Assessing the Comparative Advantages of Agricultural Export Commodities in Vietnam

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Abstract

Measuring agricultural comparative advantage is an important economic issue in both theoretical and empirical studies because it allows for tracking effectiveness and leads to more informed decision making to design agricultural value chain, development policy, and agribusiness strategy. This paper aims to (i) assess the comparative advantage of agricultural commodities in Vietnam, (ii) analyse the dynamics of the indicators over the period 1997-2014, (iii) and finally test the consistencies between the used indices. This study employs (i) trade performance frameworks such as NEI, RCA, RTA, LFI, and NRCA to measure the comparative advantage, (ii) OLS regression and transition matrices to analyse the dynamics of the indicators, (iii) statistic tools based on cardinal, ordinal and dichotomous measures to test the consistencies. The results show that: Vietnam is strongly competitive in *crop sectors* and *fishery sectors* whilst it is not competitive in *livestock sectors* and *processed food sectors*. The high probabilities of comparative advantage indicators remain in their initial classes, in which disadvantageous and strongly advantageous classes are most stable. The finding confirms that the indices are strongly consistent and useful to assess whether a country is competitive in a commodity whilst they are weakly consistent to evaluate the degree of competitiveness.

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Keywords*:* Vietnam, agriculture, competitiveness, comparative advantage, dynamics, consistency

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1. Introduction

Vietnam has favourable natural conditions to produce plentiful kinds of agricultural commodities and the industry plays an important role in Vietnam's economy and society as a whole. Agriculture contributes to 20 per cent of GDP; accounts for about 48 per cent of total employment in 2013 as the third most dependent country on agricultural employment in the world after Bhutan and Cambodia (World Bank, 2016); makes up 21 percent of total export value in the years 2007-2013 (GSO, 2016). The top agricultural export commodities of Vietnam are coffee, rice, rubber, cashew nut, pepper and fresh fruit with high market shares in the global market. After the economic reform from 1986 to 2013, the agricultural export grows 18 percent yearly and accounts for 21 percent of total export (FAO, 2016). In the last twenty years, some significant international relationship events have affected Vietnam's trade performance of agricultural sectors such as the United States and Vietnam bilateral trade agreement in 2001, Vietnam's WTO accession in 2007, and another 12 international bilateral free trade agreements.

The fundamental economic problem is how to allocate limited resources in order to ensure social welfare, including full employment and high living standards for all today and in the future. However, the scarcity of resources forces us to make choices by answering three basic economic questions: what goods to produce, how to produce the products, and for whom to produce (Begg et al, 2005). The matter is how to respond to the questions or what economic indicators help us to

make choices. There is much agreement on the economic and social importance of competitiveness indices to make the choice decision, it is less clear what exactly competitiveness is and what its most important determinants are (Fischer & Schornberg, 2007). Researchers are interested in which sectors can contribute the most to nation's economic growth and they often turn to the concept of competitiveness as a basis for analysis. Enterprises and farmers are interested in which businesses make the most profit for them and they also refer to competitiveness as a key indicator (Latruffe, 2010). Competitiveness is a central concept in stimulating policy discussions by policy makers, politicians, researchers and it is widely employed in economic research from different points of view but there is little agreement on its definition (Sarker & Ratnasena, 2014; Bojnec & Ferto, 2009). The different research objectives and different definitions of competitiveness require different frameworks for agricultural competitiveness assessment. After (1) this introduction, (2) there is a critical literature review (3) with a specific explanation of methodology before (4) presenting the empirical results (5) to make conclusion and suggestions at the end of the paper.

2. Literature review

In the economics literature, there are various definitions of competitiveness, which are modified to be appropriately employed for the objectives of the studies. Classical and neo-classical scholars generally define the competitiveness of nation as lower production cost and higher productivity. The concept of competitiveness is explained and defined variously in modern economics. Freebairn (1987) defines competitiveness as the ability to supply goods and services at the time, place and form sought by overseas buyers at prices as good as or better than those of other suppliers while earning at least the opportunity cost of returns on resources used. In the long term, competitiveness is a country's capacity to sustain and expand its share of international markets and at the same time to improve its people's standard of living. Buckley et al. (1988) and Balassa (1965) define a country-sector comparative advantage performance by the relative export market share, export growth, and profitability. Such measures, however, fail to give insights into countries balance of trade and economic strength through its failure to consider imports. Porter (1990) explains that the only meaningful concept of competitiveness at the national level is productivity. The principal goal of a nation is to produce a high and rising standard of living for its citizens. The ability to do so depends on the productivity with which a nation's labor and capital are employed. The OECD defines competitiveness as "the ability of the companies, industries, regions, nations, and supranational regions to generate while being and remaining exposed to international competition, relatively high and rising income and factor employment levels on a sustainable basis (Hatzichronologou, 1996). The EU (2003) proposes the definition of competitiveness as "the ability of an economy to provide its population with high rising standards of living and high level of employment for all those willing to work, on a sustainable basis". For a more specific definition in international trade, the UNCTAD (2002) interprets the international competitiveness is "from meaning simply higher exports to diversifying the export basket, sustaining higher rates of export growth over time, upgrading the technological and skill content of export activity, to expanding the base of domestic companies able to compete globally". Ozcelik follows the ITC to expound competitiveness as "the advantage a country has in exporting a certain product over other countries" (Ozcelik, 2012; ITC, 2007). Some scholars distinguish between comparative advantage and competitiveness because: (i) competitiveness is usually related to a cross-country comparison for a particular commodity, while comparative advantage is for accessing commodities within a

country, (ii) and competitiveness is depending on changes in macroeconomic indicators, whereas comparative advantage is structural in nature (Lafay, 1992). In this paper, the authors follow the trade performance-based to define the competitiveness of agricultural commodities as the ability of a country to export a product to global market at a high growth rate and maintain a high relative market share in comparison with other products and countries while less import the similar commodities. The paper would not differentiate the concept of competitiveness from competitive advantage, comparative advantage, and international trade specialization.

Different definitions of competitiveness and research objectives require different frameworks to capture all the elements of the concepts. Useful measures have to specify the unit of analysis and compass the competitive performance and sustainability through the creation of competitive potential and the management of competitive process. Researchers employ mainly two scientific approaches to measure and analyse competitiveness, namely models and indicators. The economic models capture the interaction of national resources, production technology, product demand, and government interventions (Master, 1995). However, models are usually custom-built to answer specific questions and require a large investment in data collection and analysis (Esterhuizen, 2006) and the popular alternatives to models are index-number indicators and frameworks generated to measure comparison across entities, change over time, and serve as thermometers (Masters, 1995). An important aspect of competitive advantage is that it is a relative measure. There is always a comparison with a base value. If market share is being analysed, it must concern market size. If competitiveness in factor markets is being assessed, the relation is to the value a factor would have in another production process (Frohberg & Hartman, 1997). Buckley et al. (1988) categorise the indices of competitiveness into three groups: competitive performance; competitive potential; and management process. Esterhuizen (2006) reviews and systematises twelve methods to measure competitiveness based on the category of Buckley. He, however, aggregates potential and process of competitiveness together and he specially discusses Porter's diamond (1990) and business confidence index which are appropriate for the South Africa social and economic conditions. Fischer & Schornberg (2007) synthesise previous approaches and evaluate the competitiveness as a function of profitability, efficiency, and growth. For measuring the comparative advantage of agriculture, Bojnec (2003) overviews the three concepts for the livestock production in Europe that are based on (i) Porter's diamond, (ii) accountancy data and Policy Analysis Matrix approach, (iii) and international trade data. According to Cai & Leung (2009), there are two complementary approaches for comparative advantage assessment in the literature: (i) the first is the domestic resource cost, (ii) and the other is the revealed comparative advantage. There is a general consensus that measuring competitiveness can be made according to three disciplines: (1) trade performance indices such as the revealed comparative advantage and its related indicators, real exchange rate, market share, export and import indicators; (2) quantitative measurements such as domestic resource cost, price, profitability, productivity, income and efficiency; (3) and non-price or qualitative approaches (Hoang, 2015, Bojnec & Imre Ferto, 2015; Gorton et al., 2001).

