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Article

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Economies

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Suggested Citation: Chi, Shu-Yi; Chang, Chiao-Chun; Chien, Li-Hsien (2025) : Global tangerine trade market: Revealed competitiveness and market powers, *Economies*, ISSN 2227-7099, MDPI, Basel, Vol. 13, Iss. 7, pp. 1-21, <https://doi.org/10.3390/economies13070203>

This Version is available at:

<https://hdl.handle.net/10419/329483>

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Article

Global Tangerine Trade Market: Revealed Competitiveness and Market Powers

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Abstract

The international trade in agricultural products is complex and diverse. Global buyers must diversify their import sources, while sellers must explore new market opportunities. In the past, there has been no analysis on how second-tier exporters, with a smaller market share compared to dominant exporters, interact in the same target market and within an existing trade market and what factors affect trade prices and market forces. Based on Vollrath's revealed competitive advantage index framework, this study analyzes the global tangerine trade (HS08052100) and means of production from 2008 to 2021, performs clustering, and estimates the residual demand elasticities of two main second-tier exporting countries—South Africa and Morocco—in four major importing countries for empirical analysis. The results show that South African tangerines have a lower market share than Moroccan tangerines in the Netherlands, the United States, and the United Kingdom. However, all data indicate that the residual demand elasticity for the country's products in the target markets is negative, indicating that South African exporters have market influence in all three markets and significantly affect the prices of Moroccan products in these markets. Unlike other studies that have focused on the ranking analysis of export indices, the novelty of this study is that it provides an oligopolistic framework based on agricultural value chain analysis, which can be used for many countries with limited export scales. The method proposed in this study is expected to help citrus traders to effectively find export markets by evaluating the remaining market niches using key market data and the prices of similar competitors in the same category.



Academic Editor: Benaissa Chidmi

Received: 31 May 2025

Revised: 27 June 2025

Accepted: 4 July 2025

Published: 15 July 2025

Citation: Chi, S.-Y.; Chang, C.-C.; & Chien, L.-H. (2025). Global Tangerine Trade Market: Revealed Competitiveness and Market Powers. *Economies*, 13(7), 203. <https://doi.org/10.3390/economies13070203>

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1. Introduction

Research on the international trade of agricultural products has progressed rapidly over the past five decades. International trade has become an emerging channel for agricultural products, and it is becoming increasingly important for countries with a surplus supply after serving limited domestic markets (Cameron et al., 2017; Chi & Chien, 2023). A significant amount of empirical evidence supports the existence of a positive correlation between the extent of international trade liberalization and the growth of the global economy (Martin, 2019; Pinilla & Rayes, 2019; Remeikiene et al., 2018; Yuret, 2016).

International trade in agricultural products can alleviate the uneven distribution of foodstuffs worldwide (Besedeš & Prusa, 2017; Carr et al., 2016), increase the diversity of

consumer choices (Fader et al., 2013), and meet demands for exotic or off-season products (Scheelbeek et al., 2020).

Due to the geographical and climatic conditions required for agricultural production, the import sources of major importing countries are often significantly concentrated in a few countries, indicating a high degree of dependence on exporting countries (Fader et al., 2013). Furthermore, with the emergence of factors that result in gaps in market supply, such as climate change in the place of origin and disruptions in the international supply chain (Gouel & Laborde, 2018; Zhao et al., 2017), other sources must be found in order to cope with these changes. Scheelbeek et al. (2020) studied the supply and diversity of agricultural products in the U.K. between 1987 and 2013. They observed that the market became increasingly reliant on imports of fruits and vegetables from regions vulnerable to climate change, with 54% of its citrus fruits being imported from “vulnerable production areas.”

Considering the perishability of fresh fruits due to time and transportation conditions, trading parties typically refrain from frequently switching partners after establishing a trading relationship to avoid losses caused by friction in customs clearance procedures and sales models (Besedeš & Prusa, 2017; Gullstrand & Persson, 2015; Peterson et al., 2018). Once dependence on international trading partners is established, the risk of domestic supply chain disruptions due to changes in trading conditions increases. Therefore, it is necessary to diversify trade sources moderately (Scheelbeek et al., 2020).

