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Abstract. Recent research has on the basis of general equilibrium models warned that trade liberalisation in non-optimally managed renewable resources might cause over-exploitation and reduced steady-state welfare. Welfare effects of trade liberalisation in open access and optimal management are found case specific and dependent on factors such as the country's status as importer or exporter, the state of the fish stocks and the size of the countries on the world market. The present paper develops an alternative partial equilibrium framework capable of identifying welfare effects of fish trade liberalisation also in the presence of complex but realistic management schemes, such as regulated open access and regulated restricted access. The case dependency known from the general equilibrium analysis is confirmed, but the introduction of realistic fisheries management schemes in the partial equilibrium model extended this case dependency. The welfare effect of trade liberalisation in an exporter country is negative under open access, but was found positive under regulated restricted access in the present paper.

Key words: Trade liberalisation, fisheries management, regulated open access, regulated restricted access, partial equilibrium model, welfare.

1. Introduction

The purpose of this paper is to develop a framework for fish trade policy analysis under complex but realistic fisheries management settings, thereby delivering the theoretical basis for empirical welfare analysis of fish trade. A partial equilibrium approach is developed and circumstances under which trade liberalisation cause welfare gains and losses are identified theoretically. Trade liberalisation is modelled as the removal of a tariff, but also applies to the analysis of reductions in other trade measures that open up or increase trade between two countries.

The development of an analytical framework for fish trade policy analysis in the presence of complex but realistic fisheries management is important, since fisheries management is decisive for whether gains or losses follow fish trade liberalisation. Furthermore, the recently introduced general equilibrium model for analysing trade liberalisation in renewable resources is only developed for open access and optimal managed fisheries [1-5]. Owing to the complexities in the existent general equilibrium model, combined with the general welfare concept of “steady state utility”, it is unlikely that this model in its present form is well suited for taking complex and realistic fisheries management schemes into account. Finally, the development of an analytical framework for trade liberalisation in products originating from fisheries with regulated open access and regulated restricted access is important, since such management exists in several and probably most fisheries worldwide. The partial equilibrium approach of the present paper links together basic results from trade theory with long runs comparative static of fisheries economics. Thereby, the paper delivers a theoretical framework for the empirical identification of welfare effects, which does not exist today. One hypothesis is that welfare effects of trade liberalisation remain empirical, i.e.

that it is impossible to obtain unambiguous results theoretically. Another hypothesis is that results obtained in the recently developed general equilibrium model of trade in renewable resources needs modification, when analyses are performed for a complex and realistic fisheries management schemes.

The issue is also important from a policy perspective since tariffs on fish products again have become an issue in the international trade negotiations of market access of non-agricultural products after the Doha Ministerial Meeting in November 2001 [6]. Moreover, most countries worldwide use trade measures on fish products today and as these measures indirectly are resource taxes in exporter countries and subsidies in importer countries, trade policies indirectly serve as fisheries management instruments. Liberalising trade will therefore affect the fisheries and might, due to externalities in production, cause counterintuitive and unintended welfare losses in countries with non-optimal fisheries management. Furthermore, Food and Agricultural Organisation of the United Nations [7] assess that 75% of fish stocks worldwide are fully exploited, overexploited or recovering. As a consequence, management measures have been imposed over the last 2-3 decades. On this basis integrated analysis of trade liberalisation and fisheries management becomes necessary to assess under what circumstances international fish trade liberalisation is desirable from a welfare economic point of view.

Finally, the issue is interesting in relation to other sectors with externalities in production, such as forestry and sectors producing with pollution. Forestry is as fisheries based on renewable resources, which might be subject to open access in some countries, e.g. tropical timber in developing countries. Although long run in forestry is longer than in fisheries, since the growth of forests is slower than of most fish stocks,

the theoretical analysis of this paper also applies to assessing the welfare effects of liberalising trade in timber products. The theoretical analysis also holds for sectors producing with pollution, since trade liberalisation might imply increased production and thereby pollution. Welfare losses will then be the result of trade liberalisation if the increased negative value of pollution exceeds the value of production.

