APPENDIX 1

RCA Indices

In the following we present some major RCA indices reported in the literature. For additional variants and other RCA indices, Memedovic (1994) and Vollrath (1991) provide more thorough reviews.

- Standard Balassa's RCA index

$$RCA_{ij}^{1} = \frac{\dfrac{X_{ij}}{\sum_{i} X_{ij}}}{\dfrac{\sum_{j} X_{ij}}{\sum_{i}\sum_{j} X_{ij}}}$$

where X_{ij} represents country i's export of product j. $RCA_{ij}^{1} > 1$ indicates country i has a comparative advantage in production of j; the greater the index, the stronger the advantage. $RCA_{ij}^{1} < 1$ indicates that country i has a comparative disadvantage in production of j; the smaller the index, the greater the disadvantage.

- RCA index suggested by Donges and Riedel (1977)

$$RCA_{ij}^{2} = \frac{\dfrac{X_{ij} - M_{ij}}{\sum_{i} X_{ij} + M_{ij}}}{\dfrac{\sum_{j} X_{ij} - \sum_{j} M_{ij}}{\sum_{i} X_{ij} + \sum_{j} M_{ij}}}$$

where X_{ij} and M_{ij} represent country i's export and import of product j. $RCA_{ij}^{2} > 1$ indicates country i has a comparative advantage in production of j; the greater the index, the stronger the advantage. $RCA_{ij}^{2} < 1$ indicates that country i has a comparative disadvantage in production of j; the smaller the index, the greater the disadvantage.

- RCA index suggested by Bowen (1983)

$$RCA_{ij}^{3} = \frac{\dfrac{T_{ij}}{Y_{i}}}{\dfrac{\sum_{i} Q_{ij}}{Y_{w}}}$$

where Q_{ij} and t_{ij} represent country i's production and net trade (i.e. production minus consumption) of product j while Y_i and Y_w represent country i's GNP and the world GNP, respectively. $RCA_{ij}^{3} > 0$ indicates country i has a comparative advantage in production of j; the greater the index, the stronger the advantage. $RCA_{ij}^{3} < 0$ indicates

that country *i* has a comparative disadvantage in production of *j*; the smaller the index, the greater the disadvantage.

- RCA indices suggested by Vollrath (1991)

$$RCA_{ij}^{4} = \frac{X_{ij}/X_{ik}}{X_{nj}/X_{nk}} - \frac{M_{ij}/M_{ik}}{M_{nj}/M_{nk}}$$

$$RCA_{ij}^{5} = \ln\left(\frac{X_{ij}/X_{ik}}{X_{nj}/X_{nk}}\right)$$

$$RCA_{ij}^{6} = \ln\left(\frac{M_{ij}/M_{ik}}{M_{nj}/M_{nk}}\right)$$

where X_{ij} and X_{ik} represent country *i*'s exports of product *j* and its total exports of other products; X_{nj} and X_{nk} represent the exports of product *j* and the total exports of other products by the rest of the world; M_{ij} and M_{ik} represent country *i*'s import of product *i* and its total imports of other products; finally, M_{nj} and M_{nk} represent imports of product *j* and total imports of other products by the rest of the world. According to Vollrath (1991, p. 276), "a positive RCA_{ij}^{4}, RCA_{ij}^{5}, or RCA_{ij}^{6} reveals a comparative advantage, while a negative value reveals a comparative disadvantage".

APPENDIX 2

A proper measure for comparative advantage variations

Since Balassa's RCA index is a measure of comparative advantage at a point in time, it seems natural to use the difference between RCA indices at the beginning and end of a period to measure the change of comparative advantage during the period.

Although this has been a common practice,[1] its theoretical justification has not been established. In the following we derive a measure of comparative advantage variation with theoretical foundation; the result shows that the direct use of the difference between RCA indices at different times to measure revealed comparative advantage variation is not generally appropriate.

Methodologically, we first derive what country *i*'s RCA index for product *j* would have been at time *t*+1 if it maintains its comparative advantage in the product during the period between time *t* and *t*+1. Then we can use the deviation of its actual $RCA_{ij,t+1}$ from this benchmark RCA index to measure its comparative advantage variation during the period.

According to equation (3), country *i*'s revealed comparative advantage in any product *j* is measured by the ratio between its share in export market *j* and its world market share. Thus, country *i*'s comparative advantage in market *j* relative to market *k* can be measured by the ratio between its shares in the two markets, i.e. $s_{ij,t}/s_{ik,t}$. Therefore, country *i* would experience no change in its comparative advantage pattern between time *t* and *t*+1 if its market share ratios for any two markets remain constant during the period, i.e.

$$\frac{\tilde{s}_{ij,t+1}}{\tilde{s}_{ik,t+1}} = \frac{s_{ij,t}}{s_{ik,t}}, \forall\, j,k, \tag{A.1}$$

where $\tilde{s}_{ij,t+1}$ represents what country *i*'s share in market *j* would have been under no comparative advantage variations.

According to equation (A.1), a country would experience no comparative advantage variation when its market share in every market grows at the same rate, i.e.

$$\forall\, j, \frac{\tilde{s}_{ij,t+1}}{s_{ij,t}} = \alpha, \tag{A.2}$$

where α is a positive constant.