The revealed comparative advantage (RCA) index of Balassa (1965) has been employed popularly in the empirical studies despite many critical comments. The main criticisms of the RCA are: (i) it serves as export specialization index; (ii) it is static and does not present the dynamics of comparative advantage over time; (iii) it does not include import side; (iv) the distribution of the

index is the asymmetric and non-normal value; (v) and the range from 0 to ∞ has problematic matters to interpret and compare; (vi) it double counts the data of a country and commodity; (vii) the index indicates the success in exporting in the world market that, however, can come from incentives and can explain competitiveness but not comparative advantage (Vollrath, 1991; Kreinin & Plummer, 1994; Dalum et al., 1998; Proudman & Redding, 2000; Benedictis & Tamberi, 2004; Hoen & Oosterhaven, 2006; Siggel, 2006; Bojnec & Ferto, 2014). In order to deal with the limitations of Balassa's index, it has been modified by scholars. Vollrath (1991) provides three alternative indices of international trade competitiveness. The first measure is the relative comparative advantage accounting for both export and import, the second one is the logarithm of the export comparative advantage, and the third is revealed competitiveness that is the difference between the logarithm of the export comparative advantage and the logarithm of import comparative advantage. Gorton et al. (2000) adapt the RCA to develop a commodity weighting index and an EU share of exports index for the cases of Bulgaria, Czech, and EU. Laursen (1998, 2015) and Dalum et al. (1998) stress that the index is asymmetrical and non-normal, and it should be made for econometric analysis. Thus, the authors transform the RCA into the revealed symmetric comparative advantage (RSCA) that is defined as *(RCA - 1)/(RCA + 1)*. The authors then use regression analysis to test the dynamics of the index values for particular commodity groups from one period to the next. Proudman & Redding (2000) introduce an empirical framework for analyzing the dynamics of international trade trends. Following the authors, an economy's RCA in a sector is given by the ratio of its share of exports in the sector to its average export share in all sectors; and the RCA may be evaluated by analyzing the external shape of the RCA distribution over time. Kreinin & Plummer (1994) suggest a dynamic RCA framework that is given as the change in a commodity in a country's exports relative to the change in the country's share in total world exports. The country is said to obtain a comparative advantage in a commodity if its share in the country's total exports increased faster than the growth in the share of the commodity in total world trade over the same period. Hoekman & Djankov (1997) and Valentine & Krasnik (2000) adapt the form of RCAs to calculate the RCA ratios for a period and its average annual growth rates. The approach has limitation for its contrast with the static RCA results and specialization in a declining industry (Edwards & Schoer, 2002). To deal with the matter, Edwards & Schoer construct the dynamic indicator of RCA by taking the logs of the equation and then differentiating totally. The indicator compares the growth in the share of a commodity in total trade of a country with the growth in the share of the commodity in total trade of the world. Hoen & Oosterhaven (2006) affirm that the RCA index ranges from 0 to ∞ and it has problematic matters. The indicator may have a moving mean larger than its expected value of 1 because of its multiplicative specification and the distribution is dependent on the number of countries and sectors. The authors suggest the additive RCA index ranging from - 1 to + 1 with a symmetric distribution that centers on a stable mean of zero. Yu et al (2009a) suggest the normalised revealed comparative advantage as an alternative measure of the RCA. The index demonstrates on the capable of revealing the extent of comparative advantage that a country has in a commodity more precisely and consistently than other alternative RCA indices in the literature. Widodo (2009) embodies two indices of RSCA and Trade Balance Index to propose an analytical tool of products mapping and use the tool to analyse export commodities of the ASEAN countries and affirm that in the cases of the countries, the higher the comparative advantage for a specific product, the higher the possibility of the country as a net-

exporter becomes, and the finding well supports the theory of comparative advantage. The RCA index is also useful to measure if countries are substitutable or complementary in exporting (Jayawickrama & Thangavelu, 2010). Brakman et al. (2011) measure the structural change in the trade comparative advantages of OECD countries by the tools of the HM index and the RCA. The authors conclude that RCA indicators are not easy to be compared between countries and the HM index may uncover the trade structure change that the change in this period has the most influential impact on trade patterns. Ceglowski (2015) measures the export competitiveness through RCA, NRCA and the lens of value added and finds that a value-added perspective reduces the degree of RCA for many competitive countries in the three global value chain manufacturing industries. There are also many other frameworks measuring the international trade performances as the export market share (EMS), the Net Export Index (NEI), the Lafay Index (LFI), the Grubel–Lloyd Index (GLI) in the empirical studies. In Vietnam, some authors employ the RCA to measure comparative advantage such as Nguyen (2013), Le (2010), and Nguyen & Sumalde (2006) but no studies are for agricultural sectors with the various CAs indices.

3. Methodology and data

Analysis frameworks

Basic trade performance indices:

Firstly, the paper analyses the basic trade performance indices such as trade balance, national export rate and world market share to analyse the trade performance of Vietnam agricultural commodity exports: (i) Trade balance: ($TB_{vs}^{t} = E_{vj}^{t} - M_{vj}^{t}$), where *t* is the considered years, *v* is the country of Vietnam, *j* is the commodity, *E* is the export, *M* is the import. (ii) National export rate: ($NER_{vj}^{t} = X_{vj}^{t}/X_{v}^{t}$); (iii) World market share ($WMS_{vj}^{t} = X_{vj}^{t}/X_{wj}^{t}$), where *w* is the world.

The Net export index (NEI):

Net export index (NEI) is a popular formula being calculated by the country's or sector's exports less its imports divided by the total value of a trade. The index considers the role of exports and imports in trade balance and the assessment of the comparative advantage in a commodity (Banterle & Carraresi, 2007). This index is also known as Trade competitiveness (TC) by Greenaway & Milner (1993), Trade balance index (TBI) by Lafay (1992):

$$NEI_{vj} = TC_{vj} = TBI_{vj} = \frac{E_{vj}-M_{vj}}{E_{vj}+M_{vj}} \quad (1)$$

where *E* is export; *M* is import; *j* denotes a commodity; *v* denotes the investigated country of Vietnam. The value of NEI_{vj} is between -1 (when a country imports only) and 1 (when a country exports only), in the case of equality in imports and exports, the value is zero. If $NEI_{vj} > 0$, country *v's* productivity of commodity *j* is higher than the world average level and therefore has comparative advantage; on the other hand, if $NEI_{vj} < 0$, that the productivity of country *v* is lower than the world average level and shows a comparative disadvantage (Han et al., 2009).

The Revealed comparative advantage of Balassa (RCA):

Balassa (1965 and 1977) defines and formulated the framework of the revealed comparative advantage (RCA) based on the first analysis of comparative advantage of Liesner (1958). The idea of Balassa index is to compare the performance of a country in one commodity or sector to the

performance of a reference group of countries using export flows based on observed export patterns or the "revealed" data. Despite many critics of the Balassa's basic methodology, such as the asymmetric value problem, the problem with logarithmic transformation, and not accounting for import, the RCA index remains a popular framework in empirical trade analysis (Yeats, 1985; Vollrath, 1991; De Benedictis & Tamberi 2001; Bojnec & Ferto, 2008). The Balassa's Revealed Comparative Advantage index can be defined as follows:

$$RCA_{vj} = \left[\frac{X_{vj}}{X_v}\right] \div \left[\frac{X_{wj}}{X_w}\right] \quad (2)$$

Where X represents exports, v is the studied country of Vietnam, j is a commodity, w is the world. RCA_{vj} is the revealed comparative advantage of Vietnam in commodity j; X_{vj} is the export of country v in commodity j; X_v is the total export of country v; X_{wj} is the world export in commodity j; X_w is the total world export. It is noted that X_v may be the export of a group of commodities and w may also mean a group of countries being investigated. The value of RCA is between 0 and $+\infty$, and the comparative-advantage-neutral point is 1. An RCA index greater than 1 indicates that the country has a comparative advantage in the commodity under investigation since it has a strong export sector and a lower than 1 value indicates a comparative disadvantage. The index reveals a higher competitiveness, namely an index number of 1.1 will mean that the country's share in this commodity's exports is 10% higher than its share of the total exports (Balassa, 1965). Generally, the higher the value of this index above unity, the stronger is the country's specialization in the commodity. The RCA indicators can be interpreted in three ways: dichotomous, ordinal and cardinal (Ferto & Hubbard, 2003; Havrila & Gunawardana, 2003). In the first case, RCA is employed to assess the existence of comparative advantage in a commodity; the second way is useful for ranking countries (or sectors) based on RCA values; and the third interpretation is utilised to measure the dimension of RCA (Banterle & Carraresi, 2007). Hinloopen & Marrewijk (2001) classify the RCA index into four groups: (a) $0 < RCA \leq 1$ those are the countries without a comparative advantage; (b) $1 < RCA \leq 2$ the countries achieve a "weak" comparative advantages; (c) $2 < RCA \leq 4$ relates a "medium" comparative advantage; and (d) $4 < RCA$ indicates a "strong" comparative advantage to rank the revealed comparative advantages among countries.

