A REVIEW OF COMPARATIVE ADVANTAGE ASSESSMENT APPROACHES IN RELATION TO AQUACULTURE DEVELOPMENT

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Abstract

The economic concept of "comparative advantage" can be a useful methodology in providing valuable information for both commercial and policy decision makings regarding aquaculture development. This paper appraises two approaches commonly used in the economics literature for comparative advantage assessment. One is the "domestic resource costs" (DRC) approach; and the other is the "revealed comparative advantage" (RCA) approach. Several aquaculture-related empirical applications of the DRC and RCA approaches are reviewed. Finally, the respective merits and problems of these two complementary approaches and how they could be used to provide policy guidance are also outlined.

Keywords: Aquaculture; Comparative Advantage; Domestic Resource Cost (DRC); Revealed Comparative Advantage (RCA)

1. Introduction

The existing and potential contribution of aquaculture to economic growth and food security has received increasing recognition in recent years (FAO 2002; 2004). Compared to traditional agricultural activities, aquaculture is still at its early stage of development in many countries or regions that have rich yet underexploited aquaculture resources (Kapetsky 1994; Kapetsky and Nath 1997; Aguilar-Manjarrez and Nath 1998). In designing aquaculture development strategies, policymakers as well as aquaculturists are eager to have information about a country's comparative advantage in aquaculture activities that compete for limited aquaculture resources; such information can facilitate efficient resource allocation to aquaculture activities most likely to succeed in the long run.

Against this backdrop, this paper attempts to review the concept of comparative advantage and discusses two approaches of comparative advantage assessment in the context of aquaculture development. In the next section we first clarify the concept of comparative advantage, which is one of the most important yet misunderstood ideas in economics.[1] Then in section 3 we review two approaches of comparative advantage assessments, i.e., the "domestic resource costs" (DRC) approach and the "revealed comparative advantage" (RCA) approach. We will introduce the rationales behind each approach, explain their technicalities, point out their merits and limitations in generating useful information for policy guidance. In section 4 we review several aquaculture-related empirical applications of the DRC and RCA approaches. Finally, we provide a summary discussion in section 5.

This paper is not intended to provide a comprehensive survey of the entire literature on comparative advantage and its assessment. Rather, our goal is to clarify how the concept of comparative advantage and its assessment can provide useful information for policy as well as business decision-makings with respect to aquaculture development.

[1] In response to a mathematician's challenge of naming one theory in all of the social sciences which is both true and nontrivial, Paul Samuelson resorted to David Ricardo's theory of comparative advantage: "That it is logically true need not be argued before a mathematician; that it is not trivial is attested by the thousands of important and intelligent men who have never been able to grasp the doctrine for themselves or to believe it after it was explained to them." (Samuelson, 1969)

2. Comparative advantage: a conceptual clarification

The concept of comparative advantage was originally introduced by David Ricardo to explain that the driving force behind international trade is not "absolute" but "comparative" advantage. That is, even if an autarky country has absolute advantage in all the goods (i.e., it can produce all the goods more efficiently than other countries), it can still benefit from international trade through increasing specialization in the goods where its comparative advantage lies.

In brief, a country has comparative advantage in the goods whose autarky relative prices (in terms of other goods) are lower than other countries. Such lower autarky relative prices reflect that the country is relatively more efficient in producing these goods so that under free trade it would be better off allocating more resources to producing them and then exporting them to pay for imports of other goods with less production as a result of the resource reallocation.

The concept of comparative advantage goes beyond the domain of international trade. That "someone has comparative advantage in (doing) something" is a common remark often encountered in different contexts. In general, an entity is considered having comparative advantage in one activity if it can do "relatively better" in that activity. "Relatively better" does not mean that this entity must have a better performance in this activity than other entities; neither does it mean that it must be better at this activity than other activities. Indeed, comparative advantage is an intricate concept related to both of these two comparative dimensions and involving an entity's performance in one activity, its performance in other activities, other entities' performance in this activity, and their performance in other activities.

Unless it is clear within a particular context, the two comparative dimensions of comparative advantage need to be specified for it to be clearly meaningful. For example, to say that "Brazil has comparative advantage in carp farming" is vague; to say that "among all the possible freshwater aquaculture species, Brazil has comparative advantage in carp farming" is a bit clearer; and to say that "among all the possible freshwater aquaculture species and relative to other Latin American countries, Brazil has comparative advantage in carp farming" is the most precise.