The present paper adds to existing knowledge by developing a theoretical framework for the empirical identification of welfare effects of fish trade liberalisation under realistic fisheries management settings.

2. Literature

Liberalisation of international trade is traditionally analysed on the basis of the Ricardian theoretical tradition applied to international economics. Within this tradition, fish is regarded as a conventional good and the presence of international trade is explained by international division of labour and specialisation resulting from differences in technology. The Ricardian theoretical tradition was followed by the Neo-classical tradition, mainly the Heckscher-Ohlin theory, which states that the presence of international trade results from differences in factor endowments. The consequence is that a global welfare optimum can only be reached in the case of free trade. Small countries, which are price takers on the world market, also face a situation where the welfare optimum can only be reached in the case of free trade, where large countries can affect their terms-of-trade and thereby reach a welfare optimum only in the presence of trade policies, provided that there is no retaliation from other countries. These results are referred to as the conventional opinion.

In the nineties, a new tradition developed where it in a general equilibrium model was shown that advantages with free trade in renewable resources that are not managed optimally exist only under certain conditions and for certain types of countries, owing to externalities in production [1-5].

Simultaneous, resource economics develops in a partial equilibrium framework. This theoretical tradition is, however, directed at bio-economics and resource management, not on trade liberalisation. It is shown in the present paper that this tradition has the ability to contribute in identifying and analysing welfare effects of liberalising fish trade. In particular where management are regulated open access or regulated restricted access, as is the case in most fisheries worldwide.

An overview of literature contributing in the explanation of welfare effects of liberalising fish trade is presented in figure 1.

Figure 1

The focus in the present paper is on the development of the partial equilibrium model. As opposed to existent general equilibrium models the partial equilibrium model is capable of identifying the welfare effects of liberalising trade in renewable resources under complex and realistic management, i.e. regulated open access and regulated restricted access. It is further capable of identifying welfare effects of trade liberalisation of different sectors.

3. The model

The partial equilibrium model of fish trade liberalisation is based on the backward bending supply function [8-12] combined with the two country analytical framework of [13]. The model consists of a backward-bending supply function and a traditional demand function. Following Clark [10], the simple equilibrium supply function of a fish stock with open access can be deduced on the basis of the Schaefer model in eq. 1.

$$\frac{dS}{dt} = rS\left(1 - \frac{S}{S_K}\right) - qES \tag{1}$$

Where S denotes the stock, t is time, r the intrinsic growth rate of the stock, S_K the carrying capacity of the stock, E effort and q the catchability coefficient. The first part of the right hand side is the absolute natural stock growth and the second is the harvest. The conditions for bionomic equilibrium are now that eq. 1 equals zero, i.e. that growth equals harvest, and that the resource rent is zero since the fishery is characterised by open access, i.e. that $R=(pqs-c)E=0$ with R representing the resource rent, p the price and c the costs. Using these conditions and rearranging gives the supply function in equilibrium, where the sustained yield is expressed in terms of the price:

$$Y = \frac{rc}{pq}\left(1 - \frac{c}{pqS_K}\right) \tag{2}$$

Where Y is long-run sustainable yield. It can further be shown that the supply function is increasing until $p=2c/qS_K$ and then decrease towards zero as p increases. Therefore, the supply function is backward-bending. The peak is known as the Maximum

Sustainable Yield (MSY) above which fishing at an effort level over the effort level associated with the MSY is characterised as biological overfishing.

The supply curve in regulated open access and regulated restricted access follows the backward bending supply (average cost) curve under open access for small fishing efforts. However, at fishing efforts sufficiently above MSY, a quota gives a vertical supply curve, since quotas traditionally are introduced only after the stock has become overexploited. Hence, for $p>2c/qS_K$, the supplies is given by $Y=\overline{Y}$, where $\overline{Y}$ represents the quota.