The Relative Trade Advantage (RTA):

Vollrath (1991) suggests the relative trade advantage (RTA) basing the analyses upon a concept of the RCA. The RTA is calculated as the difference between the relative export advantage (RXA), which is similar to the Balassa RCA index, and the relative import advantage (RMA). The major difference between the Balassa RCA index and the Vollrath indices is that (i) the RXA eliminates country and product double counting; (ii) it considers all traded goods and all countries rather than subgroups and referring to global trade intensity; (iii) and the RTA embodies for both export and import (Havrila & Gunawardana, 2003). According to Mosoma (2004), this aspect of accounting for import is becoming increasingly important due to the strong increase in intra-industry trade. The Vollrath indices are formulated as following:

Relative export advantage (RXA):

$$RXA_{vj} = \left[\frac{X_{vj}}{X_v}\right] \div \left[\frac{X_j}{X_w}\right] \quad (3)$$

Relative import advantage (RMA):

$$RMA_{vj} = \left[\frac{M_{vj}}{M_v}\right] \div \left[\frac{M_j}{M_w}\right] \quad (4)$$

Relative trade advantage (RTA):

$$RTA_{vj} = RXA_{vj} - RMA_{vj} \quad (5)$$

where X is the export and M is the import, j and v refer to the commodity and the country (Vietnam), w is the world. X_{vj} and M_{vj} are the export and import of commodity j in Vietnam, X_v and M_v are the export and import of the rest of commodities in Vietnam; X_j and M_j are the export and import of the rest of countries of commodities j, X_w and M_w are the total export and import of the rest of countries in the world minus commodity j. The value of RTA is between -∞ and +∞ and the comparative-advantage-neutral point is zero. The RXA index indicates a comparative advantage when it is greater than 1 and a comparative disadvantage when the values are between 0 and 1. The RMA index may also be less, or greater, than 1 similar to the RXA. The values of RTA may be positive in the case of comparative advantage and negative in the opposite situation.

The Lafay Index (LFI)

Lafay (1992) proposes an empirical framework to measure the comparative advantage and specialization of a commodity and a sector in a country. The index measures the difference between each product's normalised trade balance and the total normalised trade balance. Then, the result is weighted by each commodity's share in overall trade. In this respect, the comparative advantage is defined as the positive difference between the actual trade deficit of one sector and the theoretical one, corresponding to its importance to trade (Ban, 2016). The Lafay index (LFI) has the advantage of eliminating the influence of cyclical factors, controlling intra-industry trade and re-export flows by taking into consideration the importance of import, allowing for a more precise analysis of the dynamic model descriptors of production specialization and taking into account any distortions induced by macroeconomic fluctuations (Zaghini, 2005; Alessandrini et al., 2007; Svatos et al., 2010; Platania et al., 2015). This index, however, excludes the world import and export data, therefore it is useful and suitable for cross-commodity analysis but not for country-cross comparison. For analysis the comparative advantage of a commodity j (sector) for the country of Vietnam, the LFI can be expressed as follows:

$$\mathrm{LFI_j} = 100 \times \left[\frac{\mathrm{X_j - M_j}}{\mathrm{X_j + M_j}} - \frac{\sum_{j=1}^{N}(\mathrm{X_j - M_j})}{\sum_{j=1}^{N}(\mathrm{X_j + M_j})}\right] \times \frac{\mathrm{X_j + M_j}}{\sum_{j=1}^{N}(\mathrm{X_j + M_j})} \quad (6)$$

where $\mathrm{X_j}$ and $\mathrm{M_j}$ represent export and import of the product j realised by the country of Vietnam from and to the rest of world market. N is the number of analysed items in this study. The value of LFI is between -∞ and +∞ and the comparative-advantage-neutral point is zero. The positive values of LFI imply comparative advantage and specialization, higher values of LFI confirm higher degrees of specialization and the sectors make bigger contributions to the trade balance. On the other hand, the negative values of LFI state the reliance on imports or an absence of specialization and comparative advantage. Because the index measures the contribution of each product to the total normalised trade balance, the sum: $\sum_{j=1}^{N} LFI_j$ theoretically equals to zero, and this means that the increase in comparative advantage of this sector causes the decrease of others.

The Normalised Revealed Comparative Advantage (NRCA):

Yu et al. (2009a) suggest the framework of the normalised revealed comparative advantage (NRCA) modified from RCA index of Balassa to measure the comparative advantage across space and time. The NRCA evaluates the level of deviation of a country's actual export from its comparative-advantage-neutral level in terms of its relative scale related to the world export market and thus offers a proper indicator of the comparative advantage. Thus, under the comparative-advantage-neutral condition of country i's export of commodity j is stated as:

$$\hat{E}_j^v = \frac{E^v E_J}{E} \quad (7)$$

But the country *v*'s actual export of commodity j in the real world, E_j^v, would normally differ from $\hat{E}_j^v$; and the difference can be calculated as:

$$\Delta E_j^v = E_j^v - \hat{E}_j^v \quad (8)$$

Normalizing ΔE_j^v by the world export market, the NRCA index is defined as (Yu et al., 2009a):

$$NRCA_j^v = \frac{\Delta E_j^v}{E} = \frac{E_j^v}{E} - \frac{E_j E^v}{E\,E} \quad (9)$$

Where *E* is export, *v* is the country of Vietnam, *j* is the commodity under consideration. E_j^v denotes country *v*'s export of commodity *j*; E_j means the export of commodity *j* by all countries, $E_j = \sum_v E_j^v$; E^v denotes country *v*'s export of all commodities under investigation, $E^v = \sum_j E_j^v$; and *E* denotes the export of all commodities under investigation by all countries, $E = \sum_v \sum_j E_j^v$. The value of NRCA is between -1/4 and +1/4, and the comparative-advantage-neutral point is zero. Following Yu et al. (2009b), to facilitate the presentation of the results, this study also rescales the $NRCA$ scores with a constant of 10,000 which would not affect the meaning of the results, thus the value of NRCA is between -2,500 and +2,500. The value of $NRCA_j^v > 0$ (or $NRCA_j^v < 0$) implies that that country *v*'s real export of commodity *j* (E_j^v) is higher (or lower) than its comparative-advantage-neutral level ($\hat{E}_j^v$), signifying that country *v* has a comparative advantage (or disadvantage) in commodity *j*. The greater (or the lower) the $NRCA_j^v$ value is, the stronger the comparative advantage (or disadvantage) would be. Because comparative advantage is a relative concept, the interpretation of the magnitude of $NRCA$ is more meaningful within a comparative context in terms of the relative level of comparative advantage. For instance, $NRCA_x^v$ = 0.03 and $NRCA_y^v$ = 0.09 means that the relative strength of country *v*'s comparative advantage in commodity *y* is three times of its comparative advantage in commodity *x*. This index measures the level of deviation of a country's real export from its comparative-advantage-neutral degree in terms of its relative scale with respect to the world export market and thus provides a right indication of the underlying comparative advantage. The $NRCA$ index is also a proper index to access the international comparative advantage and to compare different across sectors in a country and over a period (Sarker & Ratnasena, 2014). According to Yu et al. (2009a), the $NRCA$ index has the properties that: *First*, the sum (and the mean value) of a country or a commodity's $NRCA$ scores is constant and equals to zero theoretically, thus the sum of positive $NRCAs$ equals the sum of negative $NRCAs$ for each individual commodity or country. This means that if a country gains a comparative advantage in a sector, other countries will lose comparative advantage in that sector. In the same way, if a country

gains a comparative advantage in a product, it must lose comparative advantage in other products. This rightly reflects the concept of comparative advantage. *Second*, the $NRCA$ index is additive in terms of both countries and commodities. This implies that the measurement of comparative advantage under the $NRCA$ index is independent of the classification of the commodities and countries and the $NRCA$ index can be used to compare the levels of comparative advantage across countries and time (Seleka & Kebakile, 2016). *Third*, the possible distribution of $NRCA$ scores is symmetrical, ranging from − 0.25 to + 0.25 with 0 being the neutral point. *Fourth*, the NRCA index is useful for both cross-commodity and cross-country comparisons.

The dynamics of comparative advantages

The study analyses the dynamics of the comparative advantages of agricultural commodity groups at 3-digits level with 61 observations over period 1997–2014. According to Hinloopen & Marrewijk (2001) and Bojnec & Ferto (2008), there are at least two types of stability: (i) the stability of the distribution of the trade performance indices from one period to the next; (ii) and the stability of the value of the indices for particular commodity groups every years of the full period.

