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*Full Length Research Paper*

# Establishment of indicators for early warning system on tilapia trade

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**With the development of fisheries and aquaculture, tilapia has become one of the closest species of aquatic products in contact with the international market. There are many factors which affect tilapia international trade. These factors are ultimately reflected in the volume and price of tilapia trade. In order to ensure the sustainable development of tilapia international trade, early warning system will play an integral role in forecasting the trade trends. Besides，the indicators system is the foundation to establishing early warning system. This paper summarizes different system indicators for early warning on tilapia import and export. As our case study, we selected 2 indicators, total export value and policy factor as warning situation's indicator. The total export value depends on export volume and price growth rate as warning promise index. The safety warning coefficient R, alarm limits, and the scope of the R reflect the different level of tilapia culture, analysis and prediction of changes in tilapia trading system. The indicators established in this study will give an insight to farmers, importers, and exporters as well as would be investors on the trend and dynamics involved in tilapia production and trading system.**

**Key words:** Tilapia trade, early warning system, indicators.

## INTRODUCTION

Tilapia (*Oreochromis niloticus, Oreochromis mossambica*) is native to Africa, but has been introduced in many countries around the world in recent years. According to Gupta and Acosta (2004), approximately 85 countries farm tilapia and about 98% of all farmed product is grown outside its native habitat. Tilapia is disease-resistant, reproduces easily, feeds on a wide variety of food and tolerates poor water quality with low dissolved oxygen levels. Most will grow in brackish water and some will adapt to full strength seawater. These characteristics make tilapia suitable for culture in most developing countries (ATA, 1998). Owing to these environmental friendly qualities of this species, many farmers are culturing it, and in recent years, have gained a wider consumer's acceptance. Maribel (2002)'s paper reports that, comercial production has become popular in many countries around the world and traditional markets in Asia and Africa have expanded to many countries within America and Europe. Once considered a lowly, muddy-tasting fish grown in third world countries, tilapia is now farmed in dozens of countries (in ponds, tanks and cages) and subjected to rigid quality-control standards.

According to the United Nations Food and Agriculture Organization (FAO) fishery statistics data (2010), today the most important producing country for tilapia is China, and the most important market for tilapia is the United States. Currently, China is supplying more tilapia to the US market than any other country (Carel et al., 2007; FAO 2012). According to China Customs' data (2012), in 2011, China exported some 330,300 tonnes of round (whole) fresh and frozen tilapia to the US, which was 32% more than that exported in 2008 (224,400 tonnes). China has quickly become a major supplier to the international market. This could increase the trade in tilapia, but it may also pose a threat to other producers because China can maintain low production costs and may be expected to undercut the price of other

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producers; in which case may cause other countries to resist the China's tilapia products (Tetreault, 2006). Due to this dispute and some other factors including the lack of constructive communication about sensitive issues, there was a considerable mistrust between the parties involved. Therefore, we need to identify changes in the market information timely (Paquotte and Lem, 2006; Jan et al., 2006). The purpose of this paper is to build a workable model useful in tilapia trading system.

## Function of indicators system establishment

There were a lot of influencing factors which obviously could have affected the tilapia import and export trade. Owing to these factors, there was a need to have an unbiased and as far as possible, objective information about the actual conditions and development. But the question is: What would be the significance of such factors to the tilapia culture industry?

Well this would lead to the elimination or reduction of industrial risks as well as aid in investment decision and prudent allocation of limited resources.

1. Early signals of recession or of recovery are of great interest to business minded people, the policy makers, research scientists and investors. Because such decision makers consider turning points in the aggregate level of economic activity to be of special importance, considerable effort has been spent to forecast on the occurrence of these turns (Jeong, 2003). A reasonable way to forecast these turning points is to search for sectors of the economy that tend to lead the overall economy, and then observe the different risk indicators of the import and export trade; which would suggest that, the overall economy will soon turn (Figure 1).
2. If the business-people, policy makers and investors catch the market changing information timely, they would be able to devise a comprehensive strategy that takes into account the needs and limitations of each sector or change the investment strategy according to their needs (Francisco et al., 2010; Christiaan et al., 2011).
3. In addition to the above purpose of establishing the indicators of early warning system is to improve the international competitiveness of China's tilapia trade which in turn will improve the efficiency of their culture industry, increase capital utilization rate and ensure the national interests, which will ultimately, promote the sustainable development of China's tilapia industry.