While it is difficult to precisely define what comparative advantage is, an alternative way to appreciate the concept of comparative advantage is to understand what it implies. Following the original concept of comparative advantage, to say that a country has comparative advantage in one goods implies that this country would have higher specialization in this goods under free trade than in autarky. Following a more general concept of comparative advantage, to say that a country has comparative advantage in one product implies that it is welfare improving for this country to allocate relatively more of its resources to producing this product than a typical country does. Similarly, to say that a person has comparative advantage in doing something implies that it is more efficient for him or her to specialize more in this activity than an average individual does. In sum, comparative advantage is a concept characterizing resource allocation and specialization patterns.

From an equilibrium point of view, the concept of comparative advantage characterizes equilibrium specialization patterns in the long run. For example, observing the lasting pattern that shrimp exports from Latin America and Southeast Asia have relatively high specialization in the US and Japan markets respectively, one can say that shrimp producers in Latin America have comparative advantage in exporting to the US market, while Southeast Asian shrimp producers have comparative advantage in exporting to the Japan market.

From a dynamic point of view, the concept of comparative advantage explains potential changes in specialization or trade patterns. For example, to say that an autarky country has comparative advantage in one goods implies that under free trade this country has tendency to increase specialization in that goods and export it. In light of abundant yet underexploited aquaculture resources in Sub-Saharan Africa, to say that Sub-Saharan African countries have comparative advantage in aquaculture implies that it is welfare-improving for these countries to promote aquaculture development.

Both the equilibrium and dynamic aspects of comparative advantage provide useful information: While the former reflects a country's optimal specialization pattern in the long run, the latter indicates its short-term development priorities. It should be noted that "equilibrium" is always relative because under the influence of many changing factors, comparative advantage can hardly be invariant over time.

Comparative advantage reflects the difference between benefits and (opportunity) costs. A country can gain comparative advantage in an activity from an increase in the benefits provided by this activity or a decline in its opportunity costs. Therefore, comparative advantage depends on both demand-side factors (mainly consumer preferences) and supply-side factors (mainly resource endowments and technologies);[2] and a country's comparative advantage in one activity is not only determined by its competitiveness in this activity but also by its competitiveness in alternative activities.

It is worth clarifying some common confusion between "comparative advantage" and "competitiveness" or "competitive advantage". There is no unanimous agreement on the exact definitions and the usage of these three terms. Competitiveness is usually synonymous with a country's (or firm's) long-term performance (Buckley et al. 1988). For example, in the "constant market share" (CMS) literature (see e.g., Bowen and Pelzman, 1984; Chen et al., 2000; Richardson, 1971a, b), a country's competitiveness in a market is measured by its market share; the larger market share a country controls, the greater its competitiveness in that market would be. However, there have been controversies over whether it is meaningful to talk about the competitiveness of nations (Krugman 1994; Yap 2004). In response to concerns that the US may lose from international competition under free trade, some trade economists argue that it is inappropriate to view each nation "like a big corporation competing in the global marketplace"; rather, international trade is "not a zero-sum game" but one that allows all the players to gain from exploiting their respective comparative advantages (Krugman, 1994). Competitive advantage usually refers to a country's (or firm's) characteristics that give it competitive edge to enhance its competitiveness (Porter, 1990). While competitive advantage and comparative advantage are often used synonymously, they are sometimes used in parallel for denoting different concepts. For example, in some empirical studies (e.g. Siggel and Ssemogerere, 2000; Kannapiran and Fleming, 1999; Warr, 1994; USAID 1996, 1999a-f, 2000a, b), competitive advantage is used to measure profitability under "market" prices that could be distorted by policy or other non-market forces, while

[2] Oftentimes when one uses the term "comparative advantage", what he or she means are actually the sources of comparative advantage. For example, while it is convenient to say that "low-cost labor is developing countries' comparative advantage", the exact meaning of this statement is "low cost labor is a source of developing countries' comparative advantage in labor-intensive goods".

comparative advantage is used to reflect profitability under "shadow" prices that reflect the social value of resources.

To avoid such semantic confusion, which may continue to exist for some time, authors should clearly define how they use those three terms; and readers are also responsible for respecting the authors' "freedom" in terminology. For example, in our recent study (Cai and Leung, 2005), we follow the CMS literature using market share to measure a country's "competitiveness" in exporting shrimps to each of the three major international markets (i.e., Japan, the US and the EU), and the "revealed comparative advantage" literature using RCA indices to measure a country's shrimp export "comparative advantage" in the three markets. Thus, we essentially use "competitiveness" to reflect countries' shrimp export performance in a market in the same spirit as "absolute advantage", and use "comparative advantage" to compare their export structures (i.e., their differences in specialization among the three markets). For example, as a major shrimp farming country, Thailand tends to have large market shares and hence great competitiveness in all the three markets. However, the magnitude of its competitiveness tends to be different for each market, which reflects the differences between its shrimp export structure and that of other countries. Comparative advantage is to capture such differences. In short, the more specialized a country is in a market compared to other countries, the greater comparative advantage it has in it.

