TRIPLE WIN FOR TRADE IN RENEWABLE RESOURCE GOODS BY USE OF EXPORT TAXES

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ABSTRACT

The majority of monitored fish stocks globally is fully or over exploited, that is, at or below their maximum sustainable yield stock levels. Despite this resource situation international trade in fish products have been increasing for a long time. An export tax on fish and fish products, as an alternative to Pigouvian harvest or effort taxes, is introduced in a resource-trade model for a small open economy. It is analysed to what extent such a tax could mitigate biological and economic overuse of fish stocks and increase national welfare, which is affected both through the general government budget and through effects on consumer surpluses. We also discuss briefly implications for aquaculture environment, production and trade. It is demonstrated that a resource export tax may be beneficial for total national welfare compared to a laissez-faire policy. The theoretical analysis is illustrated by a stylized case study for a small open economy.

INTRODUCTION

International trade is liberalised and increasing and there has been debate about the welfare and environmental effects of this, in particular for developing countries exporting natural resource goods, whether managed or open-access. Some fear that this may harm both welfare and resource stocks in export countries, others are convinced that most, if not all, countries will benefit from increased trade [3, 7, 13, 14]. Policy advisers and international economic policy organisations usually favour a reduction in trade taxes, but governments may be concerned about loss of revenues from such a reduction. In the 1970s and 1980s the average share of trade tax in total tax revenues was about a third and a quarter in Africa and Asia, respectively, though slowly decreasing [7]. Trade tax revenues mainly come from import, but for some countries export taxes amount to an important share of trade tax revenue. 'In 2000, 8 out of 12 countries for which data were available had more than 10% of trade tax revenue from export taxes; 5 of them having more than 20% [7, p.278].

For a country in transition from autarchy to free trade, defined by the rules and regulations of the World Trade Organization (WTO), tax revenue is just one concern. Others are related to economic development, the environment and how to finance the government budget. Openings for (more) trade for a small open economy mean changes in domestic relative prices and changes in the export and import shares of goods and services. Gains from trade for a country exporting a renewable good have been discussed in several papers. One such seminal study concludes 'that trade reduces steady state utility for a diversified resource exporter [2, p. 526]. This conclusion is based on a two-sector general equilibrium model with an open-access renewable resource industry and a manufacturing industry with constant returns to scale. Another article on this issue concluded 'that opening up for trade may result in steady-state gains from trade, even when there is open access to the resource and the country does not specialise fully in resource extraction' when 'the Brander-Taylor small, open-economy model of trade in a renewable resource and other goods is modified to allow for diminishing returns to the other goods sector' [10, p.122].

Sustainable development discussions are often concerned about three sub-sets of sustainability; economic, environmental and social development. Even though there may be differing views when it comes to operational definitions of these concepts, we shall use them in this paper within the framework of a two-sector general equilibrium model that combines and develops elements from Brander and Taylor [2], [10] and [7]. We analyse the economic, environmental and social effects of using an export tax on goods from the open-access renewable resource industry. For fish resources the majority of stocks globally are fully exploited or overexploited, that is, at or below their maximum sustainable-yield stock-level [8] and it is of interest to find policy instruments to mitigate resource degradation.

The trade regimes we discuss within a two-sector general equilibrium model are

Initially: autarchy with domestic open-access exploitation of a renewable resource (fish or another relatively fast-growing renewable resource). Domestic prices differ from world market prices.

Open trade commences: world and domestic market prices are equalised. Expected price increase for the resource good may lead to overexploitation and reduced domestic consumption of this good.

Export taxes introduced - to mitigate possible negative effects of open trade.[a]

The main objective of this paper is to analyse and compare the economic, environmental and social results of the taxed export regime with those of open trade. It will be demonstrated that the former are superior to the latter.

THE MODEL

Following [2] (BT) and [10] (RH), we assume that growth of the renewable natural resource follows the logistic growth function familiar in fisheries economics literature. Other renewable resources, such as wildlife, forest resources and pollution purification, may also have a growth curve that is a humped shape, if not as simple and well-behaved as in this equation. Trees, however, usually grow much slowly than fish.

Logistic population growth with carrying capacity normalised to unity and with harvest y is

$$\dot{S} = rS(1-S) - y\,, \qquad \text{(Eq. 1)}$$

assuming 0<S<1 to avoid cases of extinction and no harvest, with r as the intrinsic growth.