The demand function of a fish product can be deduced as the aggregate of what the single consumers are willing to pay for the fish product. That is, where consumer utilities are maximised subject to budget restrictions. For a Cobb-Douglas utility function with two goods, Y as the fish product and Q as all other goods (a numeraire good), utility (u) is given by $u(Y,Q)=Y^{a}Q^{1-a}$. Maximising this with subject to $P_Y Y + P_Q Q = X$, where X is income and $0<a<1$, yields the demand function for the fish product in eq. 3.

$$\ln(Y)=\alpha_1+\alpha_Y \ln(Y)+\alpha_Q \ln(Q) \tag{3}$$

Contrary to the supply function, the demand function for a fish product is not distinct from the demand function for a conventional good. The demand function is decreasing with yield.

The demand and supply curves of a capture fish stock are shown in Figure 2 for an open access fishery.

Figure 2

The bionomic equilibrium is shown where the supply (average cost) and demand curves intersect at *E* in Figure 2, and even though the resource rent is zero in the open access equilibrium, the existence of the fishery still results in positive economic benefits. This benefit consists of the consumer surplus (shown as the shaded triangle in Figure 2) and the producer surplus (shown as the shaded rectangle). The consumer surplus is defined traditionally as the difference between the amount the consumers are willing to pay and the amount they actually pay.

Following Copes [9], an average social cost (ASC) curve is measured in terms of the opportunity costs of capital and labor. The curve is shown in Figure 2 and is lower than the average cost curve. The producer surplus now represents the difference between average cost and average social cost curve, represented by the lower shaded area in figure 2. The producer surplus is defined as "*the return which is left to the remuneration of capital and labour above the level in alternative uses*". That is, if the remuneration of capital and labor is on the same level as in its alternative use the producer surplus is zero. Provided that it is positive, it is larger than in alternative use. Thereby, the remuneration of capital and labor is positive in open access, but not higher than in alternative use, i.e. not higher than in other industries.

4. Theoretical welfare analysis

Based on the partial equilibrium model outlined above for a closed economy, a welfare analysis of the effects of liberalising international trade in a fish product originating

from a capture fish stock, is made following the analytical framework of [13]. Krugman and Obstfeld [13] analyses an initial situation where two countries (home as the importer and foreign as the exporter) trade with one another in the presence of an import tariff. The effect of removing the tariff is analysed for the importer country, considering the other country as the rest of the world. The analyses are performed for two large countries with power on the world market. Subsequently, they are repeated for small countries facing fixed prices on the world market. This framework is applied as the basis here, although the present analysis is for a good produced on the basis of a renewable resource, whereas Krugman and Obstfeld [13] perform their analysis on a conventional good. The analyses follow in two steps. Firstly, price effects of trade liberalisation are identified and, secondly, based on the price effects, welfare analyses are performed.

Welfare is analysed in two situations. First, for two large countries with their own open access fish stock and, secondly, for two large countries with regulated open access and regulated restricted access.

In the open access case the price effects of removing an import tariff are presented in Figure 3a and welfare effects in Figure 3b and 3c. The curves in Figure 3b and 3c are identical to the curves in the left and right hand diagrams of Figure 3a.

Figure 3

Figure 3a consists of three diagrams, one of the home market, one of the world market and one of the foreign market. Demand and supply on the home and foreign markets follows directly from Figure 2, where supply and demand on the world market appears as excess supply from the foreign market and excess demand from the home market. At

the world market, the initial import tariff used in home is shown together with the corresponding prices in home (P_{TH}) and foreign (P_{TF}). Moreover, the free trade price (P_W) is shown and it appears that removing the tariff implies that the tariff wedge at the world market between prices at the home and the foreign market disappears and drives international trade up from Q_T to Q_W. Subsequently, trade liberalisation will in the model always be followed by a fall in the price in the importer country and a rise in the price in the exporter country.