Given the total export of product *j* at time *t*+1 (i.e $E_{j,t+1}$), had country *i* experienced no comparative advantage variation between time *t* and *t*+1, its export of product *j* would have been

$$\tilde{E}_{ij,t+1} = \tilde{s}_{ij,t+1} E_{j,t+1},$$

which, according to equation (A.2), gives,

$$\tilde{E}_{ij,t+1} = \alpha s_{ij,t} E_{j,t+1} \tag{A.3}$$

[1] For example, Bojnec (2001); Hiley (1999); Havrila and Gunawardana (2003); and Yeats (1992).

Accordingly, country *i*'s specialization in production *j* would have been

$$\tilde{c}_{ij,t+1} = \frac{\tilde{E}_{ij,t+1}}{\sum_{j_k} \tilde{E}_{ij_k,t+1}},$$

which, substituted in equation (A.3), gives

$$\tilde{c}_{ij,t+1} = \frac{s_{ij,t} E_{j,t+1}}{\sum_{j_k} s_{ij_k,t} E_{j_k,t+1}} \tag{A.4}$$

Then, given its actual total export $E_{i,t+1}$, country *i*'s constant-comparative-advantage benchmark export of product *j* would be

$$\tilde{E}_{ij,t+1} = \tilde{c}_{ij,t+1} E_{i,t+1},$$

which, substituted in equation (A.4), gives

$$\tilde{E}_{ij,t+1} = \frac{s_{ij,t} E_{j,t+1} E_{i,t+1}}{\sum_{j_k} s_{ij_k,t} E_{j_k,t+1}} = \frac{(1+g_j) c_{ij,t} E_{i,t+1}}{\sum_{j_k} c_{ij_k,t} (1+g_{j_k})}. \tag{A.5}$$

Since $\tilde{E}_{ij,t+1}$ represents what country *i*'s export of product *j* would have been under no comparative advantage variation, the deviation of its actual export of product *j* (i.e., $E_{ij,t+1}$) from this constant-comparative-advantage benchmark would provide a measure of the country's comparative advantage variation between time *t* and *t*+1.

Similar to how the RCA index is defined, a "revealed comparative advantage variation" (RCAV) index can be defined as

$$RCAV_{ij} = \frac{E_{ij,t+1}/E_{i,t+1}}{E_{j,t+1}/E_{t+1}} - \frac{\tilde{E}_{ij,t+1}/E_{i,t+1}}{E_{j,t+1}/E_{t+1}} = RCA_{ij,t+1} - \beta RCA_{ij,t} \tag{A.6}$$

where $\beta = \dfrac{1+g}{1+\sum_j c_{ij,t} g_j}$,

$g_j = (E_{j,t+1} - E_{j,t})/E_{j,t}$ represents the growth rate of world exports of product *j* between time *t* and *t*+1, and

$g = (E_{i+1} - E_t)/E_t$ represents the growth rate of total world exports of all products.

The RCA index can be expressed in two equivalent forms (see equations 3 and 4). Likewise, the RCAV index defined in equation (A.6) can be manifested as

$$RCAV_{ij} = \frac{s_{ij,t+1}}{s_{i,t+1}} - \frac{\tilde{s}_{ij,t+1}}{s_{i,t+1}} \tag{A.6.1}$$

or

$$RCAV_{ij} = \frac{c_{ij,t+1}}{c_{j,t+1}} - \frac{\tilde{c}_{ij,t+1}}{c_{j,t+1}}. \tag{A.6.2}$$

A positive $RCAV_{ij}$ index implies that country i has increased its comparative advantage in product j; the higher the index is, the greater the advantage gain is. A negative $RCAV_{ij}$ index would have the exact opposite implication.

It is not difficult to see that

$$\sum_j c_{j,t} g_j = g,$$

where $c_{j,t} = E_{j,t}/E_t$ represents the proportion of world cultured shrimp exports sold to market j. Thus, β would be unity when $c_{ij,t}$ is identical to $c_{j,t}$ for every market j, i.e. according to equation (4), when country i's RCA index for every market j is equal to unity (i.e. $g_j = g, \forall j$). Otherwise, β would generally be different from unity. Therefore, when the sizes of markets are changed disproportionately, direct use of the variation of RCA indices to measure comparative advantage variation would not be appropriate in general.

For example, LAC country Uruguay had catfish RCA indices of 55.48 and 35.78 respectively during 1990–94 and 1995–99, which seemingly indicates that it has *reduced* its comparative advantage in catfish between the first and second half of the 1990s. However, the country's specialization in catfish has actually *increased* from 69 percent during 1990–94 to 77 percent during 1995–99. The corresponding RCAV index, which is positive at 4.65, properly reflects this comparative advantage *gain*.

Comparative advantage analysis is a useful tool of economics that can be used to compare relative costs of production and identify species and markets with the greatest likelihood of success. Two different approaches are normally used to assess comparative advantage: the Domestic Resource Cost (DRC) and the Revealed Comparative Advantage (RCA) methods. The DRC approach is dynamic but requires data on production costs which may be hard to obtain. The RCA method is more descriptive and has less predictive potential than the DRC approach but required data are normally available. This paper illustrates the concept of comparative advantage and some of its policy implications by presenting two case studies (on shrimp export markets and aquaculture production of freshwater finfish) using the RCA method.

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