## Selection criteria for indicators

Regarding the selection criterion for indicators, the Minister of Agriculture, Fisheries and Food (MAFF 2000) of England/Britain requires that it should have policy relevance, analytical soundness, measurability, appropriate aggregation level, and is representative of social desirability of the fisheries. Besides the above, these must be simple, easily achieved, not redundant, should have variation and historical data (Bellows, 1994; Qiu et al., 2007). Indicators can be considered to be variable, permanent, signal, statistic, measurement, medium, or experiential model that is concise and potent for complicated systems with a variety of functions such as reflection, estimation, premonition and instruction (Rigby et al., 2001).

The different indicators systems based on this concept can be used to inspect and evaluate the suitability of the early warning system that can improve the sustainable development of the industry. Bellows (1994) suggested that setting up the indicators system must include the entire process from motive, designing, to final application and related feedback. The contents of the different indicator systems differ from each other, as in different countries, regions, and developmental stages, which inform their great subjectivity.

## Establishment of indicators

The clear strategy of profit maximization is considered as an assessment of the trade enterprise's financial results, adjustment of the internal business-processes, effective system of personnel motivation and developed informational base which are the main factors that help the enterprise to keep its leading positions at the market and have a positive price in the future (Barantseva et al., 2010). The risk of future major accidents cannot be measured directly. It is possible to evaluate past accidents and get a picture of the historical level. Nevertheless, within a limited sector, such as export to USA and Mexico, limited types of products, such as frozen fillets, are far too small to be able to draw useful conclusions from when it comes to loss of profit due to major risk in the tilapia international trade (Peter et al., 2002). Therefore, we need to establish improved and credible indicator systems for early determination of cause-effect relation between indicators for logical system of warning.

Attaining a relatively high level of control requires frequent registrations. Such frequent registrations will affect the amount of data possibly gained by a given risk indicator, which has to be sufficiently large to avoid problems with statistical significance. The risk indicators or databases might not place extra registration burden on the operating company. But this has to be balanced against the selection of risk indicators that show a strong relationship and must meet the scientific criteria of validity and reliability.

## Indicators system

Sometimes, the misconception is adopted that there is a fully objective way to express the risk levels through a set of indicators (David and Nicole, 2000). This implies that,

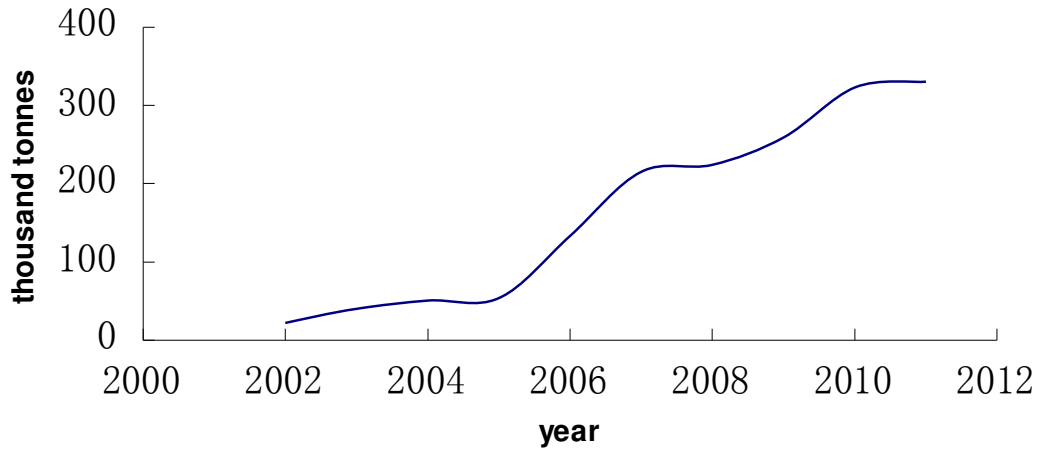


**Figure 1.** Tilapia trading volume (thousand tonnes) of China.

expressing the 'true' risk level is just a matter of finding the right indicators. However, this is a misconception. There are no single indicators that may express all the relevant aspects of price, production and safety (Robert and Qiang, 2003). There will always be a need for parallel illustrations to incorporate several approaches. However, this paper focuses on statistical indicators, and to some extent our basic principles as stated above may be misinterpreted. Yet, we would like to stress that, triangulation; a broader concept, is our fundamental approach in the project. The different types of indicators that we designed are given in Figure 2.