Based on this framework, the welfare effects of removing the tariff in the open access case are outlined in Figure 3b and 3c in home and foreign. On the home market, the following areas give the welfare effect:

Change in consumer surplus:	(a + b + g + h)
Change in producer surplus:	+ (d + e + f) – (a)
Tariff revenue:	- (f + g + h + i + j)
Change in welfare:	(b + d + e) – (i + j)

The welfare effect of trade liberalisation is generally indeterminate, since the consumer surplus rises and the tariff revenue disappears. This is similar for conventional goods.

Figure 3b can also be used to determine the welfare effect of trade liberalisation in a small importer country. In that case $P_W = P_{TF}$, since there is no effect through the terms of trade. In such an analysis it is, however, emphasised that although the analysis based on Figure 3b still applies, the analysis of Figure 3a does not, since the small country does not have the ability to affect the world market price. The domestic price is given exogenously by the world market price. In Figure 3b the tariff is then measured by the

difference between P_{TH} and P_W and the welfare change becomes (b + d + e + f). Thereby, the welfare effect of trade liberalisation in a small importing country with an open access fish stock is unambiguously positive. Again, this result follows from conventional opinion.

On the foreign market, the following areas give the welfare effect:

Change in consumer surplus:	- (x)
Change in producer surplus:	+ (x + y) – (v + w)
Change in welfare:	+ (y) – (v + w)

This implies that the welfare effect of trade liberalisation in an exporting country in the open access case is not unambiguous. If y > (v + w) welfare will rise, otherwise welfare will fall. Since Figure 3b, but not 3a, could be used to analyse welfare effects of trade liberalisation for small importer countries, Figure 3c, and again not 3a, can be used to analyse welfare effects of trade liberalisation for small exporter countries. The analysis of Figure 3c is, however, identical for small and large exporter countries, since large exporter countries in this analysis are assumed not to have trade policy instruments, such as importer countries having import tariffs.

Krugman and Obstfeld [13] analyses the trade policies of a large importer country for a conventional good by introducing the concept of "an optimal tariff" to denote the tariff at which welfare is maximised. They show that welfare can only be maximised by the active use of the trade policy, since the terms-of-trade (P_{export}/P_{Import}) will be worsened by trade liberalisation if the tariff is below the level of the optimal tariff.

Effects of removing the import tariff under regulated open access and regulated restricted access in the importer country was found similar to under open access. For the exporter country results under regulated open access and regulated restricted access, the results differ from open access. Not the price effects, but the welfare effects differ. Prices rise in the exporter country under both regulated open access and regulated restricted access.

Welfare effects of removing the import tariff under regulated open access and regulated restricted access in an exporter country are outlined in Figure 4.

Figure 4

Under regulated open access, a quota is fixed on a sustainable level and the fishery will be characterised by entry of new vessels until the remuneration of capital and labor are on the same level as in alternative use. Thus, the welfare effects in the exporter country under regulated open access are given by the following areas:

Change in consumer surplus:	- (v)
Change in producer surplus:	+ (v + r) – (x)
Change in welfare:	(r) – (x)

The welfare effect of trade liberalisation in the exporter country under regulated open access is given by *(r – x)*. It is, however, known that *x = (v – r)*, since increasing income originating from increasing prices is all used to investments in the "race for fish". Thereby, the producer surplus remains unchanged and the total welfare effect of trade

liberalization in an exporter country with a regulated open access fish stock will unambiguously be negative. This welfare loss is similar to in open access.