Therefore, a market with potential demand entices exporting countries. For these exporting countries, which are highly responsive to market changes but are small in scale, it is important to create a niche by tapping into international markets for agricultural products, assessing the development potential of each target market, and identifying the markets in which they will have a competitive edge (Bojnec & Ferto, 2016; Roosta et al., 2017).

During the production season, central exporting countries provide competitive products to the importing countries. When supply in the importing country’s market is insufficient to meet domestic demand, business opportunities are created for exporting countries. This is called “surplus demand” in economic theory. No market can be fully supplied by a single agricultural product, and existing shortages in importing markets present trade opportunities for the rest of its competitors. In this context, the global tangerine trade market is an interesting case study.

Citrus taxonomy (HS0805), which collectively refers to tangerines, mandarins, and clementines (HS08052100), is one of the most prominent categories of fruits and vegetables, with significant production and trade volumes (World Citrus Organization). Its total production was expected to exceed 162 million tons by 2021. Tangerines were produced in 94 countries and regions worldwide in 2021, producing approximately 41.95 million metric tons (FAOSTAT, 2021). Its export has been carried out in 193 countries and regions worldwide, with 11.57 million metric tons and a trade value of USD 12.1 billion in the same year.

The top five exporters accounted for 71.83% of the global total, indicating a relatively high concentration level, with a small market surplus share. The degree to which the rest of the exporting countries can exercise market power to compete against similar countries among the leading importing countries is worth noting. According to this data, several countries act as second-tier suppliers. There has been no relevant analysis on how these second-tier exporting countries interact in the same target countries after the leading country has occupied most of the market, as well as which factors impact trade prices.

To achieve these goals, this study uses a tangerine trade case study and employs a three-stage analytical framework to evaluate the market positions of second-tier exporting countries. In the first stage, we employ Vollrath’s revealed competitive advantage index

as the basic framework to show the comparative trade advantages in tangerine trade. Next, Fuzzy C-Means (FCM) is applied to group major importing countries with similar attributes to potential target markets. Finally, the extended Goldberg–Knetter model is used to calculate the residual demand elasticity (RDE) in order to compare and analyze the market power of non-major exporting countries in different groups.

The objectives and contributions of this study are as follows: (1) We calculate and compare the relative trade competitiveness of the relevant major countries and categorize them by grouping the multipoint hierarchical status of global citrus production and trade. (2) We consider South Africa and Morocco as examples, where the market power of exporters is calculated using residual demand elasticity (RDE) and the relationship between competing exporters is analyzed. (3) We discuss the impact of one exporting country's market power on the other exporting country's market competition in the same importing countries and explore how the importing country responds to the exporting country's market power.

2. Competitiveness of Agricultural Products in International Trade

2.1. Export Competitive Advantage

Agricultural product market development is closely related to global import and export flows. By describing the development and transformation of domestic and foreign supply and demand through multifaceted indicators, it is possible to understand how export-leading countries apply market forces to influence the trade structure and prices of the target country (Mavrogiannis et al., 2008). Several indicators can be used to measure the existence of such market concentration in practice, including the market share of the top manufacturers to describe market concentration, the Gini coefficient, the entropy index, the Lerner index, and the Herfindahl–Hirschman index (HHI). In addition to confirming the concentration and competitive position of the exporting country's commodities in the import market, the trade share index of the product market can be used to evaluate manufacturers' market power in determining prices through market structure analysis (De Pablo-Valenciano et al., 2017). If the share of a country's products in the target country's market increases, this also indicates that the country's products are relatively competitive (Benkovskis & Worz, 2018).

Due to the complexity and multidimensionality of agricultural competitiveness (Bahrami et al., 2023), (Balassa, 1965) introduced the concept of revealed comparative advantage (RCA), which provides a basis for both domestic and international comparisons. It has since become one of the most effective indicators of agricultural trade competitiveness (Istudor et al., 2022).