3. Comparative advantage in aquaculture: an assessment framework

Comparative advantage can be used as a descriptive (or positive) concept to provide "a basic explanation of the international pattern of specialization in production and trade" (UNIDO, 1986, p.1). On the other hand, it also "plays an important role in prescriptive (or 'normative') economics" by "providing guidelines for government policies on resource allocation and trade" (*ibid*). Thus, assessing a country's comparative advantage in different aquaculture activities can provide useful information for decision makings regarding efficient resource allocation in aquaculture development.

There are two complementary approaches for comparative advantage assessment in the literature. One is the "domestic resource costs" (DRC) approach; the other is the "revealed comparative advantage" (RCA) approach.

Domestic resource costs (DRC)

In brief, the DRC approach uses social profitability to measure comparative advantage; the greater the profitability, the stronger the advantage (Monke and Pearson, 1989). Specifically, country i's comparative advantage in good j can be measured by a DRC ratio:

$$DRC_{ij} = c_{ij}^{d} \Big/ p_{ij} - c_{ij}^{f}, \tag{1}$$

where c_{ij}^{d} and c_{ij}^{f} represent the costs of (domestic) non-tradable and tradable inputs for country *i* to produce one unit of good *j*; and p_{ij} represents the price of good *j*.

With the numerator (c_{ij}^{d}) and denominator ($p_{ij} - c_{ij}^{f}$) measuring respectively country i's domestic opportunity costs and value-added in producing good j, the DRC ratio is an inverse measure of its social profitability in the production. Specifically, $DRC_{ij} < 1$ indicates that the production of good j is socially profitable in country i in the sense that domestic resources allocated to the production have generated greater value-added than their domestic costs. In contrast, $DRC_{ij} > 1$ indicates that resources have been inefficiently allocated to producing j in the sense that the value-added is less than the opportunity costs of these resources.

Therefore, $DRC_{ij} < 1$ reflects country i's "comparative advantage" in good j in the sense that country i can increase its welfare through allocating more resources to producing good j. On the other hand, $DRC_{ij} > 1$ reflects country i's "comparative disadvantage" in good j in that resources should be shifted from this sector to other more profitable uses. In general, the smaller (or greater) the DRC ratio is, the greater (or the smaller) the comparative advantage would be.

It should be noted that social profitability needs to be gauged under "shadow" instead of market prices. As opposed to observable market prices, shadow prices are "social" prices reflecting the value of social benefits or costs. For example, a country's high profitability in aquaculture may not reflect efficient resource utilization, but could result from direct or indirect government interventions artificially lowering the production costs

or raising the output prices. Therefore, using distorted market prices to measure profitability tends to result in a "false" indication of comparative advantage or disadvantage; and shadow prices, which measure the true or social value of production costs and revenues, should be used in calculating DRC ratios for comparative advantage assessment.

Empirical DRC analyses are often conducted based on the "Policy Analysis Matrix" (PAM),[3] which is a standard apparatus for policy decision-makings (Monke and Pearson, 1989) and used widely in comparative advantage assessment related to agriculture commodities (USAID 1996, 1999a-f, 2000a, b). We will review several aquaculture-related DRC analyses (Ling et al., 1999; Lee et al., 2003; Kaliba and Engle, 2003; Cruz-Trinidad, 1994) in detail in a later section.

Revealed comparative advantage (*RCA*)

While the DRC approach uses social profitability to measure comparative advantage, the "revealed" comparative advantage (RCA) approach uses *ex post* specialization patterns to infer comparative advantage patterns; i.e., a country's actual high specialization in an activity implies that it has strong comparative advantage in that activity (Balassa, 1965). It is called "revealed" (as opposed to actual) comparative advantage because rather than reflecting true comparative advantage, high specialization could reflect the influence of policy interventions or other distortions such as tariffs or other trade barriers.

Based on the basic concept of revealed comparative advantage, many different RCA indices have been suggested (Bowen, 1983; Yeat, 1985; Vollrath, 1991; Lafay, 1992; Memedovic, 1994); yet the one most widely adopted in empirical studies remains to be the standard Balassa's RCA index (Balassa, 1965):

$$RCA_{ij} = \frac{s_{ij}}{s_i}, \tag{2}$$

where $s_{ij} = X_{ij} / \sum_i X_{ij}$ is the ratio between country *i*'s export of goods j (denoted as X_{ij}) and the world export of goods j; and $s_i = \sum_j X_{ij} / \sum_{i,j} X_{ij}$ is the ratio between country i's total exports and the total exports of the entire world.