The major indicator that may influence the world tilapia trade is total export value, which also depends on export volume and price. Export volume is affected by the export taxes, processing factories' capacity, tilapia farms' inputs, Gross Domestic Product (GDP) of the importing countries, Foreign Direct Investment (FDI), Tilapia Retail Price index (RPI), Revealed Comparative Advantage index (RCA), inflation rate, saving amount of urban and rural residents, and government inputs. Price growth rate is affected by exchange rate, product quality, trading volume and natural factors.

The export taxes and government's inputs are subjected to policy implications; when government inputs are high and export taxes are low, it will be beneficial to export. Manufacturers' capacity and tilapia farms' inputs will reflect the input of the tilapia culture industry; and directly affect the export volume of the tilapia trade. Inflation rate, GDP of the importing countries, tilapia RPI and saving amount of urban and rural residents can reflect the relationship between marketing supply and demand of tilapia global trade.

In general, with more demand in the international tilapia market, the greater the export supply. In addition, the tilapia trade is a business. It must be related to finance, and foreign direct investment and inflation rate; when these are combined, they will reflect the financial factors that affect its export volume. Foreign inflation may cause the tilapia international price to rise; thereby affecting exports. The revealed comparative advantage is an index used in international economics for calculating the relative advantage or disadvantage of a certain country in a certain class of goods or services as evidenced by trade flows. This revealed comparative advantage index mainly reflects the tilapia trade in the area of China's competitiveness in global tilapia market.

We have also designed another warning promise index--price growth rate, which is explained by exchange rate, tariff, product quality, trading volume and natural factors. Tariff and trading volume would directly affect the trading price; if the supply cannot meet the demand of international tilapia market or high tariff, the trading price would be higher. In addition, exchange rate, product quality and natural factors can also affect the price indirectly. For instance, high exchange rate may lead to relatively high domestic production costs; thereby increasing the price in relation to other competing countries. Natural factors may impact the price perpetually; cold weather in the first half of the year and disease in the second half of the year are lead cause of the low production in recent years and have concomitant timely change in price.

Furthermore, we chose policy factor as a warning situation indicator; this factor played a key role in China's tilapia import and export. Subsides, import and export quotas, as policy factor, directly affected the trading volume and price. Security or economic policy-decision-making and institutional security situation, as a policy factor reflect the situation in China and inform the pace of tilapia industrial development and industrial policy coordination.

## Formulation of composite indices

Depending on a single indicator for identification and prediction of turning points is often not prudent (Burns,