As the RCA index does not account for import and export data, it may lead to size-ability, asymmetry, and nonadditive estimation bias (Laursen, 2015; Stellian et al., 2024). Consequently, scholars have revised and supplemented it several times (Costinot et al., 2015; Ferto & Hubbard, 2003). Vollrath used import and export data to propose indirect indices, such as relative export advantage (RXA), relative import advantage (RMA), relative trade advantage (RTA), and revealed competitiveness (RC)—calculated from the difference between the first two indices—as alternative norms for comparative advantage. As the calculation considers all traded commodities and countries and avoids double counting, the Vollrath indices are considered comprehensive global indicators (Ferto & Hubbard, 2003).

Considering all traded goods and countries and covering both imports and exports, the revealed trade advantage (RTA) becomes the difference between the global relative export advantage indicator (RXA)—equivalent to the Balassa B index—and the import advantage (RMA). The difference between the RXA and RMA in logarithmic form can be expressed as the revealed trade competitive advantage (RC). Furthermore, the RC and RTA become symmetric at the origin point (Ferto & Hubbard, 2003). A positive value indicates a

competitive advantage, whereas a negative value indicates a competitive disadvantage. As these indicators can capture demand and supply dimensions and improve measurement accuracy, they have become the most widely accepted and applied indirect indices for measuring the export competitiveness of agricultural products.

2.2. Marketing Power

The trade in agricultural products is complex and multifaceted, and competition intensifies when a market opens. The conditions under which agricultural products obtain market access depend on whether a company can trade goods with superior quality and provide price advantages over imported products in the same market (Felt et al., 2011). Due to geographic marketing conditions and transaction habits, a few countries dominate markets for fresh agricultural products in major importing countries. However, a residual market exists in the other exporting countries. According to global statistics, some countries that serve as second-tier suppliers can tolerate harsh trading conditions and export products globally, even in target markets that are already occupied by products from dominant exporting countries. These second-tier sources also compete in importing markets to capture the remaining market share left by the major players. This implies that these second-tier countries influence the target import market by exercising their market power even in the residual market (Mayer et al., 2021).

Market power is defined as the ability to maintain prices above the marginal cost, where the greater the difference is, the greater the market power. Agricultural commodity traders often wield market forces that are amplified by extreme remoteness and diminish as the market size increases—as confirmed by studies on Indonesian rubber (Kopp & Brümmer, 2017).

Market forces influence growth and productivity, are intrinsically linked to globalization, and are affected by trade barriers (del Valle & Fernández-Vázquez, 2024; Mondliwa et al., 2021). There is a growing interest in buyer market power in both developed and developing countries (Gafarova et al., 2023; Graubner et al., 2021; Uhl et al., 2019) and between exporting and importing markets (Alviarez et al., 2023).

Wang et al. (2023) have shown that a country's international market power can improve its welfare and that the residual demand elasticity faced by a company or a group of companies can be used to measure market power or the degree of competition. (Goldberg & Knetter, 1999) studied the residual demand curve elasticity faced by exporters at each destination and the relationship between the existence of competitors. As the GK model uses alternative variables to estimate international suppliers' market power in trade and avoids the difficulty of obtaining trade data, it has become a widely used model in export market power studies, especially in conditions where not all participants are price takers (Felt et al., 2011; Pall et al., 2014).

Pall et al. (2014) employed the GK model to empirically demonstrate that, in the presence of imperfect competition, price discrimination, and the resulting market power, some non-traditional exporting countries, such as Russia, exhibit more competitive behavior in Albania, Georgia, and Greece than traditional wheat-exporting countries, such as the United States, Canada, and Australia. Felt et al. (2011) used the GK model estimator to analyze whether other major international pork-trading countries could demonstrate market power in gaining supply advantages after Japan's leading supplier could not provide pork. They found that the residual demand elasticity was negative and that the absolute value was significantly lower than 1, confirming that the United States, Denmark, and Canada had a market influence in the Japanese market. Among them, American exporters are in the best position to take full advantage of the market opportunities introduced by Taiwan's withdrawal. The results also demonstrated that, because the cost of switching

to another supplier may be relatively high, the degree of substitution between similar products provided by different countries is low.