[3] An example PAM is presented in the Appendix.

According to the definition in equation (2), RCA_{ij} measures country *i*'s comparative advantage in goods *j* by comparing its competitiveness in market *j* (measured by its share in the market) to its total export competitiveness (measured by its share in the entire world export market).[4] $RCA_{ij} > 1$, which indicates that country *i*'s share in market *j* is greater than its share in the world market, implies that the country is relatively more competitive in market *j* than in other markets and hence has a "revealed" comparative advantage in goods *j*. Conversely, $RCA_{ij} < 1$ implies that country *i* is less competitive in market *j* than in other markets and hence has a "revealed" comparative disadvantage in goods *j*.

It is not difficult to verify that Balassa's RCA index can be equivalently defined in another form as

$$RCA_{ij} = \frac{c_{ij}}{c_j}, \tag{3}$$

where $c_{ij} = X_{ij} / \sum_j X_{ij}$ is the ratio between country *i*'s export of goods j and its total export; and $c_j = \sum_i X_{ij} / \sum_{i,j} X_{ij}$ is the ratio between the world export of goods j and the total world export. According to this definition, $RCA_{ij} > 1$ indicates that country *i*'s export specialization in goods *j* (measured by c_{ij}) is higher than the world average (measure by c_j), which implies that (compared to other countries) country *i* has allocated relatively more of its resources to good j and hence reveals its comparative advantage in it. Conversely, $RCA_{ij} < 1$ indicates that country *i* has below-averaged specialization and hence comparative disadvantage in goods *j*.

Following the basic methodology of using specialization patterns to infer comparative advantage patterns, many RCA indices can be constructed to compare countries' specialization patterns in many activities (Richardson and Zhang, 1999). Beyond the standard application of the RCA approach to compare countries' comparative advantage in exporting different products, it can also be applied to assess countries' comparative

[4] According to the "constant market share" (CMS) literature (e.g., Bowen and Pelzman, 1984; Chen et al., 2000; Richardson, 1971a, b), a country gaining (or losing) market share is considered increasing (or reducing) its competitiveness in the market.

advantage in exporting differentiated products under the same species or same products to different markets. We will review several aquaculture-related RCA analyses (Ling et al., 1996; Traesupap et al., 1999; Cai and Leung, 2005; Cai et al., 2005) in detail later.

DRC and RCA: merits and limitations

The DRC and RCA approaches are complementary and have respective merits and limitations. Their proper application can provide useful information for both business and policy decision-makings.

The DRC approach uses social profitability to measure comparative advantage from the dynamic point of view. That is, more resources should be allocated to producing goods with a below-unity DRC ratio (i.e., positive social profitability); and fewer resources should be allocated to those with an above-unity DRC ratio (i.e., negative social profitability). Such direct policy implications are the main appeal of the DRC approach. However, two limitations of its application need to be cautioned.

It should be stressed that short-term dynamic comparative advantage indicated by a low DRC ratio is not necessarily consistent with comparative advantage in the long run. For example, a low DRC ratio may merely reflect transitory comparative advantage derived from temporary absence of forthcoming competition. Therefore, applying DRC ratios dogmatically yet neglecting the dynamic nature of the comparative advantage or disadvantage they indicate could result in misleading policy recommendations. One way to avoid this problem is to conduct sensitivity analysis to examine social profitability under different scenarios and let decision-makers themselves decide which scenario is most applicable.

Another problem of the DRC approach is methodological. Recall that when calculating DRC ratios, the costs of production need to be valued under shadow prices. However, the problem is that the actual cost structure is influenced not by shadow (input) prices but by actual prices. For example, when feed prices are distortedly kept at a low level, aquaculturists would tend to adopt more feed-intensive production systems. Then, when feeds are valued under shadow prices, those species that react to the artificial low feed prices more significantly would be more likely to have seemingly comparative "disadvantage", even though they could actually be socially efficient were farmers'

behaviors not distorted by the non-market feed prices in the first place. One way to avoid such biases is to compute social profitability based on an econometrically estimated production function rather than simply applying shadow prices to the actually observed cost structure.

While unavailability of data is a major constraint to empirical application of the DRC approach, the RCA approach is less data-demanding. The spirit of the RCA approach is to infer comparative advantage patterns through systematically comparing specialization patterns; i.e., a country's relatively high specialization (compared to other countries) in one species reveals its comparative advantage in that species.