Following Dalum et al. (1998), Ferto (2008), Sharma & Dietrich (2007), and Ban (2016), the first type of stability of the indices is analysed by using ordinary least squares (OLS) based on Galtonian regression model presented by Hart & Prais (1956) and first utilised by Cantwell (1989) in the context of specialization. The regression model employed to estimate the stability of the trade comparative advantage indices in this paper can be defined as following:

$$CA_{vj}^{t2} = \alpha_v + \beta_v CA_{vj}^{t1} + \varepsilon_{vj} \quad (10)$$

where $t_1$and t_2 are the initial year and the next one, v and j are the country (Vietnam) and commodity group under study, α is a constant, β is a coefficient regression, and ε is a residual term. The CA is the comparative advantage index under investigation such as NEI, RCA, RTA, LFI and NRCA or/and its modified indices. The CA at time t_2 for commodity group j is the dependent variable and is tested against the independent variable of the CA at time t_1 for product group j. Dalum et al. (1998) affirm that the method is one of comparing two cross-sections or cross-countries at two points in time and there is no factor of time in the observations. In this study, it is assumed that regression is linear and that the residual ε_{vj} is stochastic (ε_{vj} ~ N(0, σ). The interpretation of the regression results is as following: If $\beta = 1$ corresponds to an unchanged pattern of the CAs from periods t_1 to t_2, and there is no change in the overall degree of comparative advantage. If $\beta > 1$ means that the country tends to achieve the increase in the CAs of competitive sectors, and to endure the loss in the CAs of disadvantageous product groups except for the case of RCA index where the CAs always grows because of the index' positive value; i.e. the existing pattern of comparative advantage is strengthened, such a movement of CA may be termed *β-specialization*. On the other hand, if $0 < \beta < 1$, the country obtains the increase of CAs in the commodity groups with disadvantageous CAs indices whilst the groups with advantageous CAs indices decrease over time, except for the case of RCA index where the CAs always decline because of the index' positive value; such a movement is called *β-de-specialization*. If $\beta = 0$, then there is no relation between the pattern of specialization in the two periods. The $\beta < 0$ indicates the comparative advantage rankings of the groups are reversed. The CAs initially below the country average value are above the average in the next year, and vice versa. There is a feature from the

regression analysis to test whether the degree of comparative advantage changes over time and that $\beta > 1$ is not a necessary condition for growth in the overall specialization pattern. The sufficient condition for specialization is as following (Hart, 1976; Cantwell, 1989; Dalum et al., 1998; Sharma & Dietrich, 2007). The variance of the CAs indices at year $t2$ of group j is denoted by $(\sigma_j^{t2})^2$ then:

$$(\sigma_j^{t2})^2 = \beta_j^2(\sigma_j^{t1})^2 + \sigma_\varepsilon^2 \tag{11}$$

where β_j^2 is the square of the regression coefficient, $(\sigma_j^{t1})^2$ is the variance of the CAs indices at year $t1$, and σ_ε^2 is the variance of the error term. The coefficient of determination R_j^2 is defined as:

$$R_j^2 = 1 - \frac{\sigma_\varepsilon^2}{(\sigma_j^{t2})^2} = ((\sigma_j^{t2})^2 - \sigma_\varepsilon^2)(\frac{1}{(\sigma_j^{t2})^2} \tag{12}$$

Combining equations (11) and (12) we have

$$(\sigma_j^{t2})^2 - \sigma_\varepsilon^2 = \beta_j^2(\sigma_j^{t1})^2 = R_j^2(\sigma_j^{t2})^2 \tag{13}$$

Rewriting equation (13) to present the relationship between the variance of the two distributions:

$$\frac{(\sigma_j^{t2})^2}{(\sigma_j^{t1})^2} = \frac{\beta_j^2}{R_j^2} \tag{14}$$

This equation can be simplified to:

$$\frac{\sigma_j^{t2}}{\sigma_j^{t1}} = \frac{|\beta_j|}{|R_j|} \tag{15}$$

In the formula, R is the correlation coefficient of the regression between initial year CAs and final year CAs, then the dispersion of a given distribution is unchanged when β = R. If β > R (equivalent to an increase in the dispersion), then the degree of comparative advantage rises (it might be termed as *σ - divergence*). If β < R (equivalent to a decrease in dispersion), then the degree of comparative advantage falls (it might be termed as *σ - convergence*). Taking into consideration both regression effect $(1 - \beta)$ and the mobility effect $(1 - R)$, this study draws a realistic conclusion regarding the increasing or the decreasing level of comparative advantage in the short term and the long term.

A skewed distribution, however, violates the assumption of normality of the error term in the regression analysis, which makes the t-statistics unreliable (Dalum et al., 1998). Additionally, using the RCA indicators in regression analysis gives much more weight to values above one, as compared to observations below one (asymmetric problem). To deal with the skewness and asymmetric problem Dalum et al. (1998) propose a revealed symmetric comparative advantage index (RSCA) as follows:

$$RSCA = \frac{(RCA-1)}{(RCA+1)} \tag{16}$$

The $RSCA$ value ranges from -1 to + 1. The *RSCA* index translate the values from the intervals of *RCA* index (0, 1]; [1, +∞) into (-1, 0]; [0, +1). The main advantage of this index is that it makes below unity the same weight as changes above unity. However, the disadvantage is that forced symmetry does not necessarily imply normality in the error terms and it may lose some of the *RCA* dynamics (Ferto & Hubbard, 2003).

Transformed values of CAs also use for other indices to reduce the impact of extreme value and avoid non-normal distribution. Following the method of Ban (2016), the paper transforms the original CAs values into T-CAs values as following:

$$T - CAs = \frac{CAs}{abs(CAs)+1} \quad (17)$$

where *T-CAs* is the transform values of the comparative advantage indices such as NEI, RTA, LFI, and NRCA; and abs(CAs) is the absolute value of these indicators. The T-CAs values of RTA, LFI and NRCA are in (-1, +1), the T-NEI value is in (-0.5, +0.5). Both CAs values and T-CAs values would be tested for normal distribution before analyzing the dynamics of the indices.

The second type of stability of the values of the comparative advantage indices for particular commodity groups is assessed in two ways. First, following the empirical method utilised first by Proudman & Redding (2000), and then employed by Brasili et al (2000), Zaghini (2005), Ferto (2007), Bojnec & Ferto (2008), this study employs Markov transition probability matrices to identify the persistence and mobility of the comparative advantage indices under investigation. There is no general guide in the literature for classifying the comparative advantage indices into categories and most studies group data into different percentiles such as quartiles or quintiles (Ferto, 2007). Hinloopen & Marrewijk (2001), however, show that the boundaries between groups are difficult to interpret and the difference from one country to another makes cross-country comparisons difficult. The authors, therefore, classify the values of RCA index into 4 groups with the boundaries of 0, 1, 2, and 4. Bojnec & Ferto (2008) classify commodities into two groups: commodities with revealed comparative disadvantage (B < 1) and commodities with revealed comparative advantage (B > 1) because 99 percent of the RCA index values in their study are below two. In this study, the boundaries of disadvantageous groups and advantageous groups are remained (the comparative-advantage neutral values of NEI, RTA, LFI and NRCA are 0 and RCA is 1). The preliminary statistics shows that the probabilities of advantageous groups are relatively high over the full period, namely 46 percent for NEI, 34 percent for RCA, 47 percent for RTA, 36 percent for LFI, and 21 percent for NRCA. The paper then employs the quartile method for the advantageous commodity groups and classifies the CA indicators' values into 4 categories as follows:

Table 1: The classes of CA values and the interpretations

Categories	**Interpretation**	**NEI**	**RCA**	**RTA**	**LFI**	**NRCA**	
Class 1	Disadvantage	≤ 0	≤ 1	≤ 0	≤ 0	≤ 0	
Class 2	Weak advantage	≤ 0.78	≤ 4.4	≤ 1.4	≤ 0.3	≤ 2.4	Quartile I & II
Class 3	Medium advantage	≤ 0.94	≤ 11.9	≤ 7.5	≤ 1.6	≤ 10.3	Quartile III
Class 4	Strong advantage	> 0.94	> 11.9	> 7.5	> 1.6	> 10.3	Quartile IV

The paper employs the one – step transition probability matrix (one – step Markov chains) to analyse and describe the probability of transition between four classes in term of its moving from an initial class to other classes, in one-step of moving (moving within two adjacent years). In this study, the values of different comparative advantage indices of 61 agricultural groups over the period 1997-2014 are divided into four categories (Table 1). Let p_{ij} (i,j = 1, 2, 3, 4) denotes a one-step transition probability, that is the transition probability for the product groups which are in class "i" of year "t" moving to class "j" of year "t+1". The study also analyses a long-run (LR)

probability of remaining in a specific status of Markov transition probability matrices assuming an infinite LR period (following Hinloopen & Marrewijk, 2001; Bojnec & Ferto, 2008).

Second, the paper utilises a mobility index to analyse the mobility degree of the CAs values of the comparative advantage indices. The index identifies the degree of mobility throughout the entire distribution of CAs indices and facilitates direct cross-sectors comparisons over the full period. The index M, following the conclusion of measuring the mobility of Shorrocks (1978), assesses the trace of the transition probability matrix. This M index, thus, directly captures the relative and medium magnitude of diagonal and off-diagonal terms, and the equation of the index can be shown as following (Hinloopen & Marrewijk, 2001; Bojnec & Ferto, 2008):

$$M = \frac{n - tr(P)}{n - 1}$$

Where, M is Shorrocks index; n is the number of Classes; P is the transition probability matrix; and $tr(P)$ is the trace of P. A higher value of M index states greater mobility (the upper limit is two in our case), with a value of zero indicating perfect immobility.

