Rent seeking, interest groups and environmental lobbying: Cane Farmers versus Great Barrier Reef Protectionists

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Abstract

In this paper an interest group model of rent seeking behaviour between sugarcane farmers and environmental protectionists is developed. The motivation for this scenario comes from the debate over fertilizer run-off and its possible impact on Queensland's Great Barrier Reef. The paper takes Gordon Tullock's rent-seeking model and applies it to the bargaining process over controls on fertilizer application in an effort to learn something about the likely political outcomes of this debate.

1 Introduction

Current interest in eutrophication of the barrier reef and the possible impact of agricultural run-off on the reef and the reef lagoon is very high. The issue has received wide media exposure and has generated a government inquiry and a number of consulting reports. Contrasting with the wide public and scientific interest in the issue economic analysis of the problem has been limited. Exceptions include Beard (2002), Millen (2003)[1], Hall (2005)[2] and Brough and Beard (2006).

Given the politically controversial nature of the topic a public choice approach seems a logical way of tackling at least some aspects of the problem. The idea of treating canefarmers and environmentalists as interest-groups lobbying government for particular political outcomes seems to capture the spirit of the current political controversy and to provide a means in which to analyze the likely success of the current policy debate from the perspective of the new political economy.

Rent-seeking models of interest group behaviour date back to Tullock (1980). Surprisingly there has been little application of rent-seeking approach to environmental lobbying. Exceptions include Damania (1999) and Brooks and Heijdra (1987) as well as Migue and Marceau (1993). This approach has however been widely applied to international trade (Damania (1999), see for example Hillmann and Ursprung (1988) and has been applied to public goods by Ursprung (1990).

This is despite the widespread political lobbying one sees over the trade-offs between private sector interests and the public good nature of the environment. In Australia, confrontation between the agricultural lobby and the environmental lobby although not the norm has arisen on a number issues:

[1] University of Queensland Honours thesis 2003.
[2] University of Queensland Honours thesis 2005.

1. agricultural run-off from cane farms in north Queensland.
2. tree-clearing in Queensland.
3. salinization in the Murray-Darling basin.

Although in the latter case the degree of confrontation is not as sever as in the first two. Tree clearing and the eutrophication issue have been particularly characterized by confrontation rather than by constructively working towards co-operative solutions.

It is therefore surprising that this approach has apparently not been applied to the analysis of lobbying behaviour that is observed in relation to the environmental issues mentioned above. Tullocks theory of efficient rent seeking provides one means of shedding light on this behaviour and perhaps of making some prediction as to the likely outcomes.

In this paper a model of political lobbying on the part of canegrowers and environmentalists is presented and the impact of restrictions on fertilizer application on the likelihood of obtaining the desired political outcome of each interest group is presented. The issue is chosen to highlight the two extremes of views on what one might do about reducing nutrient run-off from cane farms. It is not suggested that imposing a quota on fertilizer application is a realistic option, rather this particular policy instrument provides a means of elucidating what impact economic factors may have on political lobbying between the sugar industry and the environmental movement. In section 2 the model is presented, section 3 discusses the Nash equilibrium of the lobbying game, section 4 political economy issues in bush electorates and section 5 concludes.

2 The Model

In the model environmental quality is treated as a public good. Farmers however do not benefit from the public good. Environmentalists alone benefit from the public good "environment". Farmers benefit from expenditure on fertilizer but this reduces the overall quantity of public good available. The environmental lobby wishes to reduce fertilizer levels to a minimal target level. So that farmers maximize expected profit over the optimal fertilizer level and the minimal level of fertilizer application. Likewise farmers attempt to maximize expected utility across optimal and minimal fertilizer application levels. The model can be conceived of as a multi-stage game. In the first stage of the game politicians propose a policy measure in the form of a restriction on fertiliser application. Comparative static results of this decision are presented. In a second stage of the game an electoral contest (via political lobbying) occurs between politicians associated with particular interest groups (producers opposed to the restriction on fertiliser application and consumers in favour of the restriction). Once the outcome of the election is known producers and consumers make appropriate production and consumption decisions in a third stage of the game. The model is solved via backwards induction. Firms (farmers) make production decisions and households (consumers) make consumption decisions. Farms are assumed to generate a non-point source pollutant which is detrimental to a public good environmental quality and consequently diminishes consumer welfare. In the second stage both farmers and consumers lobby regarding the imposition of a possibly policy measure that will penalize farmers in an effort to reduce the extent of environmental damage that is induced by farming activity.