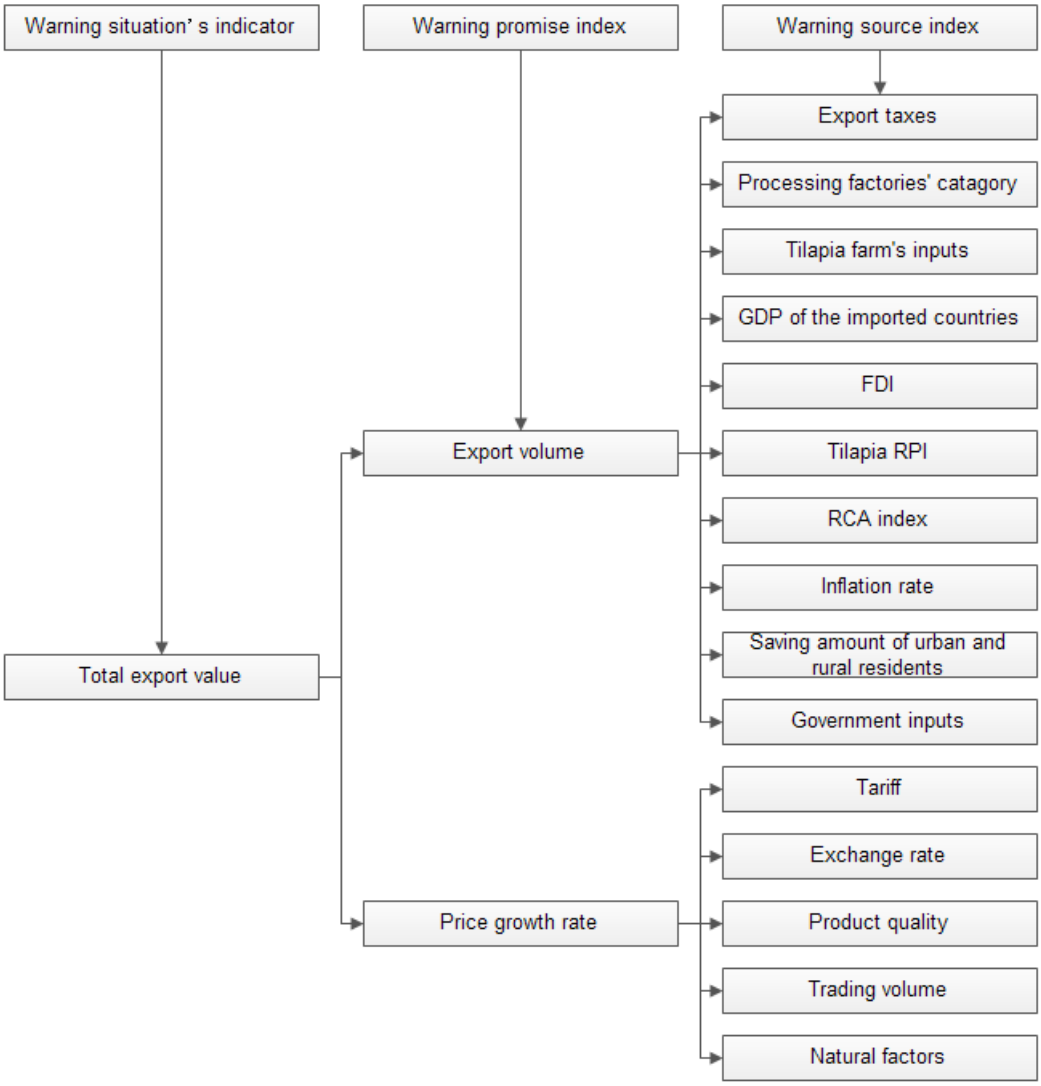


**Figure 2.** System indicators for early warning of tilapia trade.

1961); since no single leading indicator is perfect. The compilation of groups of indicators into composite indices is necessary and imperative in that respect. The composite approach has being proven to be more stable in determining turning point dates on an ongoing basis (Niemira and Klein, 1994).

A typical picture one can envisage from a single indicator is unpredictable, as some will show an increase; some may show a decreasing trend while others will usually fall within the prediction interval (middle part in the diagrams); and as such no significant trend can be concluded. It is therefore an advantage to have an overall indicator that can balance the effects of the individual indicators in order to identify the overall development. One might think that the overall indicator always would fall within the predicted interval, but this is not the case. This is due to the large differences in weighted values applied to the different categories, which implies that, some categories will dominate over others.

Warning situation's indicator selected for export value (Y) and the warning promise index (X) used to build the structural equation for the model are given below:

$$Y = X_1 \cdot [P \cdot (X_2 + 1)]$$

Where the following notations are used: Y; total export value, $X_1$; export volume, $X_2$; price growth rate and P the average price in the previous year.

To establish the warning promise indices of the VAR model, the first step is to determine the model's endogenous and exogenous variables. Export volume and price growth rate estimating equations are done using the

econometrics software –EVIEWS, as follows:

$$X_1 = c + b_1N_1 + \cdots + b_9N_9 + e_t$$

Where,
$N_1$=Export drawback.
$N_2$ =Processing factories' fixed asset income
$N_3$ =Gross tilapia farms' fixed asset
$N_4$ =GDP of the importing countries
$N_5$ =FDI
$N_6$ =Tilapia retail price index
$N_7$ =Inflation rate
$N_8$= saving amount of urban and rural residents
$N_9$ =Aquatic fiscal expenditure
$b_1$, $b_2$, $b_3$, $b_4$, $b_5$, $b_6$, $b_7$, $b_8$, $b_9$ respectively are the right weight for each indicator.