Consistency analysis

Although the economic literature interprets variously the CAs indices under this study and they are embodied in different ways based on import and export data, the significant values of the indices are to evaluate the international trade performance of a sector or a country. Ballance et al. (1987) stress two other interpretations, namely, that each index (a) supplies a commodity-specific ranking of countries by the magnitude of comparative advantage and (b) provides a demarcation between countries enjoying a comparative advantage in a particular commodity. These indices refer to as cardinal, ordinal and dichotomous measures, respectively. This paper, following Ballance et al. (1987), Ferto & Hubbard (2003), and Seyoum (2007), analyses the consistency of the CAs indices based on the Cardinal, Ordinal, and Dichotomous measures by using statistical tests:

(i) *Cardinal measures*: the measures of consistency are to compare correlation coefficients for alternative pairs of CAs indices over a period. Two perfectly consistent indices would produce a correlation coefficient of unity (positive unity for directly related and negative unity for inversely related indices). The greater than or equal 0.7 correlation coefficients indicate the strong consistency between the CAs indices (Statistical Rules of Thumb and empirical review); the correlation coefficients values ranged from 0 to 0.7 mean the weak consistency between the CAs indices whilst equal and lower than zero values affirm inconsistency.

(ii) *Ordinal measures*: the measures determine if pairs of CAs indices generate a consistent ranking of commodity groups by the degree of comparative advantages. Two perfectly consistent indices would produce a correlation coefficient of unity. The greater than or equal 0.7 correlation coefficients indicate the strong consistency between the CAs indices (Statistical Rules of Thumb and empirical review); the correlation coefficients values ranged from 0 to 0.7 mean the weak consistency between the CAs indices whilst equal and lower than zero values affirm inconsistency.

(iii) *Dichotomous measures*: these tests compare the CAs indices to establish the extent to which they are consistent in distinguishing between groups that enjoy comparative advantage and

groups that do not. Results show the share of cases in which paired indices consistently indicate that a group has a comparative advantage or disadvantage. Two perfectly consistent indices would produce the share of 100 percent. The shares of higher than or equal to 70 percent indicate the strong consistency between the CAs indices.

Scopes and data

There are different definitions and scopes of agricultural products. The EU explains agricultural products means the products of the soil, of stock farming and of fisheries and products of first-stage processing directly related to these products, and it defines the agricultural products in SITC as sections 0, 1, 21, 22, 231, 24, 261 to 265, 268, 29, and 4 (Kachel & Finkelshtain, 2010; EU, 2012). The USDA's definition of agricultural products, sometimes referred to as food and fiber products, covers a broad range of goods from unprocessed bulk commodities like soybeans, feed corn, wheat, rice, unprocessed tobacco, and raw cotton to highly-processed, high-value foods and beverages like sausages, bakery goods, ice cream, beer and wine. The WTO and the UNCTAD define in its Annex 1 agricultural products by reference to the harmonised system of product classification (HS) that the definition covers not only basic agricultural products such as wheat, milk and live animals, but the products derived from them such as bread, butter and meat, as well as all processed agricultural products such as chocolate, yoghurt and sausages. The scope also includes wines, spirits and tobacco products, fibres such as cotton, wool and silk, and raw animal skins destined for leather production. The WTO's definition is similar to the HS coverage of agriculture (HS01-24) but excluding fishing and forestry (Panagariya, 2005). The WTO and the UNCTAD modify the scope of agricultural products in SITC as sections 0, 1, 2 and 4 minus divisions 27 and 28. According to a relative definition in Vietnam, the agricultural sector includes crop, livestock, fishing and forestry (VCCI, 2009). This study follows the definition of the EU in the Revision 3 of the Standard International Trade Classification (SITC Rev. 3). *According to the EU's definition in SITC Rev. 3 agricultural products cover the codes of 0 + 1 + 21 + 22 + 231 + 24 + 261 to 265 + 268 + 29 + 4.*

The trade data for this study is mainly extracted from the United Nations Comtrade based on the SITC Rev. 3. The SITC Rev. 3 offers five levels of commodity aggregation, beginning from 1-digit sections down to 2-digit divisions, 3-digit groups, 4-digit subgroups and 5-digit items. The paper calculates the comparative advantage by the CAs indices at 2-digits with 21 agricultural commodity divisions and at 3-digits with 61 agricultural commodity groups over the period 1997 – 2014.

4. Empirical result and discussion

Measuring comparative advantages

Comparative advantage of agricultural commodities in 2014 for 2-digits divisions

The agricultural export and import performance analysis for 2-digits divisions of products shows that Vietnam in 2014 has surplus trade balances in nine agricultural commodity divisions including Fish, crustaceans, mollusc; Coffee, tea, cocoa, spices; Vegetables and fruit; Crude rubber; Cereals, cereal preprtns.; Sugar, sugr.preptns, honey; Beverages; Tobacco, tobacco manufact; Animal oils and fats. In the year, Vietnam has the most positive trade balances in Fish, crustaceans, mollusc with the value of nearly US$6.7 billion; Coffee, tea, cocoa, spices with the value of US$4.9 billion; and Vegetables and fruit with the value of US$2.5 billion. Cereals and cereal preparations division has high export value but also high import. Vietnam has the most negative balance in Animal feed

stuff; Textile fibres; and Oil seed, oleaginus fruit. Fish, crustaceans, mollusk and Coffee, tea, cocoa, spices are also the first and the second by NER and WMS whilst Vegetables and fruit is the third by NER; and Crude rubber is the third by WMS.

The assessment of comparative advantage for 2-digits data divisions of agricultural commodities by NEI, RCA, RTA, LFI, and NRCA produces relatively similar and convergent results of the strongest comparative advantage sectors. The three most powerful revealed comparative advantage divisions are Crude rubber; Fish, crustaceans, mollusc; and Coffee, tea, cocoa, spices. These divisions also have the highest value by the indices of NEI, RTA, and NRCA except LFI. Vegetables and fruit division is in place of Crude rubber division in the group of the 3 strongest divisions in the LFI indicator. It is noted that Cereals, cereal preprtns. and Cork and wood are highly comparative advantageous by the RCA and the NRCA but disadvantageous by the NEI and the LFI. There are, especially, different results of the number of the competitive divisions in Vietnam among the indices. NEI and RTA show 9 competitive divisions; RCA affirms 7 competitive divisions whilst LFI and NRCA identify only 6 competitive divisions. The weakest comparative advantageous divisions are Live animals; Oil seed; Hides, skins, furskins, raw; and Meat, meat preparations. There are three strongly competitive divisions, three averagely competitive divisions, and one weakly competitive division by the classification of the RCA.

Comparative advantage of agricultural commodities in 2014 for 3-digits groups

The result of comparative advantage analysis at 3-digits level shows that Vietnam achieves the highest world market shares in Wood in chips accounting for 15%; Spices accounting for 14.3%; Rice accounting for 11.4%; and Natural rubber accounting for 10.2%. The NEI, RCA, and RTA indices indicate that the most competitive group is Wood in chips whilst LFI and NRCA indices confirm Coffee,coffee substitute as the most advantageous group. The 5 most comparative advantageous groups by the RCA and RTA indices are Wood in chips; Spices; Rice; Natural rubber; and Coffee, coffee substitute whilst the indices of LFI and NRCA indicate a different result of the top 5 competitive group including Coffee,coffee substitute; Rice; Crustaceans,molluscs; Fish prepd,prsvd.nes; and Fish,fresh,chilled,frozn.

There is also the difference between the results of 2-digits analysis and 3-digits analysis. Some advantageous groups at 3-digits are in disadvantageous divisions at 2-digits or vice versa. Wood in chips is the most competitive group at 3-digits but the group is in the division 24 at 2-digits that is not in the top 3 divisions by RCA and NRCA indicators and it is even disadvantageous division by NEI, RTA, and LFI indices. Crude rubber (division 23) and Fish, crustaceans, mollusc (division 03) are the most advantageous divisions but their product groups are not in the top 3 groups by RCA at 3-digits level but it has 3 groups in the next 3 positions such as Crustaceans, molluscs; Fish prepd,prsvd.nes; and Fish, fresh, chilled, frozn. The classification by RCA index indicates that there are 8 strongly competitive groups (RCA value > 4), 3 averagely competitive groups, and 8 weakly competitive groups. The indices of RCA, RTA, and RSCA indicates the results of the 8 strongly advantageous groups including Wood in chips; Spices; Rice; Natural rubber; Coffee,coffee substitute; Crustaceans,molluscs; Fish prepd,prsvd.nes; and Fish,fresh,frozn. The groups are also the top strong comparative advantage commodities by RTA, LFI, and NRCA indices whilst the NEI shows a different result (Table 2).