The farmer's profit maximizing problem is given by:

$$\max_x \Pi(x) = p(ccs)x^{\alpha}\theta L - cx\theta L$$

where $p(ccs) = 0.009 p_s(ccs - 4) + 0.578$ is the price of cane according to the cane pricing formula and p_s is the pool price of sugar. CCS is a measure of the sugar content of cane in percent. x is the fertilizer application rate per hectare. θ is the proportion of total land area assigned to sugar cane and L is the total land area.

The optimal rate of fertilizer application is then given by:

$$x^* = \left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}} \qquad (1)$$

Note that assigned land are has no direct impact on fertilizer application rate in this formulation of the model.

In the second-stage farmers choose lobbying effort by maximizing the expected benefits of unrestricted application of fertilizer and restricted application of fertilizer. So that expected profit is given by:

$$E\Pi = p(\Pi^* \mid x^*)[\Pi^* - e_i] + p(\Pi^R \mid x^R)[\Pi^R - e_i] \qquad (2)$$

where:

$$p(\Pi^* \mid x^*) = \frac{\sum_{i=1}^{n} e_i}{\sum_{i=1}^{n} e_i + \sum_{j=1}^{m} l_j} \text{ and } p(\Pi^R \mid x^R) = 1 - p(\Pi^* \mid x^*). \qquad (3)$$

Environmentalists choose private and public good consumption in the first-stage of the decision process and then lobbying effort in the second stage.

Environmentalists choose lobbying effort by maximizing the expected utility from consumption of both public and private goods defined over two-states of the world one in which fertilizer application is unrestricted and one in which it is restricted. Thus environmentalists utility in the first stage is given by

$$U(c_i, z) = c_i^{\alpha} z^{\beta} \qquad (4)$$

and they face the transformation curve between private goods c_i and a public good z representing environmental quality:

$$B = pc_i + z \qquad (5)$$

Where B is the maximum production of z when production of private goods is zero.
Rearranging and substituting

The following Utility function is obtained

$$U(c_i, z) = \left[\frac{B_i}{p} - \frac{1}{p} z\right]^{\alpha} z^{\beta} \qquad (6)$$

The optimal household consumption of the public good environmental quality is then given by

$$z_0 = \frac{\beta}{\alpha + \beta} B \qquad (7)$$

The idea behind the multi-stage game is that each interest group is precommitted to a particular position before lobbying begins.

In the unrestricted state of the world the public good environmental quality z is set to the minimum level. This done by setting $z = z_0 - \sum_{i=1}^{n} x_i^*$ where z_0 is the consumers preferred or desired level of public good. In the restricted state of the world one sets $z = z_0 - \sum_{i=1}^{n} \left(x_i^*, x_R\right)^-$, where x_R is the restricted level of fertilizer application.

From this we then obtain the expected utility of the environmentalist:

$$EU_j = p(U^* \mid x^*)[U^* - l_j] + p(U^R \mid x^R)[U^R - l_j] \qquad (8)$$

where:

$$p(U^* \mid x^*) = \frac{\sum_{j=1}^{n} l_j}{\sum_{i=1}^{n} e_i + \sum_{j=1}^{m} l_j} \text{ and } p(U^R \mid x^R) = 1 - p(U^* \mid x^*).$$

Are the probabilities that farmers will be successful in their lobbying effort and unsuccessful in their lobbying effort respectively.