However, a well-recognized limitation of the RCA approach is that high specialization may not reveal true comparative advantage but result from policy or other distortions (Balassa 1965). One way to mitigate this problem is to examine specialization patterns in time series rather than merely at a point in time.

Another limitation of the RCA approach is that it does not have straightforward policy implications. A country's high RCA index in one species indicates that it has comparative advantage in this species and hence has devoted relatively more of its resources to it. However, it is unclear whether the observed high specialization level is already optimal, still not high enough, or already excessive. Conversely, a low RCA index may not indicate comparative disadvantage but could reflect comparative advantage being unexploited. Therefore, once again, it is important to examine RCA indices over time rather than at a point of time.

Notwithstanding these limitations, the RCA approach can still be very useful since it provides a systematic framework for comparing specialization patterns across countries. Such comparisons can allow young aquaculture countries to learn from the lessons and experience of those at more advanced stages. In the era of globalization, information about the global comparative advantage pattern can be invaluable to designing development strategies at both national and farm levels.

4. Aquaculture-related DRC and RCA studies: a brief review

There are an entire body of studies applying the DRC approach (e.g., Masters 1995; Monke and Pearson 1989; Pearson and Meyer 1974; USAID 1996, 1999a-f, 2000a, b;

and Yao 1997) or the RCA approach (e.g., Baldwin 1971; Bender and Li 2002; Bojnec 2001; Bowen and Pelzman 1984; Donges and Riedel 1977; Ferto and Hubbard 2003; Havrila and Gunawardana 2003; Hiley 1999; Maule 1996; Memedovic 1994; UNIDO 1982, 1985, 1986; Wolter 1977; Yeats, 1992; and Yue and Hua 2002) to assessing comparative advantage (or competitiveness) in agriculture or manufacturing products. However, aquaculture-related applications are limited. In the following we will review four aquaculture-related studies applying the DRC approach and another four applying the RCA approach.

A study by Ling et al. (1999) applied the DRC approach to examine Asian countries' comparative advantage in shrimp exports. Since data availability allowed them to compute DRC ratios for shrimp products categorized according to production systems (i.e., intensive, semi-intensive, and extensive) and destination markets (i.e., Japan, the US, and the EU), they are able to compare these ratios by countries, markets, and production systems for information about Asian countries' comparative advantage in specific shrimp farming activities, which provides a good example of the flexibility of the DRC approach.

While the authors focused on comparing shrimp producers' competitiveness, the DRC ratios they computed also exposed some interesting issues regarding resource allocation.[5] For example, one of their main findings is that "nearly all the Asian shrimp producers have a larger comparative advantage in exporting shrimp to Japan than to the US and the EU markets, largely because of the premium price received in the Japanese market". However, the questions remain why such a pattern exists and what it implies. Since a basic hypothesis is that resource reallocation under free market mechanism would tend to equalize the profitability of different shrimp farming activities, it would be interesting to find out whether there are certain constraints (e.g., technology, market access, funding, etc.) preventing countries from allocating their shrimp farming resources more efficiently to exploit their relatively large comparative advantage in shrimp exports to Japan. A similar example is regarding production systems. As the results in Ling et al.

[5] DRC ratios can measure both competitiveness and comparative advantage. Low DRC ratios indicate large profit margins. From the point of view of competition, large profit margins are a sign of strong competitiveness. From the point of view of resource allocation, large profit margins imply ample development potential.

(1999) indicate that the DRC ratio for the Philippines' intensive shrimp farming was much higher than its semi-intensive shrimp farming, shrimp farmers in the country may be interested in finding out whether they have overlooked more resource-efficient and hence profitable production systems. More importantly, policymakers should find out whether there are distortions motivating shrimp farmers to adopt less resource-efficient farming systems or constraints which do not allow them to switch system without difficulty.

Another study by Lee et al. (2003) applied the DRC approach to examine the competitiveness of eel aquaculture in Taiwan, Japan, and China. Data availability allows them to compute DRC ratios over time, which make it possible to examine the dynamics of comparative advantage. Although the focus of this study was on cross-countries comparison of eel aquaculture competitiveness, its results also provide rich information and raise several issues regarding comparative advantage and resource allocation.