Table 2: Comparative advantage of some agricultural commodities in Vietnam (at 3-digits)

Code	Groups of commodities	WMS	NEI	RCA	RTA	LFI	NRCA
246	Wood in chips, particles	***14.98%***	***1.00***	***18.34***	***21.53***	**2.10**	**6.20**
075	Spices	**14.30%**	**0.87**	**17.51**	**19.04**	**2.21**	**7.30**
042	Rice	**11.39%**	**0.97**	**13.95**	**15.66**	**5.37**	**15.60**
231	Natural rubber, etc.	**10.18%**	0.83	**12.46**	**12.86**	**2.68**	**8.69**
071	Coffee,coffee substitute	**9.27%**	**0.96**	**11.35**	**12.42**	***6.42***	***18.20***
036	Crustaceans,molluscs etc	**7.75%**	0.69	**9.49**	**8.49**	**4.05**	**14.73**
037	Fish etc.prepd,prsvd.nes	**7.25%**	**0.98**	**8.88**	**9.53**	**3.69**	**9.66**
034	Fish,fresh,chilled,frozn	**4.25%**	0.69	**5.21**	**4.52**	**3.60**	**10.44**
265	Vegetable textile fibres	**3.24%**	**1.00**	**3.96**	**4.06**	0.08	0.13
074	Tea and mate	2.93%	**0.90**	3.59	3.48	0.39	0.65
057	Fruit,nuts excl.oil nuts	2.67%	0.46	3.27	2.28	**2.07**	**6.39**
054	Vegetables	1.59%	0.51	1.95	1.35	0.91	0.05
264	Jute,oth.textl.bast fibr	1.32%	(0.58)	1.61	(0.53)	(0.01)	(0.00)
046	Meal,flour of wheat,msln	1.21%	0.75	1.49	1.18	0.10	(0.12)
035	Fish,dried,salted,smoked	1.20%	**0.88**	1.47	1.38	0.12	(0.13)
411	Animal oils and fats	1.07%	0.33	1.31	0.56	0.03	(0.17)
245	Fuel wood, wood charcoal	1.06%	0.62	1.30	1.04	0.02	(0.04)
058	Fruit,preserved,prepared	0.85%	**0.88**	1.03	0.97	0.30	(0.95)
062	Sugar confectionery	0.83%	0.33	1.01	0.42	0.05	(0.57)
	Max	**0.15**	**1.00**	**18.34**	**21.53**	**6.42**	**18.20**
	Average	**0.02**	**(0.13)**	**2.12**	**1.21**	**0.00**	**(0.00)**
	Median	**0.00**	**(0.27)**	**0.30**	**(0.05)**	**(0.01)**	**(0.83)**
	Min	**-**	**(1.00)**	**-**	**(12.74)**	**(8.42)**	**(7.68)**
	St Dev	**0.04**	**0.73**	**4.29**	**5.45**	**2.11**	**5.14**
	Competitive groups		**28.00**	**19.00**	**27.00**	**25.00**	**12.00**

The results of the 2-digits analysis and 3-digits analysis reveal that Vietnam has a higher number of strong comparative advantage groups than the average groups and the weak groups. Vietnam in 2014 achieves the comparative advantages in 28 agricultural product groups by NEI index; 19 groups by RCA index; 27 groups by RTA index; 25 groups by LFI index and only 12 groups by NRCA indicator. The average values of RCA, RTA, and LFI indices show positive results of comparative advantage whilst all medium numbers of these indices indicates the negative results. The Vietnam, generally, has strong comparative advantages in *crop sectors* such as spices (black pepper), rice, coffee, tea, fruit & nut and vegetables; and *fishery sectors* such as crustaceans (shrimp) and fish whilst the country is definitely comparative disadvantageous in *livestock sectors* such as live animal, meat, eggs & birds; and *processed food sectors* such as chocolate, cheese, butter and other processed meat & foods.

Analyzing the dynamics of the comparative advantages

Dynamics of the comparative advantages

The first type of stability (or dynamics) of the comparative advantage indices in the full period and sub-period will be empirically analysed in this part based on the OLS regression. The study first uses Skewness & Kurtosis to test the normal distribution of the original CAs indices including NEI,

RCA, RTA, LFI and NRCA; and then test for their transformed values in the years of 1997, 2005, 2006 and 2014. The results indicate that all distributions of the original CAs indices in the years are non-normal. For the T-CAs values, the test affirms that T-LFI is the only value that has normal distribution whilst all other transformed values of T-NEI, RSCA, T-RTA and T-NRCA are non-normal distributions. Therefore, the β and R value from the regression of T-LFI is more significant and reliable than LFI whilst the other T-CAs seem not to indicate clearly more significant and reliable results than the original ones. After the normality testing for the original indices and their transformed values, this paper analyses the dynamics of the comparative advantages by employing OLS model based on Galtonian regression model presented by Hart & Prais (1956) and first utilised by Cantwell (1989) in the context of specialization for both original indices and their transformed values to compare the transformation formulas. The different results of dynamics analysis are presented in table 3 and table 4.

The regression results for the original indices indicate that all β values in all periods are greater than 0, and the special case where $\beta < 0$ does not exist. The β values of NEI, RCA and RTA in all three periods are smaller than 1 and indicate that the groups with the initial strong comparative advantages by NEI, RCA, and RTA decrease their values and the groups with initial weak comparative advantages increase their values over the period; and the RCA indices tend to decline over time. The β/R values of these indices in the mentioned period are almost lower 1 except for NEI in 2006 – 2014 and the results offer evidence that there are the decreases in the dispersion of RCA and RTA indices whilst there is no change in the dispersion of NEI values. The regression results of LFI give the evidence suggesting an increase in comparative advantage or a decrease in comparative disadvantage in 1997-2005 whilst suggesting a decrease in comparative advantage or an increase in comparative disadvantage in 2006-2014 and in 1997-2014. The greater than 1 β/R values of LFI show that the LFI values get the increase in dispersion in the periods. The result of NRCA index states a different result that the commodity groups with the initial strong comparative advantage by NRCA increase their values, and vice versa, the initial weak comparative advantage decrease their values over all periods; and their dispersions increase over the times. The regression results show that the different trade performance indices seem to display the different trends and changes in the comparative advantages of agricultural commodity groups (Table 3).

Table 3: The regression results of the original comparative advantage indices

	1997 - 2005			**2006 - 2014**			**1997 - 2014**		
	β	*R*	*β/R*	*β*	*R*	*β/R*	*β*	*R*	*β/R*
NEI	0.77	0.81	0.95	0.79	0.79	1	0.52	0.57	0.91
RCA	0.75	0.94	0.8	0.52	0.86	0.6	0.31	0.7	0.45
RTA	0.72	0.88	0.81	0.52	0.81	0.64	0.29	0.63	0.46
LFI	1.07	0.89	1.2	0.96	0.92	1.04	0.94	0.78	1.2
NRCA	1.41	0.91	1.54	1.11	0.91	1.22	1.54	0.8	1.93

This study also analyses the transformed values of the used indices to achieve more significant and reliable results based on a more normal distribution of input data. Table 4 presents the result of T-CAs dynamics regression. The pairs of RCA & RSCA and NRCA & T-NRCA show the same results of specialization and dispersion overtimes. This means that the transformed values have no

impact on the dynamics of indices. NEI and T-NEI state almost the similar result except in 1997-2005 with no change of dispersion of the transformed values. RTA and T-RTA affirm the same specialization dynamics whilst they explain the opposite trend of dispersion in 1997-2005 and 1997-2014. The LFI and T-LFI have the similar dynamic patterns in 1997-2005 and 1997-2014 whilst reveal slight changes in specialization status in 1997-2005 and 2006-2014 where $\beta = 1$ indicate the unchanged pattern of comparative advantage over the times.

Table 4: The regression results of the transformed comparative advantage values

	1997 - 2005			**2006 - 2014**			**1997 - 2014**		
	β	*R*	*β/R*	*β*	*R*	*β/R*	*β*	*R*	*β/R*
TNEI	0.8	0.8	1	0.8	0.8	1	0.5	0.5	0.9
RSCA	0.7	0.8	0.9	0.8	0.9	0.9	0.6	0.7	0.9
TRTA	0.8	0.8	1.1	0.8	0.9	0.9	0.6	0.6	1
TLFI	1	0.9	1.1	1	0.9	1.1	0.9	0.8	1.1
TNRCA	1.3	0.7	1.7	1.2	0.9	1.3	1.7	0.6	2.6

Stability of the comparative advantages

The dynamics of the comparative advantage indices in this study are investigated by using the Markov transition probability matrices and mobility index for yearly values of the CAs indices. The analysis presents the probability of moving from one group to another between the starting year (1997) and the ending year (2014). The diagonal elements of the Markov transition probability matrix show the probability of remaining persistently in their initial class. The other elements of the Markov transition probability matrices provide further information on the dynamics of the CAs indices, showing the probability of moving from one class to another from the year "t" to the year "t+1" over the period 1997-2014. There are five 4x4 matrices of Markov one-step transition probability including NEI, RCA, RTA, LFI, and NRCA with 61 agricultural commodity groups at the 3-digit level and 1.037 observations in 18 years. The total probabilities of the Markov transition probability matrices imply the empirical shares of the observations in the classes (1, 2, 3, 4) in the full period. The long-run (LR) probabilities of the Markov transition probability matrices supply the evidence on the LR probability of remaining in the specific class for the analysed CAs indices.