Harvest follows the Schaefer production technology

$$y = ql_y S\,, \qquad \text{(Eq. 2)}$$

implying that catch per unit effort l_y is proportional to stock size, with q as the catchability coefficient. Effort is assumed to consist of labour only that comes from a given total supply in competition with the other industry (see below).[b] The other factor of production is the common-pool natural resource. The long-run steady-state catch is

$$y = ql_y(1 - \frac{q}{r}l_y) \qquad \text{(Eq. 2')}$$

and require that $l_y < \frac{r}{q}$ to avoid extinction. This assumption is made throughout the paper.

We shall focus on steady-state solutions since most fish resources are relatively fast-growing and transition periods tend to be short enough to allow us to neglect discounting. This is in line with RH, whereas BT analysed the transition period, but without using a positive discount rate. Of course, the main reason to focus on the steady state is to keep the analysis as simple as possible. We also neglect the intermediary industry that usually exists to transform raw fish into marketable goods, defending this on the assumption that such an industry has CRS technology with raw fish as the main variable input [1]. The ex-vessel price of fish will therefore move proportionally to the consumer price.

The other industry produces goods x according to either constant returns to scale (CRS, with $\gamma=1$ as in BT) or to decreasing returns production technology (DRS, $\gamma<1$; with $\gamma=<1/2$ in RH)

$$x = al_x^{\gamma}, \quad 0<\gamma\leq 1,\ x\geq 0, \qquad \text{(Eq. 3)}$$

using labour l_x as the only input.

Input constraint, assuming full employment, requires

$$l = l_x + l_y \qquad \text{(Eq. 4)}$$

with l as the total supply of labour.

Open-access equilibrium in the resource industry requires the value of the average product of effort (labour) to be equal to marginal cost of effort, $VAP_y(l_y) = MC_y(l_y)$, which implies

$$p_D q(1 - \frac{q}{r} l_y) = w, \qquad \text{(Eq. 5)}$$

when domestic price of fish, p_D and wage level, w, are considered constant.

A necessary condition for equilibrium in the general industry is

$$\gamma a l_x^{\gamma-1} = w, \qquad \text{(Eq. 6)}$$

which follows from profit maximisation of $\pi = x - wl_x$ wrt l_x, when the price of x is used as numeraire.

Downward-sloping domestic resource demand equals

$$p_D = by_D^{-1}, b = \beta a, \qquad \text{(Eq. 7)}$$

which follows from utility maximisation, given a Cobb-Douglas utility function $u = y^{\beta} x^{1-\beta}$ for the representative consumer and the budget constraint $p_D y + x = a$, where a is income. The difference between the world market and the domestic market fish price is because of a unit tax τ on fish exports.

The gross domestic product (GDP - production approach) is

$$R = py + x \qquad \text{(Eq. 8)}$$

with p as the world market price of fish.

Thus

$$p = p_D + \tau \qquad \text{(Eq. 9)}$$

For most seafood products traded internationally the primary product makes up a substantial part of the cost of the final product. The simplifying assumption about CRS technology for the intermediaries between harvesters and consumers allows the use of mark-up pricing for the intermediaries. The world market price *p* is therefore assumed to be adjusted to reflect the relative content of the primary product in the final product.

The quantity of fish produced is used either domestically, y_D, or for export, y_E

$$y = y_D + y_E . \qquad \text{(Eq. 10)}$$

Equations (1)-(10) comprise the model to be analysed in the following. It includes the main features of both BT and RH, including the important CRS of the former and the DRS of the latter. Our analysis will demonstrate that the use of a (fish) resource export tax is beneficial for both types of technology in the other industry.

The production possibility frontier

Before proceeding to analyse the effects of a resource export tax on production we shall demonstrate the production possibility frontier (PPF), for x and y, to get a graphical picture of its shape. This is done for the constant return-to-scale (CRS) case, i.e. for $\gamma = 1$, to keep it simple.

For the resource industry, using (1) and (2), the following long-run restriction on harvest prevails

$$y = ql_y(1-\frac{q}{r}l_y),\ 0 < l_y < \frac{r}{q}. \qquad \text{(Eq. 11)}$$

From (11) and (3) follows in the CRS case of $\gamma = 1$

$$y = q(l-\frac{1}{a}x)(1-\frac{q}{r}(l-\frac{1}{a}x)) = y(x), \qquad \text{(Eq. 12)}$$

Thus *y(x)* describes the PPF. From (12) we derive the terminal points $x_{\min} = a(l-\frac{r}{q})$ and $x_{\max} = al$ for *y=0.* If there is a maximum of y this requires *dy/dx=0*, and from (11) we derive $x^{**} = a(l-\frac{r}{2q})$.