2.3. Global Production and Trade of Tangerines

According to FAO statistics, tangerine production averaged 31.25 million tons annually from 2008 to 2021, with the top ten producing countries accounting for 82.3% of global production. China—the largest producer—accounted for half of the world's citrus production (16,536.6 thousand tons, or 52.92%), followed by Spain (7.10%), Turkey (3.82%), Brazil (3.25%), and Egypt (2.95%). This result indicates that production is highly concentrated in certain countries.

However, after analyzing the export value of each country as a global percentage, it was found that 90% of the world's citrus exports were concentrated in 14 exporting countries or regions between 2008 and 2021. The top five exporters (Spain, China, Turkey, Morocco, and South Africa) accounted for 71.5% of the global citrus export trade, indicating that these countries have significantly influenced the direction of the world's tangerine trade (Table 1). Even without domestic production, a country can play the supplier's role in the global market. The Netherlands, for instance, does not produce citrus fruits domestically, but is the world's seventh-largest exporter of citrus fruits.

Table 1. Major tangerine-producing and tangerine-exporting countries in the world (2008–2021).

Country Code	AVE-Pro	AVE-Export	Export 2008	Export 2012	Export 2016	Export 2021
ESP	7.1%	36.01%	52.85%	40.01%	32.19%	28.32%
CHN	52.9%	17.04%	9.12%	17.34%	20.49%	16.81%
TUR	3.8%	7.24%	5.87%	6.80%	7.20%	7.53%
MAR	2.9%	6.96%	6.26%	5.97%	6.70%	7.54%
ZAF	0.8%	4.27%	2.10%	2.62%	4.23%	8.64%
PAK	1.8%	2.96%	1.43%	3.42%	3.53%	2.66%
NLD	0.0%	2.63%	3.36%	2.03%	2.78%	3.18%
PER	1.1%	2.75%	1.24%	1.82%	3.03%	3.80%
CHL	0.3%	2.42%	0.56%	1.73%	2.99%	3.29%
ISR	0.5%	1.91%	1.56%	1.71%	1.49%	0.97%
AUS	0.4%	1.64%	0.70%	1.27%	2.52%	2.38%
ITA	2.3%	1.46%	2.21%	1.91%	0.98%	0.40%
USA	2.3%	1.51%	1.43%	1.38%	1.39%	1.78%
ARG	1.4%	1.26%	0.82%	1.33%	1.58%	2.32%
Subtotal	77.8%	90.06%	89.53%	89.33%	91.10%	89.62%

Note: Ave-pro indicates average tangerine production, and Ave-exports represent average tangerine exports in the country.

Although the top 14 exporting countries have accounted for 90% of global exports over the past 14 years, approximately 10% of the regions/countries (106) have citrus export records. This finding indicates that the global market is so vast that even small export capacities can yield niche markets. Market demand in importing countries creates opportunities for hundreds of citrus-exporting countries to gain a foothold; therefore, the long-tail phenomenon prevails (see Figure 1).