Regulated restricted access exists in several different forms and may or may not secure optimal management, dependent on how both input and output regulation are used. If a quota is fixed at the MEY level and input is limited to the minimum necessary, management is optimal in an economic sense. Trade liberalisation will then be followed by welfare gains. If, on the other hand, the quota is fixed on a level above MSY and the input remains limited to the minimum necessary, the welfare effect of trade liberalisation in the exporter country are, as shown in figure 4, given by the following areas:

Change in consumer surplus:	- (v)
Change in producer surplus:	+ (v) – (r)
Change in welfare:	+ (r)

The welfare effect of trade liberalisation in the exporter country under regulated restricted access is unambiguous positive, since all the increasing income appearing due to the rising prices, cause extra profit. This welfare gain following from trade liberalisation in an exporter country with a regulated restricted managed fish stock with a quota above an effort level associated with the MSY is new and does not follow from conventional opinion.

The welfare effects of trade liberalisation where both countries have their own managed fish stock then depend on the detailed design and use of the management system. In non-optimally managed fisheries this design and use is again determined by

the relative power of managers and fishermen, since the fishermen currently active have an interest in maximising their individual harvest and profit. Otherwise, their followers will gain in the future at their expense. Against them stands the interest of society, which might gain by reducing short run harvest in order to maximise steady state harvest and welfare. The level at which the quota is set will now depend on who is the strongest. Fishermen associations will lobby for an open access situation and the government will work for optimal management.

The effect of trade liberalisation in an importer country with an open access fish stock depends on whether the importer country possesses market power on the world market. Markets for several individual fish species are found internationally integrated [14, 15]. This implies that countries need to be very large in terms of consumption to be able to influence world prices. On the other hand, the majority of global fish consumption is consumed within three countries; Japan, the EU and the US, implying that such importer countries are large and might be able to affect the world market prices. Furthermore, several examples of fish consumption being characterised as heterogeneous in terms of e.g. cultural differences, imply that niche markets also exists. On niche markets, importer countries might be able to influence prices through their trade policies.

The effect of trade liberalisation of renewable resources then follows from the traditional theory of international economics. The exception is, however, for a large importer country where the welfare effect of trade liberalisation is indeterminate, since consumers gain, the tariff revenue falls and producers might gain or lose. This effect is also indeterminate for a conventional good according to the traditional theory of

international economics, but the present analysis show that the effects are driven by more factors.

Since the above conclusions are reached using a two-country model for fishing fleets fishing on one species solely owned by the single country and for trade in only one product form, aspects such as competition between more than two countries, shared stocks, multi-species fisheries, environmental multi-species relations and localisation of value added activities are ignored. The inclusion of such factors in the analysis would increase the applicability of results.

5. Discussion

The results of the recently developed general equilibrium model of trade in renewable resources was confirmed in the present paper in, that welfare effects of trade liberalisation depend on several factors, including the countries' status as importers or exporters, the state of the fish stock and the size of the country on the world market. But the hypothesis that some results from the general equilibrium model of trade in renewable resources needs modification when taking realistic fisheries management into account also seems to hold. For example, Brander and Taylor [2] find that the small exporter country of a renewable resource loses harvest and steady state utility from trade liberalisation. In the present paper it is found that in the small exporter country of a regulated open access fish stock, the catch will remain unchanged, consumer surplus fall and producer surplus remain unchanged. Hence, a total welfare loss result, but without any effect on supply. In the small exporter country of a regulated restricted access fish stock the catch will also remain unchanged, consumer surplus fall, but

producer surplus will rise. The result is a total welfare gain, as opposed to the welfare loss under open access in the general equilibrium model.

The hypothesis of the present paper that welfare effects of trade liberalisation remain theoretically indeterminate and therefore empirical also holds. The case dependency result of the general equilibrium model of trade in renewable resources was confirmed, but the introduction of realistic fisheries management schemes in the partial equilibrium model extended this case dependency, owing to differences in management systems and the use of them.