In Table 3 of the paper we find that the eel farming DRC ratios have been on an upward trend in all the three countries during most of the time in the 1990s, which is consistent with the conjecture that profit margins tend to diminish as an industry becomes mature. The results also indicate that Japan had comparative disadvantage in eel farming for most of the 1990s, with DRC ratios greater than unity as well as negative private profitability. This situation should alarm policymakers in Japan to consider whether and how eel farming could be sustainable in the long run and if not, how the government can help reallocate the resources to more efficient uses. Taiwan faced a similar situation, mostly because of the competition from China. What made the situation even more ominous for eel farmers in Japan and Taiwan is the fact that China's eel DRC ratios were still distant from the unity benchmark, which indicates its ample development potential in eel farming. Interestingly, due to a significant decline in the price of tradable inputs (mostly seed and feed), the eel DRC ratios in both Japan and Taiwan were below unity in 1999. This reflects the dynamic nature of comparative advantage revealed by DRC ratios. Besides, it also emphasizes the importance of examining DRC ratios over time instead of at a point in time.

Kaliba and Engle (2003) provided a case study using the Policy Analysis Matrix (PAM) to examine the impact of market failures on the private and social profitability of

catfish farming in Chicot County, Arkansas. Unlike the foregoing two studies that use the domestic market prices of non-tradable inputs to compute DRC ratios, this study demonstrates that significant divergences between market and shadow prices can exist because of market failures and provides a good illustration of shadow price estimation.

Table 1 Policy Analysis Matrix for catfish farms in Chicot County, Arkansas 2001[1]

	Size (ha)	Mean acreage	Revenue	Cost of tradable inputs			Cost of factor of production				Net profit
				Chemical	Energy	Overhead	Feeds	Labor	Land	Capital	
Private values[2]	<40	53	1.20	0.04	0.23	0.10	0.72	0.10	0.26	0.45	-0.69
	40<81	136	1.24	0.06	0.17	0.11	0.73	0.20	0.09	0.35	-0.47
	81<121	244	1.24	0.03	0.15	0.06	0.59	0.20	0.10	0.27	-0.17
	121-202	378	1.32	0.03	0.17	0.05	0.66	0.21	0.10	0.24	-0.13
	>202	869	1.48	0.01	0.21	0.05	0.60	0.21	0.06	0.16	0.18
Social values	<40	53	2.50	0.04	0.23	0.10	1.00	0.11	0.50	0.47	0.06
	40<81	136	2.50	0.06	0.17	0.11	0.97	0.23	0.60	0.37	0.00
	81<121	244	2.50	0.03	0.15	0.06	0.69	0.23	0.74	0.28	0.32
	121-202	378	2.50	0.03	0.17	0.05	0.67	0.24	0.94	0.25	0.16
	>202	869	2.50	0.01	0.21	0.05	0.56	0.24	0.80	0.17	0.47
Divergences	<40	53	-1.30	0.00	0.00	0.00	-0.28	-0.01	-0.24	-0.02	-0.75
	40<81	136	-1.26	0.00	0.00	0.00	-0.24	-0.03	-0.51	-0.02	-0.47
	81<121	244	-1.26	0.00	0.00	0.00	-0.09	-0.03	-0.64	-0.01	-0.49
	121-202	378	-1.18	0.00	0.00	0.00	-0.01	-0.03	-0.84	-0.01	-0.29
	>202	869	-1.02	0.00	0.00	0.00	0.04	-0.03	-0.73	-0.01	-0.29

Notes: 1. Price and cost values are in nominal terms and presented in $/kg.
2. Cost calculations are based on Chicot County catfish farms survey data

Source: Kaliba and Engle (2003)

The results of Kaliba and Engle (2003) show that while catfish farming in the region had negative profits under market prices, its social profitability under shadow prices is positive with below-unity DRC ratios. As shown in Table 1, the market prices of live catfish in the US during 2001 were below 1.5 $/kg, under which most of catfish farming in Chicot County had negative private profits. However, when the distortions on the catfish output prices (alleged to be caused by dumping) and production costs (caused by implicit subsidies) are accounted for, the shadow prices of catfish would be 2.5 $/kg; and the shadow value of production costs would be higher as well. However, under these shadow output prices and production costs, catfish farming in Chicot County would have had positive social profits (i.e. their DRC ratios less than unity). Table 1 also shows that large-scale catfish farming in the region tends to be more socially profitable, which raises

the question whether there are constraints (e.g., lack of funding sources) hindering more efficient resource utilization.

Cruz-Trinidad (1994) applied the DRC approach to examine the comparative advantage of three types of (penaeid) shrimp farming (i.e., extensive, semi-intensive, and intensive) in the Philippines. This paper provides a detailed demonstration of the empirical procedure of the DRC approach, which mainly includes "conversion of financial cost to economic cost" (i.e., shadow price estimation), "disaggregation of economic cost into its domestic and foreign components", and "translation of imported inputs into its border prices". In particular, the author calculated the "adjusted" DRC ratios that account for environment externalities as implicit domestic resource costs of shrimp farming. The results show that the Philippines had comparative advantage in shrimp farming even when environmental costs were accounted for; and the advantage was the greatest for the semi-intensive farming system and the smallest for the extensive system. The author mentioned that currency devaluation has helped the Philippines preserve its comparative advantage in shrimp farming when shrimp prices started going down. This raises the issue that whether such comparative "advantage" due to cheap currency is a true advantage or merely a result of government promoting or protecting export-oriented industries through currency devaluation. The answer perhaps depends on whether the devaluation is permanent or transitory.

