It is also possible to see that a total tax revenue of 4.208 is achievable by charging a tax rate of 33%, when suppliers do not act strategically. If they do then the tax rate must be increased to 40% to recover the same amount of revenue.

The second experiment that we considered increased the maximum demand (meaning that the line after expansion would be congested more often). This had the effect on each firm’s offer curve of increasing the price and flattening the curve so as to minimize the tax due in the high-demand scenarios. From Table 1, we can see that a higher proportion of the tax due under offer curve ‘S’ is avoided at the new equilibrium ‘St’ than in the baseline, while at the same time consumer surplus is significantly reduced. The message here is that suppliers will have more incentives to avoid contributing to the cost of line capacity increases that are not sufficient to reduce congestion significantly.

The final experiment considered how the size of the line upgrade affected the equilibrium behaviour. In fact, when the size of the upgrade is small (see the case with J=6 in Table 1), firms behave more competitively after the tax is imposed, and we can see that pre-tax consumer surplus is higher for the equilibrium where firms take the tax into account. This places firms in a prisoner’s dilemma, in which both would prefer not to alter behaviour in response to the tax, but must do so in equilibrium, even though this yields an inferior outcome.

Conclusions

Incentives to change offer behaviour to avoid beneficiary-pays charges weaken with increased uncertainty in demand shocks. When future demand (and wind generation) is known, suppliers can increase their offers on inframarginal bids with little risk of not being dispatched at the forecast point. This incentive attenuates when the risk of not being dispatched increases.

Incentives to change offer behaviour increase when the benefits of line expansion are large (such as if the line expands a large amount) or there is a high probability of the expanded line being congested (amounting to more certainty in the dispatch point).

In some circumstances, incentives to avoid tax can result in an equilibrium that is more competitive than that obtained in the absence of a tax.

		Baseline		Increasing Tax Rate				Large Demand Shock		Increasing old line capacity			
Parameters	Price cap	6		6		6		6		6		6	
	Max Shock	10		10		10		20		10		10	
	Marginal cost (c)	1		1		1		1		1		1	
	Enlarged capacity (K)	8		8		8		8		8		8	
	Restricted capacity (J)	2		2		2		2		4		6	
	Tax rate	0.25		0.33		0.4		0.25		0.25		0.25	
		S	**St**	**S**	**St**	**S**	**St**	**S**	**St**	**S**	**St**	**S**	**St**
Welfare Values	Pre-tax rent per firm with line upgrade	9.333	9.492	9.333	9.519	9.333	9.536	14.667	15.175	9.333	9.386	9.333	9.286
	Taxable benefit for each firm	4.125	3.399	4.125	3.257	4.125	3.153	6.750	3.827	2.833	2.572	1.292	1.316
	Tax per firm	1.031	0.850	1.361	1.075	1.650	1.261	1.688	0.957	0.708	0.643	0.323	0.329
	Post-tax benefit for each firm	8.302	8.643	7.972	8.444	7.683	8.275	12.979	14.218	8.625	8.743	9.010	8.957
	Total consumer surplus with line upgrade	5.333	5.015	5.333	4.962	5.333	4.928	2.667	1.650	5.333	5.227	5.333	5.428
	Consumer benefit	4.500	4.269	4.500	4.232	4.500	4.210	2.250	1.345	2.667	2.667	0.833	0.888
Tax	Consumer tax	1.125	1.067	1.485	1.397	1.800	1.684	0.563	0.336	0.667	0.667	0.208	0.222
	Producer tax	2.063	1.699	2.723	2.150	3.300	2.523	3.375	1.913	1.417	1.286	0.646	0.658
	Total tax	3.188	2.767	4.208	3.547	5.100	4.207	3.938	2.250	2.083	1.953	0.854	0.880
Change	Change in pre-tax consumer surplus	-0.318		-0.371		-0.405		-1.017		-0.106		0.094	
	Change in pre-tax producer benefit	0.318		0.371		0.405		1.017		0.106		-0.094	
	Change in post-tax producer benefit	0.681		0.944		1.183		2.479		0.237		-0.106	

Table 1: Sensitivity analysis of equilibrium behaviour.