Thus a maximum of *y* for a positive *x* requires $\frac{r}{2q} < l$ and a positive $x_{\min}$ requires $\frac{r}{q} < l$. Since $x \geq 0$ we have $x_{\min} = 0$. Figure 1 gives a graphical description of the PPF in case of a large resource sector, meaning $\frac{r}{2q} < l < \frac{r}{q}$. Note that $l_y > \frac{r}{q}$ on a permanent basis implies extinction of the fish resource. A humped shape production possibility frontier may exist in cases where the renewable resource sector is of significant size. For a welfare-maximising nation only the negatively-sloped part of the production possibility frontier would be of interest, but imperfect property rights regimes may imply other adaptations.

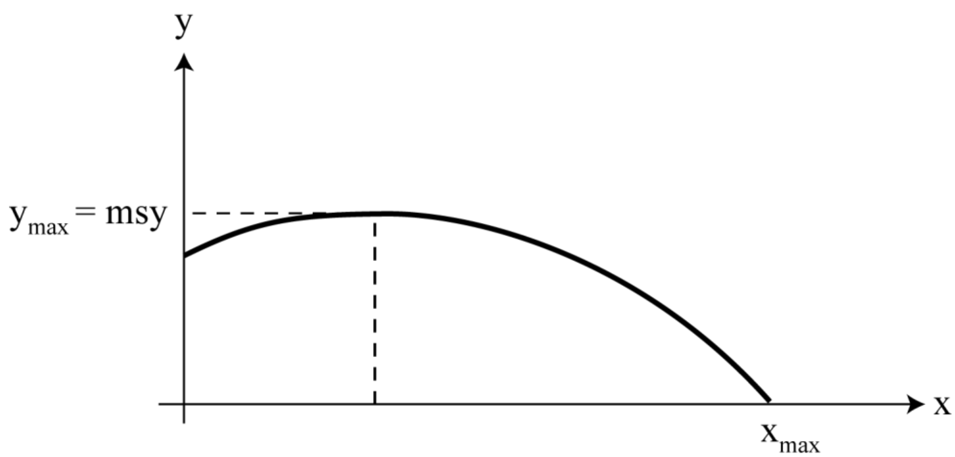

Figure 1. The production possibility frontier (PPF) may be hump-shaped in the case of a large resource sector.

The resource export tax

First we investigate whether or not it is possible to increase the gross domestic product, R, the production of fish, y, and/or the production of other goods, x, by introducing a resource export tax. Such a tax creates a wedge between the world market price and the domestic price of fish. By assumption (no other sales, value added taxes or subsidies exist) consumers and producers domestically face the same price, equal to the world market price minus the export tax.

Assume a two-sector open economy with export of a renewable resource good produced from a renewable resource with logistic growth and harvesting that takes place under an open-access regime. If so:

Proposition 1

1.1 There is a positive export tax that will increase the gross domestic product.

1.2 This is valid in both the case of constant returns to scale and the case of decreasing returns to scale in the other sector of the economy.

1.3 This is valid independently of whether the open-trade solution causes biological overexploitation or not.

1.4 The steady-state resource stock increases with the resource export tax.

We shall start by proving Proposition 1.4. To find the effect on the open-access equilibrium stock of a resource export tax we use the labour market equilibrium equation

$$(p-\tau)q(1-\frac{q}{r}l_y) = \gamma a(l-l_y)^{\gamma-1}, \qquad \text{(Eq. 13)}$$

derived from equations (5) and (6), having substituted for l_x from (4). Since l_y in (13) implicitly is a function of τ, we can find

$$\frac{dl_y}{d\tau} = \frac{q(1-\frac{q}{r}l_y)}{-[\frac{(p-\tau)q^2}{r} + \gamma a(1-\gamma)(l-l_y)^{\gamma-2}]} < 0, \qquad \text{(Eq. 14)}$$

recalling that $l_y < \frac{r}{q}$. At equilibrium harvesting it follows from (1) and (2) that $S = 1 - \frac{q}{r}l_y$. Thus

$$\frac{dS^o}{d\tau} = -\frac{q}{r}\frac{dl_y}{d\tau} > 0, \qquad \text{(Eq. 15)}$$

and Proposition 1.4 is proved.