Now we switch to the RCA approach. Ling et al. (1996) applied the RCA approach to assess the export performance of major cultured shrimp producers in the Japanese and US markets. Based on the international trade statistics during 1989-1991, they computed the RCA indices for 9 major cultured shrimp producers in the Japan and US markets respectively. The results reveal countries' comparative advantage in differentiated shrimp export products (e.g., Taiwan's strong comparative advantage in live shrimp export to Japan and fresh shrimp export to the US; the Philippines' strong advantage in dried/salted/in brine shrimp export to Japan; Ecuador's strong advantage in fresh/shell-on shrimp export to the US, etc.). Identifying such comparative advantage patterns is only the first step, what is more important is to understand the driving forces behind them. As pointed out by Ling et al. (1996), Taiwan's remarkable comparative advantage in live shrimp export to Japan comes from its "well-established, integrated network of live

shipping, packing and transporting techniques and facilities". Thus, other countries that wish to develop similar comparative advantage would know where to spend their effort.

Similar to Ling et al. (1996), Traesupap et al. (1999) also applied the RCA approach to assess major shrimp producers' comparative advantage in exporting shrimps to Japan and the US, yet they used more updated data (1991-1996) and considered more categories of differentiated shrimp products.

Cai and Leung (2005) is our recent study applying the RCA approach to assessing shrimp export comparative advantage. Instead of examining the comparative advantage of shrimp producers in differentiated shrimp products, we were interested in their comparative advantage in exporting shrimps to different markets. The main purpose of this study is to demonstrate a systematic framework for comparative export performance assessment. Methodologically, we use market share to measure a country's competitiveness in a market and identify "size advantage" and "comparative advantage" as two contributing factors; the former captures the competitiveness due to a country's total export capacity, while the latter captures the competitiveness due to the degree of its specialization in the market. We emphasized on examining the dynamics of comparative advantage and developed a more accurate index for its measurement compared to the common practice of directly using the difference between RCA indices at two points in time to measure the comparative variation between them, which is not precise and could cause misleading results.

Table 2 illustrates some results of this study. It shows that in the mid-1990s, Southeast Asia as a whole has strong comparative advantage (i.e. RCA index greater than unity) in exporting cultured shrimp to the Japan market, relatively weak advantage (i.e. RCA index less than unity) to the US market, and the weakest advantage to the EU market. This is not surprising considering the geographic proximity of the region to Japan. However, the results show that the region has increased its comparative advantage in the US market at the expenses of the other two markets between the mid-1990s and the early-2000s. The results also indicate that 5 major shrimp farming countries in the region (including Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam) have different comparative advantage patterns. For example, unlike the other four countries in the region, Thailand had weak comparative advantage in the Japan market in the mid-1990s;

and the advantage has declined significantly between the mid-90s and the early-2000s. Although Thailand was the only one with strong comparative advantage in the US market, all of the five countries except the Philippines have increased their comparative advantage in the US market; and the growth of Viet Nam was the most impressive. In the EU market, Malaysia was the only one with strong comparative advantage, while Indonesia and the Philippines have increased their comparative advantage. The RCA indices and their dynamics are not the end but a means to systematically characterize countries' specialization patterns. More fruitful tasks would be to uncover the possible underlying causes of these patterns and their implications.

Table 2. Cultured shrimp export RCA and RCA dynamics of 5 Southeast Asian countries

Countries	RCA indices in Japan		RCA indices in the US		RCA indices in the EU	
	Initial (Mid-90s)	Variation (Mid-90s to early-2000s)	Initial (Mid-90s)	Variation (Mid-90s to early-2000s)	Initial (Mid-90s)	Variation (Mid-90s to early-2000s)
Indonesia	2.4	-0.37	0.3	0.03	0.2	0.41
Malaysia	1.0	0.17	0.1	0.09	2.5	-0.21
Philippines	2.3	0.21	0.3	-0.04	0.0	0.19
Thailand	0.9	-0.22	1.1	0.23	0.7	-0.42
Viet Nam	1.9	-0.54	0.2	0.59	0.3	0.03
Southeast Asia	**1.4**	**-0.17**	**0.8**	**0.15**	**0.6**	**-0.17**

