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Consistency tests of comparative advantage measures: An empirical evidence from the Malaysian and selected Asian shrimp products

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Abstract

The aim of this study is to examine the consistency between the Balassa index and Vollrath indices in measuring comparative advantages of the Malaysian shrimp products with other major shrimp exporting nations as comparator. The study uses Balassa index and Vollrath indices to measure comparative advantages of the Malaysian shrimp products. The indices then are compared by consistency tests. Malaysia was generally not competitive in shrimp trade; however, revealed comparative advantage (RCA) and relative export advantage (RXA) indices show some extent of competitiveness on non-frozen shrimp product. Thailand had a remarkable competitiveness in shrimp trade as compared to other major exporting countries. Although we found that double-counting problem in the Balassa index is insignificant in measuring export performance of the Malaysian shrimp sector, import could be an important variable in accessing its trade competitiveness. Marginal import of a sector may lead to relative trade advantage (RTA) index consistent with RCA and RXA indices. Considering exports and imports of a particular commodity in measuring competitiveness is more consistent with the real world phenomenon of two-way trade. Selecting measurement of comparative advantage should rigorously base on trade behaviour of a sector as well as theoretical constructs. The competitiveness of the Malaysian shrimp products remains unclear due to the lack of contemporary analyses backed by formal testing procedures. The results and policy implications of this study provide stakeholders insights into comparative advantage as well as trade position of the products. Better measurement for revealed comparative advantage, particularly for shrimp products, is discussed in this paper.

Introduction

Various approaches and methods for the measuring of comparative advantage exist (Balassa, 1965; Vollrath, 1991). In the current competitiveness studies, there are two common measurements used by a number of scholars. On one hand, Balassa index is adopted in order to measure export competitiveness (Kuldilok *et al.*, 2013) and comparative advantage (Shang *et al*., 1998; Wijnands, et al., 2008; Wijnands, *et al.*, 2010). Generally, this measurement is solely based on export data, which is not taking imports into account. On the other hand, the Vollrath indices are used to measure comparative advantage as well as trade competitiveness (Seyoum, 2007; Bojnec and Ferto, 2009; Bojnec and Ferto, 2011; Ismail *et al*., 2013).

When investigating the comparative advantage, past studies have been largely based on revealed comparative advantage theory (Liesner, 1958; Balassa, 1965; Kunimoto, 1977; Bowen, 1983; Vollrath, 1991). As comparative advantage can be revealed through nation or commodity trade patterns; trade reflects relative costs and also differences in non-price factors (Balassa, 1965). In fact, consistent data for imports and exports are readily available even for rather narrowly defined product categories (Ballance *et al.*, 1987). Therefore, trade measures have traditionally been at the core of measuring comparative advantage and competitiveness of nations, industries and product specializations. However, these measurements are not taking imports into account, which fails to fully explain competitiveness of a nation.

There are numerous studies that adopted revealed comparative advantage (RCA) in the sectorial analysis for competitiveness (Shang *et al.*, 1998; Wijnands et al., 2008; Wijnands *et al*., 2010, Kuldilok *et al.*, 2013). Kuldilok *et al.* (2013) uses an RCA approach for both major tuna exporters in the world market and competitors in individual export markets. Past studies also computed trade competitiveness of the Malaysian food industry that has been examined using RCA approach. For instance, Ismail and Radam

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(2004) and Ismail *et al.* (2005) measured comparative advantage in the Malaysian food industry using indicators such as Domestic Resource Costs (DRC), Social Cost-Benefit (SCB), Net Export Index (NEI) and RCA indices, while Wijnands *et al*. (2008) and Wijnands *et al.* (2010) extended the analysis to include policy analysis indicators.