3 N-Player Symmetric Nash Equilibrium of the Lobbying Game

The results in this section for N-player symmetric Nash equilibrium are well known in the literature on rent-seeking, however the details differ depending on the specifics of particular models.

Utilizing the results of the previous section, on substituting in and assuming symmetry one obtains the following

$$E\Pi = p\left(\Pi^* \mid x^*\right)\left[\Pi^* - e_i\right] + p\left(\Pi^R \mid x^R\right)\left[\Pi^R - e_i\right]$$

$$= \frac{\sum_{i=1}^{n} e_i}{\sum_{i=1}^{n} e_i + \sum_{j=1}^{m} l_j}\left[p(ccs)\left(\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\right)^{\alpha}\theta L - c\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\theta L - e_i\right] + \qquad (9)$$

$$\left[1 - \frac{\sum_{i=1}^{n} e_i}{\sum_{i=1}^{n} e_i + \sum_{j=1}^{m} l_j}\right]\left[p(ccs)\left(\left(x_i^*, x_R\right)^{-}\right)^{\alpha}\theta L - c\left(x_i^*, x_R\right)^{-}\theta L - e_i\right]$$

Assuming symmetry one obtains

$$E\Pi = p\left(\Pi^* \mid x^*\right)\left[\Pi^* - e_i\right] + p\left(\Pi^R \mid x^R\right)\left[\Pi^R - e_i\right]$$

$$= \frac{ne}{ne + ml}\left[p(ccs)\left(\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\right)^{\alpha}\theta L - c\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\theta L - e\right] + \qquad (10)$$

$$\left[1 - \frac{ne}{ne + ml}\right]\left[p(ccs)\left(\left(x_i^*, x_R\right)^{-}\right)^{\alpha}\theta L - c\left(x_i^*, x_R\right)^{-}\theta L - e\right]$$

Maximizing this under the assumption of symmetry to find:

$$\frac{\partial EU}{\partial e}=\frac{n(ne+ml)-n^2e}{(ne+ml)^2}\left[\Pi^*-e\right]-\frac{n(ne+ml)-n^2e}{(ne+ml)^2}\left[\Pi^R-e\right]-1=0 \tag{11}$$

Solving for *e* and assuming *e* to be non-negative one obtains:

$$e(l)=\frac{-ml+\sqrt{nml\left(\Pi^{*-}\Pi^R\right)}}{n} \tag{12}$$

Which will be non-negative if $n\left(\Pi^{*-}\Pi^R\right)\geq ml$.

Similarly the reaction function of the environmentalists to lobbying by farmers can be derived. Assuming symmetry the objective function of the environmentalists is given by:

$$EU=\frac{ne}{ne+ml}\left[U^*-l\right]+\left[1-\frac{ne}{ne+ml}\right]\left[U^R-l\right] \tag{13}$$

Maximizing this with respect to *l* gives:

$$\frac{\partial EU}{\partial l}=\frac{-nem}{(ne+ml)^2}\left[U^*-l\right]+\frac{nem}{(ne+ml)^2}\left[U^R-l\right]-1=0 \tag{14}$$

From this one obtains only one positive real valued reaction function for the environmentalists:

$$l(e)=\frac{-ne+\sqrt{nem\left(U^R-U^*\right)}}{m} \tag{15}$$

Proposition 1: The unique symmetric Nash equilibria of the lobbying game is given by

$$l^*=\frac{nm\left(\Pi^*-\Pi^R\right)\left(U^R-U^*\right)^2}{\left[n\left(\Pi^*-\Pi^R\right)+m\left(U^R-U^*\right)\right]^2}$$

$$e^* = \frac{nm\left(U^R - U^*\right)\left(\Pi^* - \Pi^R\right)^2}{\left[n\left(\Pi^* - \Pi^R\right) + m\left(U^R - U^*\right)\right]^2}$$

Proof (see appendix of Hillmann and Ursprung (1988))

Note that depending on the level of restrictions imposed on fertilizer application a number of different equilibria result:

Proposition 2: If $x^* < x^R$ (unrestrictive legislation) then $l^* = 0$ and $e^* = 0$