In addition, from (14) it follows directly that $\frac{dl_x}{d\tau} > 0$, owing to (4). The resource export tax contributes unambiguously to the transfer of labour from the fishing industry to the other industry. The effect of this on production in each of the two industries can now be found; from (3) follows $\frac{dx}{d\tau} > 0$, and from (1) at biological equilibrium we have $\frac{dy}{d\tau} = r(1-2S)\frac{dS}{d\tau} <-> 0$ for $S >=< \frac{1}{2} = S_{msy}$. The resource export tax unambiguously implies increased production in the other industry, whereas production in the resource industry increases only if the resource was already biologically overexploited.

To prove Propositions 1.1-1.3, the effects on gross domestic product of a resource export tax, we use the labour market equilibrium equation (13). Since x and y now are functions of τ it follows also that the domestic product, *R*, is a function of the resource export tax. We are interested in how *R* is affected by τ, in particular to find the conditions for a positive effect. Substituting for l_x from equation (4) in (8) we have $R(l_y(\tau)) = py(l_y(\tau)) + x(l - l_y(\tau))$, and from this follows

$$\frac{dR}{d\tau} = p\frac{dy}{dl_y}\frac{dl_y}{d\tau} + \frac{dx}{dl_x}(-1)\frac{dl_y}{d\tau} = (p\frac{dy}{dl_y} - \frac{dx}{dl_y})\frac{dl_y}{d\tau} = (VMP_y - VMP_x)\frac{dl_y}{d\tau}. \qquad \text{(Eq. 16)}$$

From (16) we conclude

$$\frac{dR}{d\tau} > 0, \text{ if } VMP_y < VMP_x, \text{ since } \frac{dl_y}{d\tau} < 0. \qquad \text{(Eq. 17)}$$

Proposition 1.1 is proved since the open-access condition for the harvest industry is $VAP_y = VMP_x$ and, in this model, $VMP_y < VAP_y$. Proposition 1.2 is proved, since we have assumed $\gamma \leq 1$ throughout the analysis above. Proposition 1.3 holds, since the proofs above are valid whether $VMP_y < 0$ (biologically overexploited resource) or $VMP_y > 0$ (biologically underexploited resource), as long as (17) is fulfilled. Figure 2 illustrates these findings.

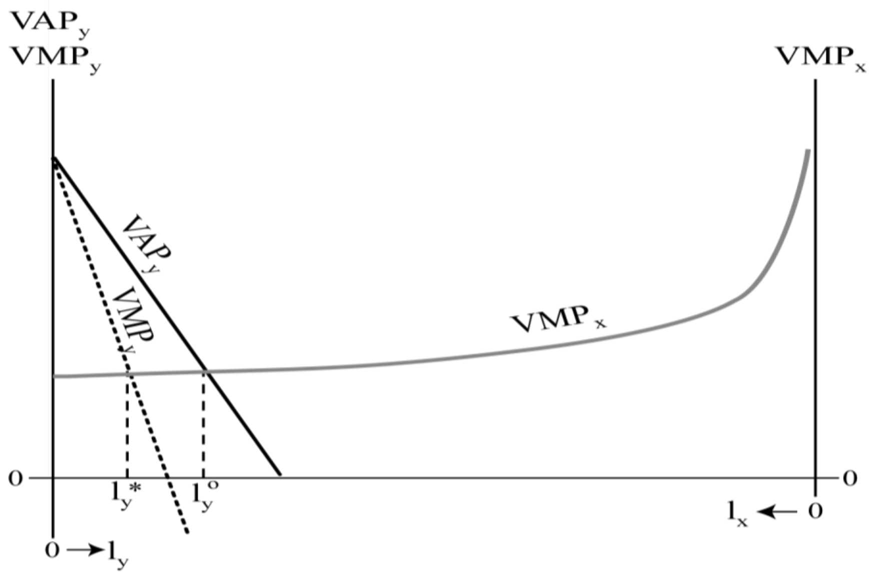

Figure 2. Equilibrium allocation of labour between the two industries of the economy depends on the trade and tax regimes. The open-trade level of labour in the resource industry is l_y^o. The resource export tax moves l_y in the direction of l_y^* that maximises GDP.

The gross domestic product increases with the resource export tax since the value of the marginal product of labour in the harvest industry is less than the value of the marginal product of labour in the manufacturing industry for the open-trade solution. There is, of course, a limit to this increase. Maximum of R with respect to τ requires $\frac{dR}{d\tau} = 0$, thus $VMP_y = VMP_x$ from (16); the corresponding labour allocation to the harvest industry in this particular case is labelled l_y^* in Figure 2. Propositions 1.1-1.3 hold for the following labour allocation, l_y, to the harvest industry $l_y^* < l_y \le l_y^o$, where l_y^o is the open-trade level.