In the recent years, there has been a considerable interest in the use of the Vollrath indices. The main reason for this increased interest is attributable to the use of export and import data in measuring comparative advantage. Besides, Vollrath (1991) emphasises the presence of two limitations in the Balassa index; firstly, that a double-counting problem occurred in the commodity and/or country considered, and secondly the importance of the simultaneous consideration on the import side. Which means the set of the commodities and the countries in the denominator should exclude the commodity and country mentioned in the numerator in order to avoid the double-counting problem. The Vollrath indices are also measured as the difference between revealed comparative export advantage and its counterpart, the relative import specialization index.

When import and export are the concern, past attempts have been driven by the Vollrath approach (Mosoma, 2004; Seyoum, 2007; Bojnec and Ferto, 2009; Bojnec and Ferto, 2011; Ismail *et al.*, 2013). The Vollrath approach implies relative trade advantage, rather than just measure export performance that could not reflect the actual trade position. Given that we are interested in the competitiveness of Malaysian shrimp products, revealed comparative advantages are chosen to be calculated with other major shrimp exporting countries as the comparator. Thus, this paper argues that adopting the Vollrath approach in this study can help provide more accurate analysis of competitiveness of the Malaysian shrimp industry. As the approach encompasses both supply and demand effects and are more consistent with the theoretical concept of comparative advantage than other RCA approaches.

Shrimp products in Malaysia mainly produced from marine capture fisheries and aquaculture. Contribution of inland capture fisheries is marginal, at average of 0.3% of total shrimp production for the period of 2004 to 2011. Figure 1 illustrates that contribution of farmed shrimp to the total shrimp production is increasingly significant, it increased from 28% in 2004 to 38% in 2011; in fact, it once reached to the highest share at 43% for 2009 and 2010.

Shrimp is the most traded fishery commodity in Malaysia. Export value of shrimp product

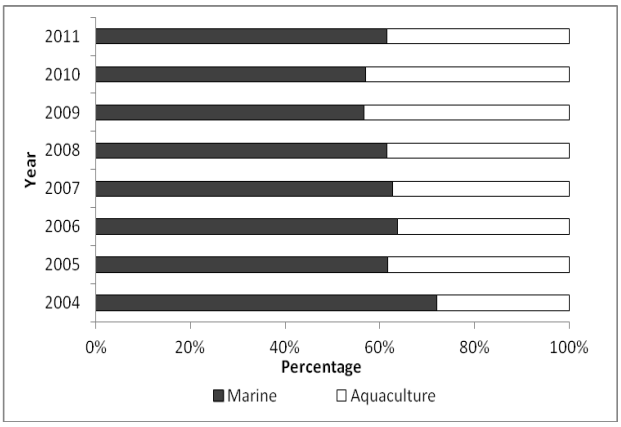

Figure 1. Contribution of wild caught shrimp and farmed shrimp to total shrimp production, 2004-2011 (%)
Source: Department of Fisheries (2004-2011)

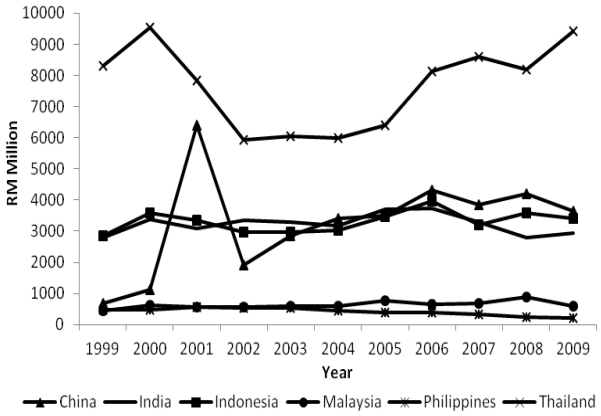

Figure 2. Balance of trade (BOT) of shrimp products by nations, 1999-2009
Source: Global Trade Information Services (2011)

contributed 49.7% of total fishery export value in 2011 (Department of Fisheries, 2011) as compared to 40.9% in 2006 (Department of Fisheries, 2006). The Department of Fisheries also indicates that shrimp is the second most imported fishery product, where it constituted of 21.7% of total fishery import value in 2011, increased from 19.7% in 2006.