Proof

$$l^* = \frac{nm\left(p(ccs)\left(\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\right)^{\alpha}\theta L - c\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\theta L - \left(p(ccs)\left(\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\right)^{\alpha}\theta L - c\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\theta L\right)\right)\left(U^R - U^*\right)^2}{\left[n\left(p(ccs)\left(\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\right)^{\alpha}\theta L - c\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\theta L - \left(p(ccs)\left(\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\right)^{\alpha}\theta L - c\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\theta L\right)\right) + m\left(U^R - U^*\right)\right]^2}$$

$$e^* = \frac{nm\left(U^R - U^*\right)\left(p(ccs)\left(\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\right)^{\alpha}\theta L - c\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\theta L - \left(p(ccs)\left(\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\right)^{\alpha}\theta L - c\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\theta L\right)\right)^2}{\left[n\left(p(ccs)\left(\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\right)^{\alpha}\theta L - c\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\theta L - \left(p(ccs)\left(\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\right)^{\alpha}\theta L - c\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\theta L\right)\right) + m\left(U^R - U^*\right)\right]^2}$$

Note that because in a profit maximum marginal revenue equals marginal costs the marginal profit terms in the denominator of both equations reduce to zero, which then gives the result.

□

Note that the optimal lobbying effort in this case is independent of the restriction imposed on fertilizer application. In the case in which legislation is unrestrictive clearly canegrowers and environmentalists will not regard this as an issue. It takes a political party to run with the issue in order for either interest group to devote effort to lobbying.

Proposition 3: If $x^* > x^R$ (restrictive legislation) then

$$l^* = \frac{nm\left(p(ccs)\left(\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\right)^{\alpha}\theta L - c\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\theta L - p(ccs)\left(x^R\right)^{\alpha}\theta L - c\left(x^R\right)\theta L\right)\left(\left[\frac{B_i}{p}-\frac{1}{p}\right]^{\alpha}\left(z_0 - nx^R\right)^{\beta} - \left[\frac{B_i}{p}-\frac{1}{p}\right]^{\alpha}\left(z_0 - nx^*\right)^{\beta}\right)^2}{\left[n\left(p(ccs)\left(\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\right)^{\alpha}\theta L - c\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\theta L - p(ccs)\left(x^R\right)^{\alpha}\theta L - c\left(x^R\right)\theta L\right) + m\left(\left[\frac{B_i}{p}-\frac{1}{p}\right]^{\alpha}\left(z_0 - nx^R\right)^{\beta} - \left[\frac{B_i}{p}-\frac{1}{p}\right]^{\alpha}\left(z_0 - nx^*\right)^{\beta}\right)\right]^2}$$

$$e^* = \frac{nm\left(\left[\frac{B_i}{p}-\frac{1}{p}\right]^{\alpha}\left(z_0 - nx^R\right)^{\beta} - \left[\frac{B_i}{p}-\frac{1}{p}\right]^{\alpha}\left(z_0 - nx^*\right)^{\beta}\right)\left(p(ccs)\left(\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\right)^{\alpha}\theta L - c\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\theta L - p(ccs)\left(x^R\right)^{\alpha}\theta L - c\left(x^R\right)\theta L\right)^2}{\left[n\left(p(ccs)\left(\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\right)^{\alpha}\theta L - c\left[\frac{c}{p(ccs)\alpha}\right]^{\frac{1}{\alpha-1}}\theta L - p(ccs)\left(x^R\right)^{\alpha}\theta L - c\left(x^R\right)\theta L\right) + m\left(\left[\frac{B_i}{p}-\frac{1}{p}\right]^{\alpha}\left(z_0 - nx^R\right)^{\beta} - \left[\frac{B_i}{p}-\frac{1}{p}\right]^{\alpha}\left(z_0 - nx^*\right)^{\beta}\right)\right]^2}$$

Proof

After substitution and simplification the result is immediately obvious.