The implications of these findings are two-fold, covering economic modelling and policy issues. The implication for economic modelling is that neither conventional opinion, nor the opinion following from the recently developed general equilibrium model of trade in renewable resources, are sufficient to identify the welfare effect of liberalising fish trade. Reliable modelling of the welfare effects of fish trade liberalisation might necessarily be undertaken for complex and realistic management systems, such as regulated open access and regulated restricted access. Moreover, since the welfare effects depend on several and sometimes opposed factors, empirical analysis is in most cases necessary to reach unambiguous results. Therefore, reliable modelling should necessarily be based on detailed knowledge of management, since many management systems are of the regulated restricted access type, which might be relatively effective or totally ineffective, dependent on the use. Finally, reliable modelling should take into account that vessels are heterogeneous, since a part of the total welfare effect is otherwise omitted.

The policy implications of the findings from the recently developed general equilibrium model of trade in renewable resources suggest that blind trade liberalisation

in capture fish products is not necessarily desirable. Basically, welfare related to the uses of trade policies is interconnected to fisheries management and a welfare optimisation policy needs to take both into account. The optimal policy remains simultaneous optimal fisheries management and free trade for small countries. This is also the case for large countries, except that the optimal policy remains determined where trade policies are actively used to exercise market power.

The policy implication of the finding of the present paper adds to this knowledge by detailing the analysis of fish trade liberalisation suggesting that some conclusions from the general equilibrium model of trade in renewable resources should be modified for realistic fisheries management schemes. For example, the welfare effect of trade liberalisation in an exporter country is negative under open access [2], but positive under regulated restricted access. The finding of the present paper further add to the findings from the recently developed general equilibrium model of trade in renewable resources by that welfare effects of trade liberalisation remains indeterminate and thereby empirical. Therefore, the identification of welfare effects of fish trade liberalisation must be based on empirical studies, which can depart from the present partial equilibrium approach.

Hence, even though the findings from the recently developed literature and the findings of the present paper add to the understanding of the welfare effects of fish trade liberalisation, the issue is far from fully settled. A number of contributions have been made in the last decade. Schulz [11] Conclude that “trade policy is a too general measure for the management of living resources, and may implicate important economic distortions to the ecological system”. Brander and Taylor [16] Further concludes that “while we are convinced that none of our results is sufficient reason to abandon ongoing

trade liberalisation around the world, we are equally convinced that trade liberalisation is a two-edged sword for a country with a comparative advantage in renewable resources and weak property rights in these sectors". Emami and Johnson [4] conclude that the WTO "should not always insist on free trade, rather they must pay careful attention to the particular relationships between trade conditions and natural resource policies among trading nations". The present paper finds that under realistic management settings the results obtained in the general equilibrium model needs modification, welfare effects are case specific and their identification claims empirical analysis.

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FIGURE 1. **The contribution of international trade theory and resource economics in explaining welfare effects of liberalising international fish trade.**