Source: Cai and Leung (2005)

In another recent study (Cai et al., 2005), we applied the RCA approach to examine the comparative advantage of Asian, Latin American, and Sub-Saharan countries' comparative advantage in the farming of three major freshwater aquaculture species (i.e., carp, catfish, and tilapia). Our purpose is to provide a systematic assessment of these countries specialization patterns regarding those three species. Due to lack of applicable trade data, we use production data for this assessment; hence such "production" comparative advantage would be different from the conventional "trade" comparative advantage revealed by trade specialization patterns. The main difference is that a country's production serves both domestic and foreign markets. Thus, it is possible that even when a country has relatively high specialization in farming one species, its trade specialization in this species could be low if most of the production are consumed domestically. Comparing "trade" comparative advantage is more straightforward than comparing "production" comparative advantage because while countries face similar

conditions in the international trade markets, the conditions in their domestic markets could differ significantly. However, while trade specialization patterns reflect the export performance of different species (i.e., their ability to earn foreign exchanges), production specialization patterns provide more general information about the importance of different species regarding economic development.

5. Summary

Originally introduced to explain the benefits of international trade, comparative advantage has become a powerful concept widely applied to address development issues. In the context of aquaculture development, policymakers in a country always want to know about the country's comparative advantages in aquaculture so that they can design proper policies to foster these advantages into sustainable competitiveness. Information about comparative advantage is also important for individual aquaculturists to devote to promising aquaculture activities and avoid untenable enterprises.

There are two approaches for comparative advantage assessment. The DRC approach uses social profitability to measure comparative advantage; i.e., the higher the social profitability, the stronger the comparative advantage, while the RCA approach uses observed specialization patterns to reveal comparative advantage patterns; i.e., high specialization reveals strong comparative advantage.

The purpose of these two approaches is to provide systematic information for policy guidance; such information should be correctly understood and used with discretion in policy decision-making regarding aquaculture development.

DRC ratios can provide information about the true economic viability and resource utilization efficiency of aquaculture activities, which is useful for determining aquaculture development priority. Other things being equal, priority should be given to aquaculture activities with relatively low DRC ratios because such activities not only use domestic resources more efficiently, but also tend to be more economically viable due to their relatively larger profit margins. However, it should be borne in mind that the comparative advantage reflected by low DRC ratios may be transitory and unsustainable in the long run. On the other hand, regarding an aquaculture activity with high DRC ratios (i.e., low social profitability), the proper policy reaction is not to simply give it a

low development priority, but to identify the underlying causes of such low profitability and help improve it.

While the DRC approach should be used with discretion, the application of the RCA approach is more of an art. It should be borne in mind that RCA indices use relative specialization level to measure "revealed" comparative advantage. While a country's high RCA index in one aquaculture activity indicates the importance of this activity to its aquaculture development, it does not necessarily imply that the country should further promote the activity since the high specialization may already be optimal. Indeed, DRC analysis should be applied to make sure that a country's high revealed comparative advantage does not reflect over commitment of resources beyond the efficient level of allocation. The dynamics of a country's RCA pattern would be highly informative since it reveals the country's special features in aquaculture development. Comparing its own RCA dynamics to other countries' experience can help a country to determine whether its aquaculture development properly reflects its underlying comparative advantage. RCA analysis is especially useful for a country whose aquaculture development is still at its "infancy" stage. When designing its aquaculture development strategy, this country can learn from the comparative advantage patterns of other countries with similar resource endowments yet more advanced aquaculture development. Understanding the driving forces behind these patterns and their transition can help the country avoid making similar mistakes and design a more sensible aquaculture development blueprint.

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Appendix

Table A.1. Structure of the Policy Analysis Matrix (PAM)

	Revenue	**Cost of intermediate inputs**		**Profits**
		Tradable inputs	Domestic factors	
Private profit	A	B	C	D
Social profit	E	F	G	H
Divergences	I	J	K	L

Private profits (D) = (A – B – C) and social profits (H) = (E – F – G).
Output transfers (I) = (A – E); input transfers (J) = (B – F) and factor transfers (K) = (C – G).
Net transfers (L) = (D – H); or (I – J –K).
Domestic resource cost ratio (DRC) = G / (E – F).
Nominal protection coefficient on tradable outputs (NPCO) = A / E.
Nominal protection coefficient on tradable inputs (NPCI) = B / F.
Effective protection coefficient (EPC) = (A – B) / (E – F).

Source: Kaliba and Engle (2003); originally from Monke and Pearson (1989)