□

This result will be utilized in what follows and is shown here for purposes of comparison.

4 Factors Contributing to the Political Success of Each Lobby

Politicians are assumed in this type of model to maximize the probability of electoral success. That is a politician will maximize the probability of their particular agenda winning by choosing the level of restriction on fertilizer application. In case I politicians will have no impact at all on the electorate with this issue and would regard the whole issue of eutrophication of the barrier reef and restricting the level of fertilizer application in the sugar industry as a political non-issue. In case II however some political mileage could be gained from the issue by maximizing the probability of electoral success by choosing a more or less restrictive level of fertilizer application.

4.1 Rural Electorate

In the case in which the legislation is restrictive the behaviour of a self-interested politician becomes interesting. A self-interested politician will attempt to maximize the probability of re-election given unrestricted application of fertilizer by farmers by choosing a cap on fertilizer application x^R. To find an analytical solution for x^R appears difficult, however that does not mean that no conclusions can be drawn about the behaviour of politicians. In the case in which the legislation is restrictive rational behaviour on the part of a self-interested ``conservative ''politician implies that an increase in the efforts of the green lobby would reduce the lobbying effort of cane growers:

Proposition 4: $\dfrac{\partial e}{\partial l} < 0$

Proof

A self-interested politician will attempt to maximize the probability of re-election given unrestricted application of fertilizer by farmers by choosing a cap on fertilizer application x^R:

$$p(\Pi^* \mid x^*) = \frac{ne(x^R)}{ne(x^R) + ml(x^R)}$$, differentiating

$$\frac{\partial p(\Pi^* \mid x^*)}{\partial x^R} = \frac{ne^{'}(x^R)(ne(x^R) + ml(x^R)) + ne(x^R)(ne^{'}(x^R) + ml^{'}(x^R))}{(ne(x^R) + ml(x^R))^2} = 0$$

$$= ne^{'}(x^R)(ne(x^R) + ml(x^R)) + ne(x^R)(ne^{'}(x^R) + ml^{'}(x^R)) = 0$$

$$= e^{'}(x^R)(2ne(x^R) + ml(x^R)) = -e(x^R)ml^{'}(x^R)$$

Rearranging, one obtains:

$$\frac{e^{'}(x^R)}{l^{'}(x^R)} = \frac{-e(x^R)m}{2ne(x^R) + ml(x^R)} < 0$$

□

The implication is clear cane farmers are able to free-ride off the political conservatism of local members. Urban greens lobbying of conservative rural politicians is not likely to be effective.

Differentiating the lobbying effort of consumers with respect to the cap on fertilizer according to the ration rule of calculus, it is clear that one only need evaluate the numerator of $l^{'}(x^R)$ to determine the sign marginal lobbying effort. To see this clearly, it is easier to evaluate the numerator of $l^{'}(x^R)$ using the Nash equilibrium condition

$$l^* = \frac{nm(\Pi^* - \Pi^R)(U^R - U^*)^2}{[n(\Pi^* - \Pi^R) + m(U^R - U^*)]^2}.$$

This leads to the following lemma:

Lemma: $l^{'}(x^R)$ is either positive or zero

Proof

The proof proceeds by way of proof by contradiction. So we will assume first that the lemma is incorrect and then argue to a contradiction. First however, differentiating

$l^*(x^R)$ with respect to x^R one obtains for the numerator of $l^{'}(x^R)$:

$$numerator = \left(-nm\frac{\partial \Pi^R}{\partial x^R}(\Delta U)^2 + nm\Delta\Pi 2\frac{\partial U^R}{\partial x^R} \right)[n\Delta\Pi + m\Delta U]^2$$

$$-2[n\Delta\Pi + m\Delta U]\left(-n\frac{\partial \Pi^R}{\partial x^R} + m\frac{\partial U^R}{\partial x^R} \right) nm\Delta\Pi(\Delta U)^2$$

Now note the following $\Delta\Pi = \Pi^* - \Pi^R$ and $\Delta U = U^R - U^*$, also note that both these terms will be positive because restricting fertilizer reduces profits of farmers and increases utility of consumers. This also means that $\frac{\partial \Pi^R}{\partial x^R} < 0$ and $\frac{\partial U^R}{\partial x^R} > 0$. This means we are able with some effort to sign the numerator of marginal consumer lobby effort.