Table 5 shows the Markov transition probability matrices for the CAs indices of agricultural commodity groups. The results, generally, indicate that the high probabilities of CAs indices remain in their initial class (high diagonal elements) in which the class 1 of disadvantageous groups and the class 4 of strongly disadvantageous groups especially maintain the highest probabilities and they are the most stable. These also mean that the groups without initial comparative advantage seem to stay to be uncompetitive whilst the groups with strong initial comparative advantage continue to maintain their competitive positions. The probabilities of shifts from less advantageous groups to more advantageous groups are very low whilst the probabilities of moves from more advantageous groups backward to less advantageous groups are higher. There are, especially, no case of the group moving from class 4 back to class 1 and class 2, and no shifts from class 2 to class 4 by the indices of RCA, RTA, and NRCA. The probabilities of closer shifts are higher than the probabilities of longer moves between classes. The average probabilities of mobility and stability in the matrices, moreover, are also different between the CAs indices. The RCA indices are the highest average

probability of stability and the lowest average probability of mobility, the average probabilities of NRCA, LFI, and RTA are next, whilst NEI indicators endure the lowest average probability of stability and the highest average probability of mobility.

Table 5: Markov transition probability matrices for the CAs indices of agricultural products

NEI	Obs: 1037	*Class 1*	*Class 2*	*Class 3*	*Class 4*
	Class 1	92.45	5.58	0.36	1.62
	Class 2	14.78	77.39	6.96	0.87
	Class 3	1.68	20.17	59.66	18.49
	Class 4	6.82	5.3	16.67	71.21
	Total	53.91	23.14	10.7	12.25
	Long run	57.76	24.15	8.6	9.48

LFI	Obs: 1037	*Class 1*	*Class 2*	*Class 3*	*Class 4*
	Class 1	93.78	5.16	0.15	0.91
	Class 2	17.58	71.43	8.79	2.2
	Class 3	1.06	15.96	74.47	8.51
	Class 4	6.86	2.94	1.96	88.24
	Total	63.45	17.55	8.58	10.41
	Long run	62.98	16.72	7.14	13.16

RCA	Obs: 1037	*Class 1*	*Class 2*	*Class 3*	*Class 4*
	Class 1	95.03	4.68	0.15	0.15
	Class 2	19.43	73.14	7.43	0
	Class 3	3.37	16.85	77.53	2.25
	Class 4	0	0	4.49	95.51
	Total	66.25	16.88	8.39	8.49
	Long run	70.31	16.74	7.16	5.78

NRCA	Obs: 1037	*Class 1*	*Class 2*	*Class 3*	*Class 4*
	Class 1	97.56	2.08	0.24	0.12
	Class 2	34.48	56.9	8.62	0
	Class 3	7.14	7.14	69.05	16.67
	Class 4	0	0	2.54	97.46
	Total	79.27	5.11	3.76	11.86
	Long run	64.01	3.73	3.87	28.39

RTA	Obs: 1037	*Class 1*	*Class 2*	*Class 3*	*Class 4*
	Class 1	91.73	7.01	0.9	0.36
	Class 2	18.07	78.57	3.36	0
	Class 3	7.32	11.38	73.17	8.13
	Class 4	0	0	9.17	90.83
	Total	54.19	23.14	10.99	11.67
	Long run	58.7	23.55	8.19	9.56

Table 5 also reports the empirical ergodic distribution (total probability) as well as the implied ergodic distribution (long-run probability). In most cases of CAs indices, the implied and the empirical distributions are relatively similar and these indicate that the Markov transition probability matrices accurately capture the underlying distribution to investigate differences in mobility between the CAs indices (Hinloopen & Marrewijk, 2001). The LR probabilities results indicate that the shares of disadvantageous and less advantageous groups increase and more advantageous groups decline for NEI, RCA, and RTA indices whilst disadvantageous and less advantageous groups decrease and more advantageous groups grow for LFI and NRCA indices. The LR probabilities results also confirm a more polarised distribution for LFI and NRCA indices whilst asymmetry is showed for NEI, RCA and RTA indices, tending to a right skewed distribution.

Testing the consistency of the comparative advantage

The consistency test based on the correlation coefficient between the CAs indices as cardinal measures are shown in table 6 that there is no perfect correlation between the CAs indices, and the highest correlation coefficients are between RCA & RTA in 1997, 2000 and 2002 with R of 0.98 affirming the strongest consistency. In average, the high correlations ($\geq$ 0.7) of the CAs pairs of

RCA & RTA, RCA & LFI, RCA & NRCA, RTA & LFI, RTA & NRCA, and LFI & NRCA indicate strong consistencies between the indices as cardinal measures, in which the pair of RCA & RTA is the most consistent with the average R of 0.96, and the pair of RCA & NRCA is the second consistent with the average R of 0.86. Whilst all correlation coefficients of NEI with other CAs indices are low (<0.7) indicating the weak consistency between them; the especial case is the weakest consistency between the pair of NEI & NRCA with the poorest average R of 0.46.

Table 6: Cardinal test - correlation coefficients of paired CAs indices

	NEI				RCA			RTA		LFI
	RCA	RTA	LFI	NRCA	RTA	LFI	NRCA	LFI	NRCA	NRCA
1997	0.41	0.43	0.53	0.36	0.98	0.81	0.91	0.84	0.89	0.88
1998	0.46	0.48	0.52	0.40	0.96	0.86	0.94	0.89	0.90	0.91
1999	0.42	0.46	0.52	0.37	0.97	0.83	0.91	0.85	0.88	0.91
2000	0.47	0.52	0.52	0.36	0.98	0.70	0.80	0.75	0.79	0.87
2001	0.50	0.55	0.48	0.33	0.96	0.73	0.85	0.79	0.83	0.84
2002	0.52	0.55	0.51	0.37	0.98	0.77	0.85	0.81	0.85	0.89
2003	0.49	0.54	0.50	0.38	0.97	0.76	0.88	0.80	0.86	0.86
2004	0.51	0.56	0.54	0.41	0.94	0.75	0.88	0.77	0.83	0.85
2005	0.51	0.56	0.55	0.42	0.94	0.76	0.89	0.77	0.83	0.85
2006	0.55	0.61	0.59	0.48	0.96	0.73	0.88	0.77	0.84	0.83
2007	0.59	0.64	0.57	0.51	0.97	0.72	0.89	0.77	0.86	0.82
2008	0.62	0.65	0.56	0.54	0.96	0.74	0.90	0.79	0.87	0.83
2009	0.60	0.65	0.55	0.53	0.96	0.69	0.87	0.75	0.84	0.81
2010	0.61	0.65	0.57	0.53	0.93	0.71	0.88	0.75	0.82	0.82
2011	0.62	0.66	0.58	0.55	0.95	0.68	0.83	0.73	0.78	0.83
2012	0.58	0.63	0.58	0.53	0.93	0.65	0.80	0.70	0.76	0.84
2013	0.59	0.64	0.59	0.57	0.91	0.62	0.80	0.68	0.72	0.81
2014	0.61	0.67	0.61	0.57	0.94	0.64	0.79	0.75	0.74	0.81
Average	**0.54**	**0.58**	**0.55**	**0.46**	**0.96**	**0.73**	**0.86**	**0.78**	**0.83**	**0.85**

Notes: All correlation coefficients are significant at 0.01 level

The consistency test for the RCA indices as ordinal measures is based on the rank correlation coefficient for each pair of CAs indices. The results of ordinal measures are relatively different in comparison with the results of cardinal measures. In average of the full period, there are four pairs of CAs indices obtain the strong consistencies with high correlation coefficients (≥0.7) including NEI & RCA, NEI & RTA, NEI & LFI, and RTA & LFI, in which the highest correlation coefficient is between RTA & LFI with the average R of 0.89 stating the strongest consistency. Whilst NRCA is weakly consistent with all other CAs indices with low correlation coefficients (<0.7), and RCA is only strongly consistent with NEI. The weakest consistency is also between the pair of NEI & NRCA with the poorest average R of 0.49 (Table 7).

The last test for the consistency of CAs indices is a dichotomous measure presenting the share of product groups in which both of the paired indices suggest comparative advantage or disadvantage. The table 8 shows that, with the correlation coefficients = 1, RCA & RTA is perfectly consistent over the full period; NEI & LFI is perfectly consistent in 1998-2001 and 2009-2011, and very strong consistency in other years (R>0.95). Dichotomous measures test also demonstrate a different result with cardinal and ordinal measures that all paired indices of CAs are strongly consistent with higher or equal 0.74 correlation coefficients.