The shrimp trade generates remarkable trade surplus to the national food bill. According to Figure 2, trade surpluses generated from shrimp products increased from RM453 million in 1999 to RM900 million in 2008. The trade surplus generated from shrimp product contributed 54.9% of total fish trade surplus in 2008, although it once achieved at 77.4% in 1999. It shows that shrimp products are important to the Malaysian fishery and food industry in some extend.

However, trade surplus generated from Malaysian shrimp products was relatively less as compared to other nations. Figure 2 illustrates that Thailand generated the highest trade surplus from shrimp products, approximately 3-fold greater than

China, Indonesia, and India in 2009. Trade surplus from shrimp products of these three nations was at average of RM3,329 million with standard deviation of RM356 million in 2009.

The Malaysian shrimp industry has been also facing competition internationally. Malaysian shrimp exports are competing with major world exporters, such as China, India, Indonesia, Thailand, and the Philippines, for the similar shrimp species and markets. In fact, Malaysian shrimp exports consisted of 2.72% of total shrimp exports among the major exporters, on average, between 1999 and 2009; this is, after Indonesia, the second lowest export share. Besides, the export value for Malaysian shrimp products has also dropped from RM1.3 billion in 2005 to RM1.1 billion in 2009. This continuous decline in terms of market share and export value might affect the contribution of its share to the fish trade surplus and also to the nation's food bill.

The competitiveness of Malaysian shrimp trade, however, still remains unclear due to the lack of contemporary analyses backed by formal testing procedures. It is important to examine comparative advantage of the Malaysian shrimp industry in order to address the mentioned issues. Thus, this study adopts the Balassa index and the Vollrath indices in measuring comparative advantage of the sector. Next, both the Balassa index and the Vollrath indices are to be compared.

This study would provide evidence on competitiveness of the Malaysian shrimp products as well as better proxies in measuring comparative advantage of Malaysian shrimp industry. A competitiveness analysis of the shrimp sector would give a clearer picture of the trade position of Malaysia's shrimp sector in the global market as compared to its potential regional competitors. It is particularly important for Malaysia's shrimp commodity because it has been identified as a most traded fishery product of the nation, but has yet to identify the competitive food products for import substitution and/or export.

Materials and Methods

The Balassa approach

The first revealed comparative advantage index employed in this study uses the approach formulated by Balassa (1965):

$$RCA = (Xij / Xit) / (Xnj / Xnt) \quad (1)$$

where *Xij* denotes exports of country *i* for shrimp commodity *j, t* is a set of food and agricultural commodity and n is a set of selected major shrimp exporting countries. RCA is based on observed trade patterns and measures a country's exports of shrimp products relative to its total food and agricultural exports and to the corresponding exports of the selected nations. Comparative advantage is revealed if RCA is greater than 1.

The Vollrath approach

A different interpretation of revealed comparative advantage is furnished by Vollrath (1991), which offer three alternative measures of the comparative advantage. They are; relative export advantage (RXA), import specialization index (RMA), and relative trade advantage (RTA), expressed as,

$$RXA_{ij} = \frac{(X_{ij} / X_{ir})}{(X_{tj} / X_{tr})} \quad (2)$$

$$RMA_{ij} = \frac{(M_{ij} / M_{ir})}{(M_{tj} / M_{tr})} \quad (3)$$

$$RTA_{ij} = RXA_{ij} - RMA_{ij} \quad (4)$$

Based on equations 2, 3, and 4, in this paper, X denotes the exports and M denotes the imports of the shrimp commodity *i* of country *j, n* is the 23 food and agricultural commodities listed in the Harmonized Coding and Classification System (HS) code excluding shrimp itself, and *r* are the selected top five countries excluding country *j*. The commodity and the country that mentioned in the nominator of the RXA and RMA are excluded in the set of the commodities and the countries in the denominator in order to avoid double-counting.