Inspection of the numerator indicates at first sight that the sign of $l^{'}(x^R)$ is indeterminate, however on closer inspection and with some rearranging of the equation one obtains the condition for the numerator to be negative:

$numerator < 0$ is given by

$$-\frac{\partial \Pi^R}{\partial x^R}(\Delta U)^2[n\Delta\Pi + m\Delta U] + \Delta\Pi 2\frac{\partial U^R}{\partial x^R}[n\Delta\Pi + m\Delta U]$$

$$< -2n\frac{\partial \Pi^R}{\partial x^R}\Delta\Pi(\Delta U)^2 + 2m\frac{\partial U^R}{\partial x^R}\Delta\Pi(\Delta U)^2$$

This implies that both $[n\Delta\Pi + m\Delta U] < 2n\Delta\Pi$ and $[n\Delta\Pi + m\Delta U] < m(\Delta U)^2$.

This means that $m\Delta U < n\Delta\Pi$ and that $n\Delta\Pi$ adds to the total additive gain to consumers from restricting fertilizer $m\Delta U$ will be less than the multiplicative gain ΔU. The first of these conditions implies that in aggregate producers gain more from a liberal policy than consumers gain from a restrictive policy or alternatively producers would lose more than consumers would gain from capping fertilizer application. Under these circumstances a green politicians chances of election would be maximized if consumers expanded lobbying efforts and producers reduced lobbying efforts. However the gain to producers from the liberal policy must be less than the increase in utility per person that consumers would get from a restrictive policy. The total loss to producers cannot both be more than what consumers gain as a group and less than what an individual consumer gains, this is a contradiction. Consequently it can be concluded that the numerator is non-negative and that the sign of $l'(x^R)$ is either positive or zero.

□

In a similar manner to the argument employed in proposition 4 the rational behaviour on the part of a self-interested but green politician in a rural electorate implies that an increase in green lobbying will lead to an increase in the lobbying effort of cane farmers:

Proposition 5: $\frac{\partial e}{\partial l} \geq 0$

Proof

First note that we also assume $x^* > x^R$**.** Now consider that $p(\Pi^R \mid x^R) = 1 - p(\Pi^* \mid x^*) = 1 - \frac{ne(x^R)}{ne(x^R) + ml(x^R)}$.

$$\frac{\partial p(\Pi^R \mid x^R)}{\partial x^R} = 1 - \frac{ne'(x^R)(ne(x^R) + ml(x^R)) + ne(x^R)(ne'(x^R) + ml'(x^R))}{(ne(x^R) + ml(x^R))^2} = 0$$

$$(ne(x^R) + ml(x^R))^2 = ne'(x^R)(ne(x^R) + ml(x^R)) + ne(x^R)(ne'(x^R) + ml'(x^R))$$

which implies $e'(x^R) = \frac{(ne(x^R) + ml(x^R))^2}{(2ne(x^R) + ml(x^R))n} - \frac{e(x^R)ml'(x^R)}{2ne(x^R) + ml(x^R)}$

or $\frac{e'(x^R)}{l'(x^R)} = \frac{(ne(x^R) + ml(x^R))^2}{l'(x^R)(2ne(x^R) + ml(x^R))n} - \frac{e(x^R)m}{2ne(x^R) + ml(x^R)}$

This will be negative if $l'(x^R) < 0$. By the above lemma this is not the case.

□

The result is unstable lobbying competition in rural electorates for rural green candidates. If one consider rural electorates in Queensland proposition 4 implies that urban green consumer groups are likely to have little impact on conservative politicians in the bush, which is not surprising. Proposition 5, implies a lobbying war between different parties for more environmentally minded candidates in the bush. The theory of rent-seeking would view this as a case in which rents are completely dissipated.