Table 7: Ordinal test - rank correlation coefficients of paired CAs indices

	NEI				RCA			RTA		LFI
	RCA	RTA	LFI	NRCA	RTA	LFI	NRCA	LFI	NRCA	NRCA
1997	0.88	0.89	0.76	0.52	0.79	0.62	0.56	0.88	0.56	0.63
1998	0.92	0.78	0.62	0.37	0.64	0.49	0.38	0.83	0.44	0.52
1999	0.76	0.84	0.74	0.33	0.64	0.47	0.33	0.85	0.33	0.52
2000	0.79	0.85	0.78	0.42	0.64	0.55	0.46	0.87	0.48	0.54
2001	0.79	0.89	0.73	0.39	0.70	0.43	0.54	0.79	0.42	0.56
2002	0.83	0.84	0.71	0.52	0.63	0.47	0.57	0.84	0.49	0.68
2003	0.77	0.85	0.72	0.50	0.60	0.45	0.57	0.84	0.49	0.63
2004	0.79	0.84	0.72	0.49	0.61	0.48	0.55	0.89	0.54	0.65
2005	0.80	0.87	0.78	0.50	0.61	0.54	0.57	0.89	0.50	0.64
2006	0.78	0.88	0.82	0.56	0.57	0.54	0.61	0.93	0.55	0.70
2007	0.80	0.87	0.78	0.58	0.63	0.55	0.60	0.89	0.60	0.74
2008	0.87	0.86	0.76	0.53	0.67	0.59	0.58	0.91	0.61	0.77
2009	0.85	0.86	0.77	0.52	0.65	0.61	0.57	0.92	0.61	0.77
2010	0.86	0.85	0.77	0.51	0.64	0.59	0.55	0.94	0.63	0.75
2011	0.86	0.84	0.75	0.54	0.62	0.56	0.57	0.92	0.61	0.78
2012	0.86	0.83	0.78	0.50	0.66	0.60	0.55	0.94	0.67	0.74
2013	0.85	0.84	0.78	0.50	0.66	0.60	0.54	0.95	0.65	0.73
2014	0.87	0.87	0.80	0.51	0.68	0.62	0.54	0.94	0.65	0.77
Average	**0.83**	**0.85**	**0.75**	**0.49**	**0.65**	**0.54**	**0.54**	**0.89**	**0.55**	**0.67**

Notes: All correlation coefficients are significant at 0.01 level

Table 8: Dichotomous test - shares (%) of the matching CAs indices

	NEI				RCA			RTA		LFI
	RCA	RTA	LFI	NRCA	RTA	LFI	NRCA	LFI	NRCA	NRCA
1997	0.79	0.79	0.97	0.89	1.00	0.75	0.87	0.75	0.87	0.85
1998	0.83	0.83	1.00	0.86	1.00	0.84	0.83	0.84	0.83	0.86
1999	0.76	0.76	1.00	0.85	1.00	0.77	0.78	0.77	0.78	0.85
2000	0.75	0.75	1.00	0.86	1.00	0.77	0.78	0.77	0.78	0.86
2001	0.75	0.75	1.00	0.77	1.00	0.75	0.75	0.75	0.75	0.77
2002	0.77	0.77	0.97	0.90	1.00	0.74	0.80	0.74	0.80	0.87
2003	0.77	0.77	0.97	0.92	1.00	0.74	0.82	0.74	0.82	0.89
2004	0.82	0.82	0.98	0.93	1.00	0.80	0.85	0.80	0.85	0.92
2005	0.78	0.78	0.98	0.92	1.00	0.77	0.83	0.77	0.83	0.90
2006	0.77	0.77	0.95	0.90	1.00	0.75	0.87	0.75	0.87	0.89
2007	0.85	0.85	0.97	0.92	1.00	0.82	0.87	0.82	0.87	0.89
2008	0.87	0.87	0.98	0.93	1.00	0.89	0.90	0.89	0.90	0.92
2009	0.84	0.84	1.00	0.92	1.00	0.84	0.89	0.84	0.89	0.92
2010	0.87	0.87	1.00	0.95	1.00	0.87	0.89	0.87	0.89	0.95
2011	0.82	0.82	1.00	0.90	1.00	0.82	0.89	0.82	0.89	0.90
2012	0.82	0.82	0.98	0.93	1.00	0.84	0.89	0.84	0.89	0.92
2013	0.84	0.84	0.97	0.93	1.00	0.87	0.87	0.87	0.87	0.93
2014	0.82	0.82	0.98	0.95	1.00	0.84	0.87	0.84	0.87	0.97
Average	**0.81**	**0.81**	**0.98**	**0.90**	**.00**	**0.80**	**0.85**	**0.80**	**0.85**	**0.89**

In general, the consistency tests imply the findings that the five CAs indices under study are not perfectly consistent as the cardinal and the ordinal measures of comparative advantages. There is only 57 percent of strongly consistent pairs as cardinal measures and 46 percent strongly consistent pairs as ordinal measures of 180 observations over the period 1997-2014. However, the result suggests that the CAs indices are reasonable proxies as dichotomous measures with 100 percent of strongly consistent pairs and many perfectly consistent pairs. The dichotomous measure test, moreover, confirms that all the five indices are strongly consistent in measuring comparative advantages and serve as useful proxies in determining whether a country obtains comparative advantages in export commodities. In other words, the trade indices of NEI, RCA, RTA, LFI and NRCA are strongly consistent and useful to assess whether a country or a commodity has comparative advantage whilst they are weakly consistent to evaluate the degree or rank of comparative advantage. This result is relatively similar to and supports the finding and conclusion of Ferto (2004), especially between RCA and RTA indices.

5. Conclusion and suggestions

The comparative advantages analysis at 2-digits agricultural product divisions with 21 observations reveals that Vietnam has the comparative advantages in 9 of 21 product divisions by NEI and RTA, 7 divisions by RCA, 6 divisions by LFI and NRCA. The most competitive divisions are Crude rubber; Fish, crustaceans; Coffee, tea, cocoa, spices. The analysis at 3-digits groups with 61 observations shows that Vietnam obtains competitiveness in 28 of 61 commodity groups by NEI, 19 groups by RCA, 27 groups by RTA, 25 groups by LFI, and only 12 groups by NRCA. The top advantageous groups are Wood in chips, particles; Spices; Rice; Natural rubber; Coffee, coffee substitute; Crustaceans, molluscs; Fish etc. prepd; and Fish, fresh, chilled,. The Vietnam, generally, has strong comparative advantages in *crop sectors* such as spices rice, coffee, tea, fruit & nut and vegetables; and *fishery sectors* such as crustaceans and fish whilst the country is definitely disadvantageous in *livestock sectors* such as live animal, meat, eggs & birds; and *processed food sectors* such as chocolate, cheese, butter and other processed meat & foods. The degrees of strong comparative advantages of agricultural commodities in Vietnam are relatively higher than other countries in the previous empirical studies by the classification of Hinloopen & Marrewijk (2001).

The dynamics analysis by OLS indicates that the initial strong comparative advantages by the indices of NEI, RCA, and RTA decrease their values and the groups with initial weak comparative advantages increase their values over the period; and there are the decreases in the dispersions of NEI, RCA, and RTA indices over time. LEI index shows the different dynamics with β-specialization result in 1997-2005 and the dispersion increasing result in all periods. NRCA index affirms a difference with other indices that the index has β-specialization and the dispersion increasing result in all periods. There are also, notably, not really significant variances between the CAs indices and their T-CAs indices.

The analysis of stability and mobility by employing Markov transition probability matrices shows that the high probabilities of the CAs indices remain in their initial classes, in which the class 1 of disadvantageous groups and the class 4 of strongly disadvantageous categories especially maintain the highest probabilities and they are the most stable. The result also means that the groups without initial comparative advantage seem to stay uncompetitive whilst the groups with strong initial

comparative advantage maintain their competitive positions. The probabilities of shifts from less advantageous groups to more advantageous groups are very low whilst the probabilities of moves from more advantageous groups backward to less advantageous groups are higher. There are no cases of the move from class 4 back to class 1 and class 2, and no shifts from class 2 to class 4 by the indices of RCA, RTA, and NRCA. The probabilities of closer shifts are higher than the probabilities of longer moves between classes. The LR probabilities results also confirm a more polarised distribution for LFI and NRCA indices whilst asymmetry is showed for NEI, RCA and RTA indices, tending to a right skewed distribution.

The result of consistency test proves that the 5 CAs indices under study are not perfectly consistent as the cardinal and the ordinal measures of comparative advantages whilst the dichotomous measure test confirms that the 5 CAs indices are strongly consistent in measuring comparative advantages and they serve as useful proxies in determining whether a country obtains comparative advantages in export commodities. In other words, the trade performance indices of NEI, RCA, RTA, LFI, and NRCA are strongly consistent and satisfactory to assess whether a country or a commodity has comparative advantage whilst they are weakly consistent to evaluate the degree or the rank of comparative advantages.

In order to utilise the strong comparative advantages in agricultural export commodities, Vietnam should sustainably improve the productivity and the quality of the agricultural products based on the approach of global value chain and concentrate on upgrading production technology, international quality standards, vertical and horizontal linkage, farm management, and market information systems. It is important to promote the export-oriented investment in the agricultural products to procure local and foreign capital, technology, employment, skills, and managements. Vietnam, especially, is essential to move its comparative advantage patterns from the primary and low value-added agricultural products to the processed food sectors and high-value items. The future studies of the competitiveness of agricultural sectors in Vietnam should be evaluated by both quantitative and qualitative frameworks based on value chain approach by multi-dimensions indicators. Trade performance indices are also useful and necessary for the cross-country analysis of comparative advantages at the level of regions in which Vietnam is a member.

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