For variable *i*, shrimp commodity is differentiated by categories based on the HS code at 6-digit level, which are frozen shrimp, non-frozen shrimp, and prepared and preserved shrimp. Shrimp commodity is only a sub-commodity under the fishery commodity (HS03), while fishery commodity is only one of the food and agricultural products within the 23 group of commodities.

Consistency test for the revealed comparative advantage approaches

Previous studies (Balance *et al*., 1987; Ferto and Hubbard, 2003; Seyoum, 2007) have demonstrated empirical consistency among alternative RCA indices in various sectors, such as industrial, agri-food, and services sectors, respectively. Cardinal, ordinal, and dichotomous measures were commonly used to examine the consistency. Ballance *et al.* (1987) and Ferto and Hubbard (2003) found mixed results on the consistency of the indices, which is the indices are not highly consistent in cardinal and

ordinal measures, but it is consistent in dichotomous measure. This implies that the RCA indices are not perfectly consistent and could not provide similar ranking of nations by the degree of comparative advantage, but they agree in distinguishing between nations that enjoy a comparative advantage and nations that do not. It is, thus, impossible to identify empirically a best measure of comparative advantage, but the indices are useful in identifying some extent of comparative advantage of a nation in a particular product group. Seyoum (2007) found the Balassa, relative export advantage (RXA), and relative trade advantage (RTA) indices are highly consistent on cardinal and dichotomous measures, and moderate consistent in ordinal measure. This implies that import specialization index (RMA) is not significant in measuring comparative advantage, as the main difference of RTA with Balassa and RXA indices is that import is taken into account. However, RMA index has not been illustrated and the impact of RMA index in RTA calculation is unclear in Seyoum (2007).

In this paper, consistency test is used to compare both the Balassa index and Vollrath indices. Seyoum (2007) highlights that it is important to examine the extent to which the RCA approaches are consistent in their identification of comparative advantage. According to Ballance *et al*. (1987), there are three statistical tests to access the consistency of the RCA approaches; they are cardinal, ordinal, and dichotomous measures.

Cardinal measure is computed by comparing correlation coefficients for alternative pairs of indices. Inconsistent indices would yield a correlation coefficient less than unity or of the wrong sign. Thus, the degree of the correlation coefficient departs from unity is important indicator, not statistical significance of the coefficient. Ordinal measure determines whether pair of RCA indices provides a consistent ranking of nations by the degree of competitiveness. It is established by computing rank correlation coefficients for each product and each pair of the RCA approaches. Dichotomous measure compares alternative RCA approaches of comparative advantage to establish the extent to which they are consistent in distinguishing between countries that enjoy comparative advantage and countries that do not. In this study, correlation coefficient was calculated for each shrimp product and for each pair of the indices across nations. Then, the correlation coefficients for each pair of indices were averaged across products to obtain the degree of the correlation coefficient illustrated in Table 2. Moreover, RXA-RMA ratio is illustrated in this paper to demonstrate the importance of RMA index in computing RTA index. Low value of the ratio implies the RMA index is significant in the RTA index, vice-versa.

Data description

All indices defined above are measured for Malaysian shrimp trade in food and agriculture products over the period 1999-2009, with the major shrimp exporting nations as comparators. The annual import and export data of shrimp and food and agricultural of China, India, Indonesia, Malaysia, Thailand, and the Philippines were extracted from the Global Trade Information Services (GTIS) in January 2011. There are three six-digit shrimp product groups, namely frozen (shrimps and prawns, frozen, in shell or not, including boiled in shell), non-frozen (shrimps and prawns, not frozen, in shell or not, including boiled in shell), and prepared and preserved shrimp (shrimps and prawns, prepared or preserved).