6 Conclusion

This paper applies Tullock (1980)'s model of rent-seeking to the problem of environmental lobbying for a hypothetical restriction on fertilizer application rates in Queensland sugar-cane electorates bordering the Great Barrier Reef region. The paper verifies a number of well-known results on Nash equilibria in rent seeking games before proceeding to analyse the consequences of restrictions on fertilizer application rates on poltical behaviour in rural electorates. In particular, the possible impact of urban green lobby groups on bush politics is examined and it is shown that the presence of green candidates in bush electorates would lead to a lobbying war and consequent high levels of rent dissipation.

The model can easily be extended to study political lobbying behaviour in urban electorates and this would be interesting to do for purposes of comparison. A further extension would be to try and determine the level of fertilizer application that would maximise each politician chances of electoral success. However, this would require numerical analysis and is a non-trivial exercise.

References

Beard, R and Wegener, M (2001) Industry structure and reform of the Queensland Sugar Industry: A computational model, *Economic Analysis and Policy* vol. 31 no.2 September.

Beard, R. (2002) Potential impacts of deregulating land assignment in sugarcane on eutrophication of the Great Barrier Reef Lagoon, *Mimeo*.

Brooks, M.A. and Heijdra, B.J. (1987) Rent-seeking and Pollution Taxation: An extension, *Southern Economic Journal* vol 54 No. 2 pp. 335-342.

Brough, L. and Beard, R.M. (2006) A multi-agent simulation model of the impact of eutrophication on the Great Barrier Reef Lagoon using the dynamic information architecture system DIAS, *Paper presened at the 50th AARES National Conference*, Sydney.

Centre for International Economics (2002) *Cleaning up the Act: The impact of changes to the sugar industry Act 1999*, Centre for international economics, Canberra and Sydney December.

Damania, R. (1999) Political competition, Rent Seeking and the Choice of Environmental Policy Instruments, *Environment and Resource Economics* Vol. 13 pp. 415-433.

Hall, P. (2005) *A Community Based Dynamic Bio-economic Model of the Impact of Sugar Cane Production on Eutrophication of the Great barrier Reef Lagoon*, School of Economics, Honours Thesis, the University of Queensland St. Lucia.

Hillman, A.L. and Ursprung, H. (1988) Domestic politics, foreign interests, and international trade policy, *American Economic Review* Vol. 78 No. 4, pp. 729-745.

Lee, D. R. (1985) Rent-seeking and its implications for pollution taxation, Southern *Economic Journal* , pp. 731-744.

Lockard, A. and Tullock, G. (Eds.) (2001) *Efficient Rent Seeking: Chronicle of an Intellectual Quagmire*, Kluwer Boston.

Migue J-L. and Marceau R. (1993) Pollution Taxes, Subsidies and Rent Seeking, *Canadian Journal of Economics* Vo. 26 No. 2, pp. 355-365.

Millen, S. (2003) *A dynamic game theoretic model of the impact of coastal agriculture on Queensland fisheries : a case study of the Burdekin River*. School of Economics, Honours Thesis, The University of Queensland St. Lucia.

Neary, H.M. (1997) A Comparison of Rent-Seeking Models and Economic Models of Conflict, *Public Choice* 93: 373-388.

Productivity commission (2003) *Industries, Land-Use and Water Quality in the Great Barrier Reef Catchment*, Research Report, Commonwealth of Australia February .

Tullock G. (1980) Efficient Rent Seeking, in: Buchanan, J. Tollison, R.D. and Tullock, G., *Toward a Theory of the Rent-Seeking Society*, Texas A&M University Press, College Station.

Ursprung, H.W. (1990) Public Goods, Rent Dissipation and Candidate Competition, *Economics and Politics* vol.2 no.2, pp. 115-132.

Williams D. McB. (2001) Impacts of Terrestrial Run-Off on the Great Barrier Reef World Heritage Area, CRC Reef Research Centre, August.