Domestic consumption and export of the resource good

To discuss domestic consumption of the resource good we should distinguish between the three regimes of *autarchy*, *open trade* and *export taxed trade*. For policy reasons it may be of interest to know how opening of trade, from autarchy, will change the domestic consumption of the resource good (as well as that of the other good), and how a resource export tax will further affect consumption. We will prove

Proposition 2

In this two-sector economy, domestic consumption of both the resource good and the other good will increase with the introduction of an export tax on the resource good compared with open trade.

It is possible to prove Proposition 2 in the same way as we proved Proposition 1, using the model equations and implicit derivation. In this case, however, it can be done even more simply. Initially we assume that the increased GDP, following the introduction of the resource export tax, is redistributed to consumers through a lump sum transfer. From the consumer behaviour described above we know that the budget share for each good is constant and equal to the marginal elasticity of utility, $\beta = \dfrac{(p-\tau)y_D}{a}$. Now, domestic consumption, y_D, increases if consumers' income, a, increases, and/or the domestic price of the resource good decreases. This happens through a combination of the substitution effect and the income effect. For the other good the same arguments hold, since $1-\beta = \dfrac{x_D}{a}$. QED.

The shifts in export, consumption and resource yield are demonstrated in Figure 3, focusing on the somewhat realistic case for a developing country, with an underexploited biological resource under autarchy. Supply is the long-run backward-bending yield curve, $y^S(p)$, derived from $VAP_y = VMP_x$. for the open-access harvested fish stock [5]. This curve has the traditional upward-sloping shape for a relatively low price of fish and is backward-bending from the point where price exceeds what is necessary to bring about the maximum sustainable yield. Assuming downward-sloping demand as in (7), based on maximisation of a Cobb-Douglas utility function and fixed income, the autarchy solution may be equal to y_D^A in Figure 3. From this it is clear that international trade, either open or with a resource export tax, implies a reduction in the domestic consumption of the resource good, from y_D^A to y_D^C or y_D^T, respectively. Domestic consumption under taxed export is always higher than under open trade when the domestic consumer price equals the supply price for the resource harvest sector. The export of the resource good used in the example in Figure 3 is higher with taxed than with open export. Since, however, the exported quantity of the resource good equals the difference between harvest and domestic consumption, $y_E = y^S(p) - y^D(p)$, it is obvious from this figure that export may decrease for a lower world market price and/or a higher export tax, comparing taxed with open export.

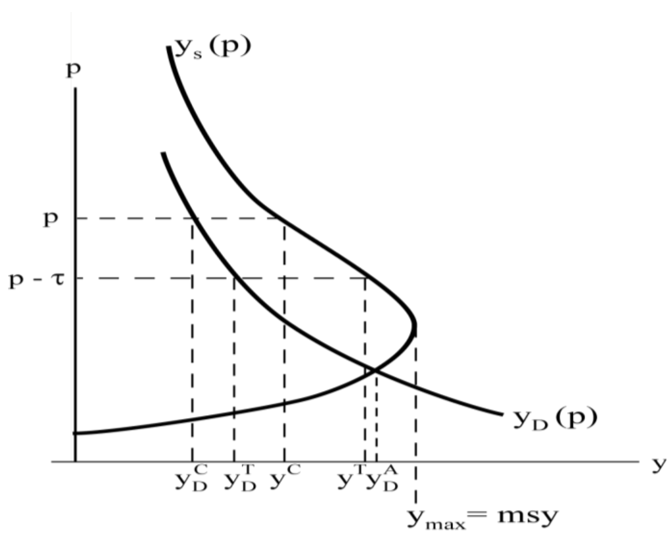

Figure 3. The backward-bending supply curve and downward-sloping domestic demand are basics for graphical analysis of fish consumption and trade under the regimes of autarchy, open trade and export taxed trade.

Aquaculture goods and export tax

We shall distinguish between two cases of aquaculture and the environment. First, aquaculture may be dependent on input of wild-caught fish. If this fish is from an open-access resource and goes into aquaculture feed in a fixed proportion, the analysis and conclusion above will hold. An export tax on aquaculture goods will induce a reduction in the aquaculture industry and thereby in the harvest industry as well. Second, if aquaculture is using environmental services, for example, mangrove forests, inflicting negative externalities on other producers or consumers, the previous analysis may be adapted to include this scenario. To conclude, an export tax will have the same positive welfare effects in the case of aquaculture as for the renewable resource industry above if there is a negative externality in the production of fish from aquaculture.