Results and Discussion

Competitiveness of the Malaysian and selected countries' shrimp products is shown in Table 1. Generally, the indices show that shrimp products of Malaysia are not competitive in international market. RCA and RXA indices illustrate that Malaysia was competitive in non-frozen shrimp product. However, when import specialization is taken into account, the product is found not competitive, as average RTA index of the product was negative for the observed period. Although the RTA indices suggested that Malaysia had relative trade disadvantage for most of the studied period, Malaysia still generated remarkable trade surpluses for frozen shrimp across the years. The average balance of trade for frozen shrimp was RM515 million with a standard deviation of RM98 million for that period. Frozen shrimp, in fact, contributes 81.4% of balance of trade for total shrimp product, on average. The standard deviation also shows that Malaysia had generated trade surpluses for this product in a consistent way.

Products which are competitive in all three measurements are frozen shrimp of India, and Indonesia, non-frozen shrimp of Thailand and the Philippines, and prepared and preserved shrimp of Thailand. Products with revealed comparative advantage in 1999 but show revealed comparative disadvantage in 2009 in one or more indices are frozen shrimp of the Philippines, non-frozen shrimp of Indonesia, and prepared and preserved shrimp of Thailand. Products with revealed comparative disadvantage in one or more indices in 1999 but

Table 1. Revealed comparative advantages (RCAs) for Malaysian shrimp products and selected shrimp exporters, 1999-2009 (indicators in Italics)

	Frozen [a]			Non-frozen [a]			Prepared [a]		
Country	RCA	RXA	RTA	RCA	RXA	RTA	RCA	RXA	RTA
China	0.31	0.24	-0.54	0.56	0.47	-0.07	0.81	0.83	***0.56***
India	***2.21***	***2.81***	***2.69***	0.15	0.14	***0.13***	0.25	0.22	***0.07***
Indonesia	***2.15***	***2.75***	***2.58***	0.36	0.34	***0.22***	0.24	0.21	-1.07
Malaysia	0.55	0.51	-1.78	***1.86***	***2.38***	-8.81	0.12	0.10	-3.52
Thailand	***1.87***	***2.44***	-2.59	***1.82***	***2.56***	***2.01***	***2.98***	***15.37***	***7.61***
The Philippines	0.15	0.12	***0.06***	***2.59***	***2.92***	***2.90***	0.01	0.01	-0.34

Note: [a] Frozen: shrimps and prawns, frozen, in shell or not, including boiled in shell. Non-frozen: shrimps and prawns, not frozen, in shell or not, including boiled in shell. Prepared: shrimps and prawns, prepared or preserved.

Table 2. Correlations among RCA measures to test consistency of indices

	Cardinal	RXA	RTA	Dichotomous	RXA	RTA	Ordinal	RXA	RTA
Frozen [a]	RCA	0.988	0.535	RCA	0.948	0.475	RCA	0.980	0.522
	RXA		0.508	RXA		0.483	RXA		0.539
Non-frozen [a]	RCA	0.992	0.861	RCA	0.982	0.758	RCA	0.996	0.839
	RXA		0.876	RXA		0.774	RXA		0.848
Prepared [a]	RCA	0.959	0.201	RCA	0.986	0.202	RCA	0.996	0.232
	RXA		0.253	RXA		0.218	RXA		0.246

Note: [a] Frozen: shrimps and prawns, frozen, in shell or not, including boiled in shell. Non-frozen: shrimps and prawns, not frozen, in shell or not, including boiled in shell. Prepared: shrimps and prawns, prepared or preserved.

then gain revealed comparative advantage in 2009 are frozen shrimp of Thailand, non-frozen shrimp of Malaysia and the Philippines, and prepared and preserved shrimp of Indonesia. It is worth mentioning that Thailand is the selected nation that achieves revealed comparative advantages in all three indices for two shrimp commodities; namely non-frozen and prepared and preserved shrimp products. However, the competitiveness for the prepared and preserved shrimp product is declining in the recent year, as RTA indices were negative in 2008 and 2009.