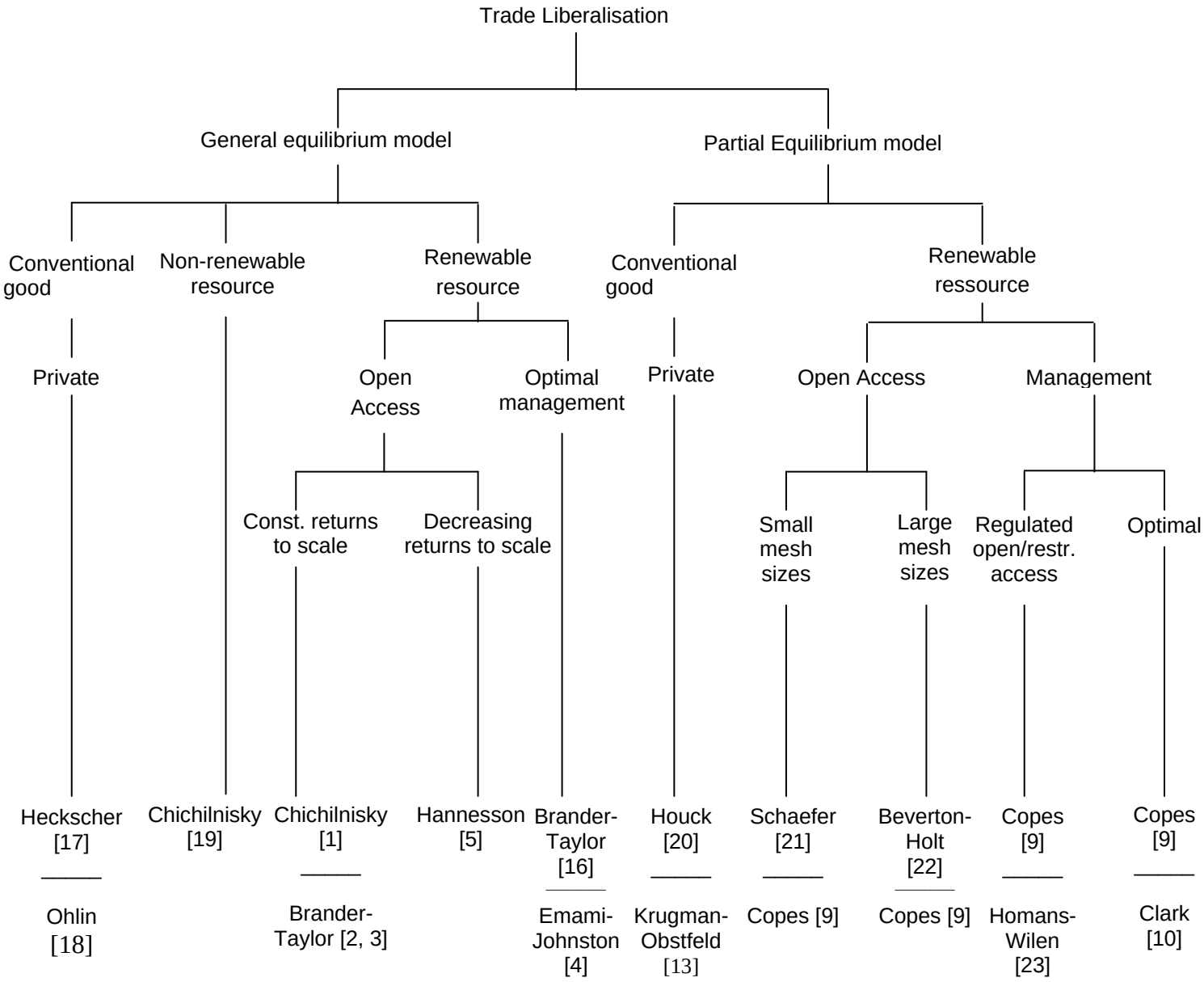


FIGURE 2. **Supply and demand of a capture fish stock under open access**

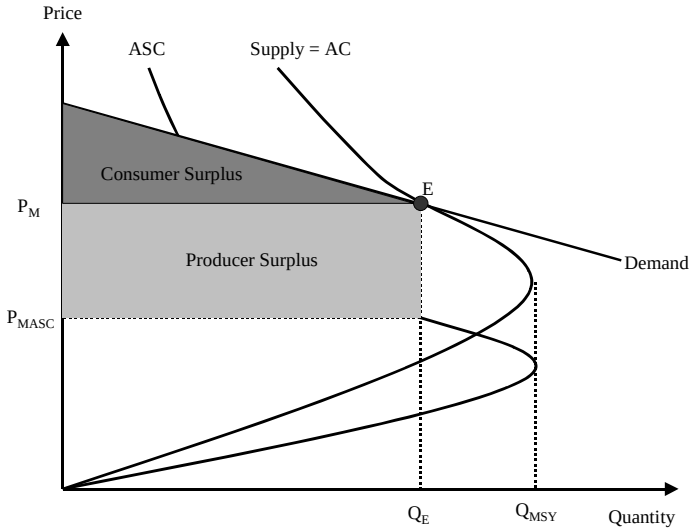
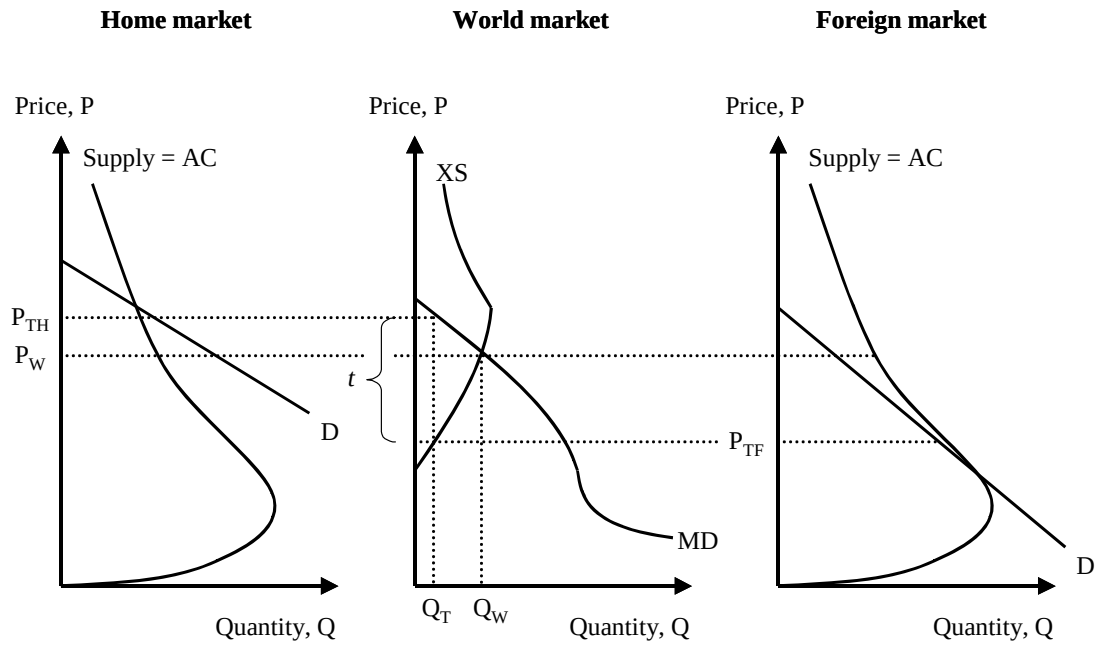
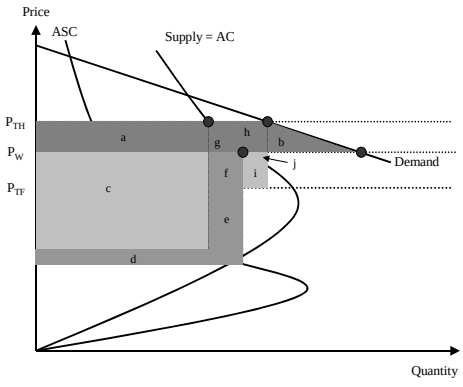


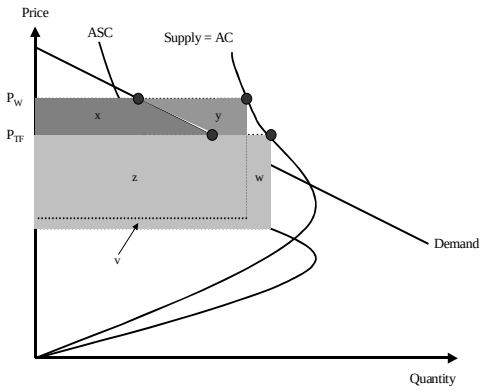
FIGURE 3. **Effects of removing a tariff under open access**



a) Price and quantity effects



b) Welfare effects in home



c) Welfare effects in foreign

FIGURE 4. **Welfare effects of removing a tariff under regulated open access and regulated restricted access in an exporter country**