DISCUSSION

For several renewable natural resources and environmental goods traditional property or use rights are difficult to establish and to enforce in full. In such cases, as in fisheries, there are management challenges from economic, ecological and social (including employment and consumer surplus issues) perspectives. To mitigate such problems several policy instruments have been suggested and discussed in the literature. These include technical regulations, licences, Pigouvian taxes, total allowable catch (TAC), individual transferable quotas (ITQs), and marine protected areas (MPAs). In actual fisheries all of these instruments have been used, although Pigouvian taxes are rarely applied (exceptions include minor resource taxes in Vietnam, the research and salmon marketing export taxes in Norway and management cost recovery in New Zealand).

The resource export tax discussed in this paper generates a triple win for the country, if we compare export taxed trade with open trade, since the natural resource stock, GDP and domestic consumption of the resource good increase. In reality, countries have a public sector that contributes to social sustainability and development, and RET helps to fund this without the negative effects of most tax wedges. The opposite, in fact, holds: the RET yields positive effects as the tax may neutralise the distortion of an open-access regime. We could say that this policy instrument is positive from all three sustainability perspectives, environmental, economic and social. Theoretical, and applied, analyses of trade liberalisation for fish often conclude that welfare effects may be negative unless efficient management systems are in place [13, 14]. RET would mitigate such problems even with an open-access resource industry.

From a monitoring, control and enforcement (MCE) perspective, RET may have some advantages compared with a direct tax on fish harvest. First, in most actual cases harvesters are much more plentiful than exporters, and so is the number of landing places compared with the number of foreign trade exit points of a country. Taxing fewer and bigger entities may be simpler administratively than taxing many small ones. Second, since MCE costs are likely to increase with the number of people and firms operating, total administrative costs are likely to be lower for RET. Third, historically, foreign trade has been monitored rather strictly in most countries to ensure the financial revenues from trade. Administrative systems for registration and tax collection already, therefore, exist.

With particular regard to developing countries exporting food to developed countries there are strict rules and regulations to ensure food safety. Producers usually find domestic trade rules are easier to observe, and for local trade it may just be a matter of agreement between sellers and buyers at the beach, quayside or the local market. RET would therefore not apply directly to all fish production of a country. To what extent there are spillover effects between export, domestic and local markets and the harvesters, remains to be investigated in the light of both price and income effects.

As demonstrated above, taxed export of renewable resource goods implies higher domestic consumption and income than does open trade. In actual trade, with a huge number of products and species, the increased GDP would allow the import of substitutes for the resource good, e.g. cheaper fish in place of expensive fish. This may be an advantage for poor people in the case of high-value fish for export, such as some lobsters, crabs and prawns. In total, the domestic consumption of cheap, but still nutritious, food may increase from RET compared with open trade.

Tariff escalation in import countries, especially in many developed countries, used to protect their own value-added processing industries may be met by differentiated export taxes. This would neutralise negative employment effects that would otherwise occur and harm the intermediaries' value-added production in the export countries. Using per unit tax or ad valorem tax does not matter in the model discussed above, but if we allowed different degrees of value-added per unit of raw material, it usually would. In the context of differentiated export taxes it may be that a mix of per unit and ad valorem taxes would be optimal.

CONCLUSION

The majority of commercially-exploited and monitored fish stocks globally are fully exploited or overexploited, that is, at or below their maximum sustainable-yield stock-level [8]. In addition, there are thousands of stocks of marine fish, shellfish, crustaceans and seaweed harvested for which there hardly exists any scientific monitoring programme. In search of policy instruments to mitigate resource degradation, we have demonstrated in this paper, within the framework of a two-sector general equilibrium model, that there exists a positive export tax that will increase the gross domestic product and increase the resource stock. This is valid for both the case of constant returns-to-scale and the case of decreasing returns-to-scale in the other sector of the economy. It is also valid irrespective of whether the open-trade solution causes biological overexploitation or not.

In the two-sector economy discussed in this paper, domestic consumption of both the resource good and the other good will increase with the introduction of an export tax, within certain limits, on the resource good compared with open trade.

We find that an export tax will have the same triple win for aquaculture as for the renewable resource industry if there is a negative externality in the production of fish from aquaculture.

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ENDNOTES

[a] Ferreira (2007) demonstrates that a binding quantitative restriction constitutes a second best option in this case.

[b] For simplicity we disregard the producer surplus that would stem from heterogeneous fishing effort, even under open access (Copes, 1972; Nielsen, 2006).