Table 2 illustrates results of the consistency test for the RCA indices by shrimp products. The results show that the RCA and RXA indices are highly consistent as cardinal, ordinal, and dichotomous measures of revealed comparative advantage. This is due to these indices share similar criteria and imports are not taken into account, the different of these indices is that RXA index eliminates double-counting problem of the RCA index. In fact, we argue that the double-counting problem in the Balassa approach that highlighted by Vollrath (1991) is not significant in measuring export competitiveness for shrimp products in Malaysia due to relative small amount of export value as compared to the reference countries. As both the RCA and RXA indices are largely consistent in measuring whether countries have export competitiveness in shrimp products.

The results also reveal a weak degree of consistency between RCA index and RTA index and also RXA index and RTA index. The inconsistency among the indices suggests that empirical studies based on any index as a cardinal measure might be highly sensitive to the particular index chosen (Ballance *et al*, 1987). This also implies that import specialization index is a significant variable in measuring trade competitiveness as well as revealed comparative advantage, as RTA index considers exports and imports with a particular commodity, which is consistent with the real world phenomenon of two-way trade. Moreover, the RTA index embodies both the relative demand and relative supply dimension, which provide more accurate comparative advantage of a sector.

Consistency of RCA and RTA and also RXA and RTA for non-frozen product is relatively high than other shrimp product. This is due to the non-frozen shrimp product has remarkable high RXA-RMA ratio, particularly for non-frozen shrimp of India and the Philippines, as shown in Table 3. High RXA-RMA ratio is due to extraordinarily low RMA index values for the observed period, and it is mainly caused by low numerator of the numerator (import value for non-frozen shrimp of those particular nations). It implies that RTA index can be substituted by both the RCA and RXA indices if the import of a particularly product is not significant.

The results are somewhat in accord with the findings of Ballance *et al.* (1987) and Ferto and Hubbard (2003). It is, thus, important to highlight suggestion of Ballance *et al.* (1987), where empirical work incorporating measures of comparative

Table 3. RXA-RMA ratio by product by country

Country	Frozen [a]	Non-frozen [a]	Prepared [a]
China	0.31	0.86	3.06
India	24.59	173.12	1.47
Indonesia	16.11	2.79	0.17
Malaysia	0.22	0.21	0.03
Thailand	0.49	4.61	1.98
The Philippines	2.19	162.74	0.03

Note: [a] Frozen: shrimps and prawns, frozen, in shell or not, including boiled in shell. Non-frozen: shrimps and prawns, not frozen, in shell or not, including boiled in shell. Prepared: shrimps and prawns, prepared or preserved.

advantage should rigorously base the specification of such measures on theoretical constructs rather than adopting heuristic measures that have appeared in the previous works. Although the indices are not identical, particularly RTA index with RCA and RXA indices, these indices are useful in identifying some extent of comparative advantage of a nation's particular product group.

Conclusions

This paper offers empirical consistency among three indices of revealed comparative advantages, and also analysis of the comparative advantages of Malaysian shrimp products in relation to that of the major shrimp exporting countries, accessed for the period 1999 to 2009. The analysis shows that Malaysia was generally not competitive in shrimp trade; somehow Malaysia had export competitiveness in non-frozen shrimp. Thailand had remarkable trade competitiveness in shrimp products, particularly in non-frozen and prepared and preserved shrimp products. However, Thailand is losing the competitiveness for the prepared and preserved shrimp product in the recent year.

Balassa index are found highly consistent with the RXA index implies that double-counting problem in the Balassa index is not significant in measuring export competitiveness of the Malaysian shrimp sector. On the other hand, both of the Balassa index and RXA index were weakly consistent with the RTA index. The result suggests that import specialization index (RMA) is an important variable in measuring trade competitiveness of a shrimp sector. Moreover, the Balassa index and RXA index of non-frozen shrimp product were highly consistent with the RTA index. This is mainly due to the extremely low import value for Indian and Filipino non-frozen shrimp product. Thus, the mixed empirical results suggest that measurement of comparative advantage should rigorously base on theoretical constructs (Ballance *et al.*, 1987) as well as trade behaviour of an industry.

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