Regression equation for the above mode is:

$T=Y_0+k_0f+k_1Q_1+k_2Q_2+\ldots\ldots+k_mQ_m$

Where f is the product price index, $Q_i$ (i = 0,1, ..., m) representative for exchange rate, tariff, product quality, trading volume and natural factors. Regression coefficients $k_i$ (i = 0,1, ..., m) for each variable. Security early warning coefficient is given as:

$$SC = \frac{T_i - T_j}{\Delta XN} - 1 .$$

Where,
SC is the safety warning coefficient; $T_i$ and $T_j$, respectively are representative of the warning year and profit growth rate in the base year we have designed; ΔX compared with the base year, the number of products export increase (ΔX> 0); N is the whole tilapia production in the base year.

Alert level was set according to the size of the interval of R. when R ≥ 0, the alert level is set as a non-alert; when -1 ≤ R <0, the alert level holds; when R <-1, the alert level is set to be given a higher priority.

$$GDP = C + I + G + (X - M)$$

Where,
C= Private consumption
I = Gross investment
G= Government spending
X= Exports
M= Imports

The revealed comparative advantage was first proposed by Balassa in 1965. It reflects a country's exports of goods from certain types of providers of proportion size of export product relative to the proportion of such goods in world trade (Hua and Zheng, 2011; Wu, 2012).

RCA index, $$RCA = \frac{X_{ij}/X_i}{W_j/W}$$

Where i stand for the particular country, j: is the product's category.
$X_{ij}$: is the export value of the country's product k (for example, frozen tilapia, fresh tilapia or frozen tilapia filets)
$X_i$: is the total tilapia export value of the country in question.
$W_j$: is the total tilapia export value of product k in the whole world
W: is the total tilapia export value of the whole world

Inflation rate $$IR = \frac{P_1 - P_0}{P_0} \times 100\%$$

Where IR= inflation rate
$P_1$= current average price level
$P_0$= the price level a year ago

**Designing risk early warning system**

The process of designing risk early warning systems needs to focus on a variety of sources of change. International competitiveness and price growth rate showed a significant upward trend, but also directly reflected the changes in product supply-demand relations.

Therefore, the economic risks warning will select the price change rate as the warning promise indicators to be observed, and to reflect the trend curve. Choose the time coordinates as abscissa, let Σt = 0 and the trend model $\Delta x = a + bt + ct^2$, standard error is calculated by the following equation:

$$S=\sqrt{\frac{\sum_{t=1}^{n}(x_t-\Delta x_t)^2}{n-3}}=\sqrt{\frac{\sum_{t=1}^{n}x^2{}_t-a\sum_{t=1}^{n}x_t-b\sum_{t=1}^{n}tx_t-c\sum_{t=1}^{n}t^2x_t}{n-3}}$$

Where Δx stands for the change in forecast prices over time.

Analyzing the effects of capital operation and natural factors to the industry's profitability in short-term provides a theoretical basis for predicting the near future, long-term competitiveness and profit trends.

Policy factors involve the use of the Delphi Method that can make you to arrive at an average score which shows the average level of policy implication.

**Conclusion**

This study has developed the indicators of the early warning system for forecasting tilapia import and export

trade in China. Because there is no individual perfect measure for warning nowadays, we have attempted to discuss the construction of indicators which hinges on what aspect of competition it sought to study. Thus, various measures of import, and export or overall competitiveness have been identified, together with their respective fields of application. Furthermore, for one and the same definition, a number of different measures of competitiveness may be advanced. Their quality depends on the components used for their construction; the geographical coverage and the level of aggregation of markets and competitors.

Despite the serious problems posed by construction and aggregation, indicators of competitiveness can be a useful analytical tool in breaking down and analyzing changes in the major countries' exposure to competition. This has helped to analyze the risk brought to China by the newly-industrializing countries of South-east Asia as competitors on the world market. Moreover, for a number of countries, long-term movements in these indicators of competitiveness shed light on trends in trade volumes, both directly by pinpointing causes for demand shifts, and indirectly by indicating changing patterns of profitability in the tradable goods sectors.

We have presented a new indicators system which offers a convenient method to analyze the risk of the tilapia international trading system. Also, amalgamating the whole system would allow the government manager to identify those sustainability factors with greater strengths in domestic country. These aspects made it possible to establish the policies needed to preserve and encourage the international investors and culture farmers.

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