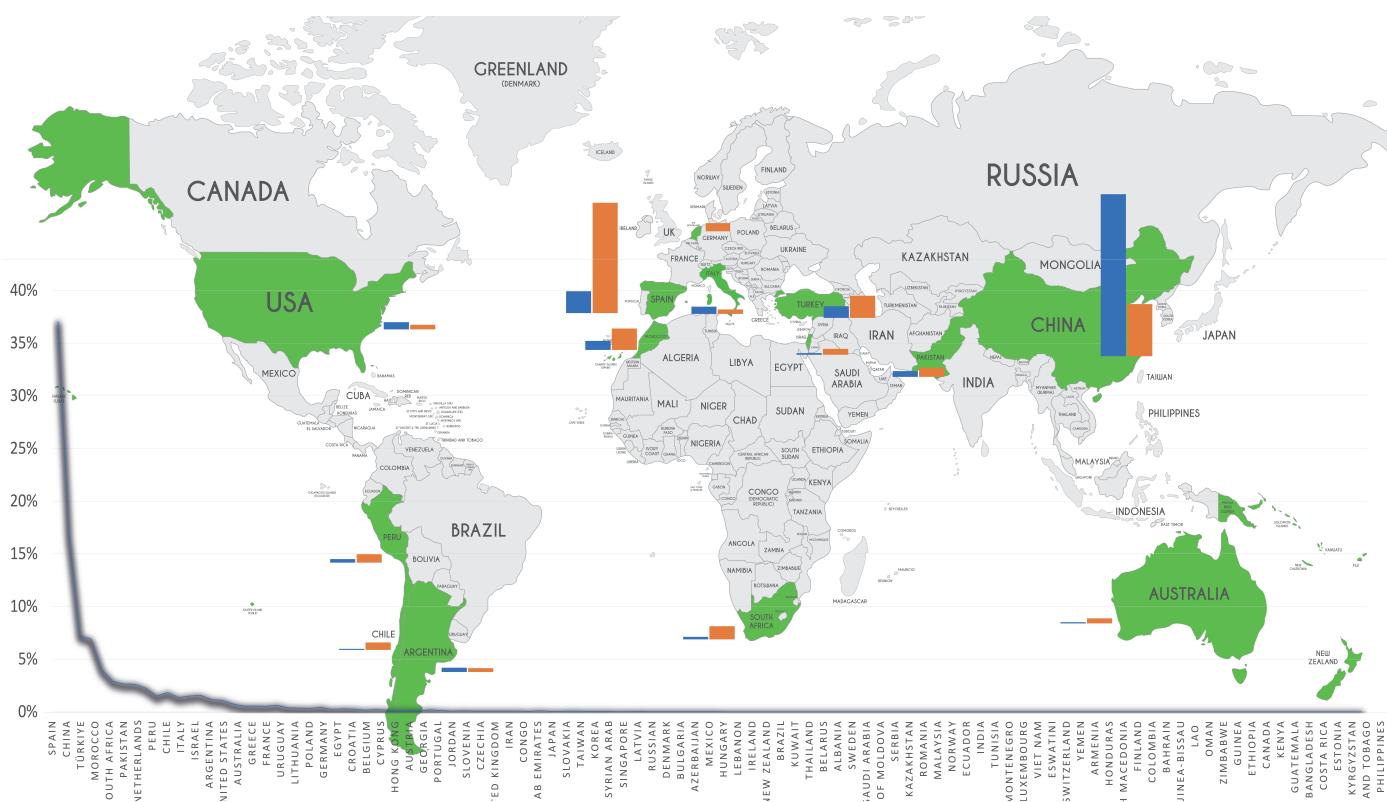


Figure 1. Global tangerine export share: 2008–2021 average. (Note: Blue and orange bars represent the country's average citrus production and export values, respectively, as a percentage of the world's total).

Statistics show that the main export markets of the aforementioned countries each have their dominant markets. Although Spain's exporting countries are relatively scattered, they are mostly concentrated in continental European countries. China's exporting countries are mainly Southeast Asian countries, such as Vietnam and Thailand, while Russia is the destination for half of Turkey's citrus exports. It can be observed that the main markets of these three exporting countries do not overlap substantially. On the contrary, Morocco and South Africa are quite scattered, with export records in Europe, Asia, and Africa. The Herfindahl–Hirschman Index (HHI) of each country is as follows: Turkey (0.324), China (0.185), Morocco (0.163), Spain (0.140), and South Africa (0.013) (see Figure 2).

Regarding importing countries, 95% of the world's citrus import value during the analysis period came from trade with 40 countries/regions. The top six countries accounted for 54% of the sample, as follows: Russia (13.89%), France (9.78%), Germany (9.77%), the United States (7.85%), the United Kingdom (7.80%), and the Netherlands (5.00%). Assuming a cross-comparison among the major trading countries, we find that exporters, such as Morocco and South Africa—because their export scope is not limited to regional markets—face competition in the remaining demand markets of these importing countries, after many citrus import markets have been dominated by the largest suppliers. Consequently, they compete with one another. This is particularly evident in countries with relatively free and open trade. It is worth examining whether these smaller exporters can exercise their market power in major importing countries to gain a competitive advantage over similar countries.

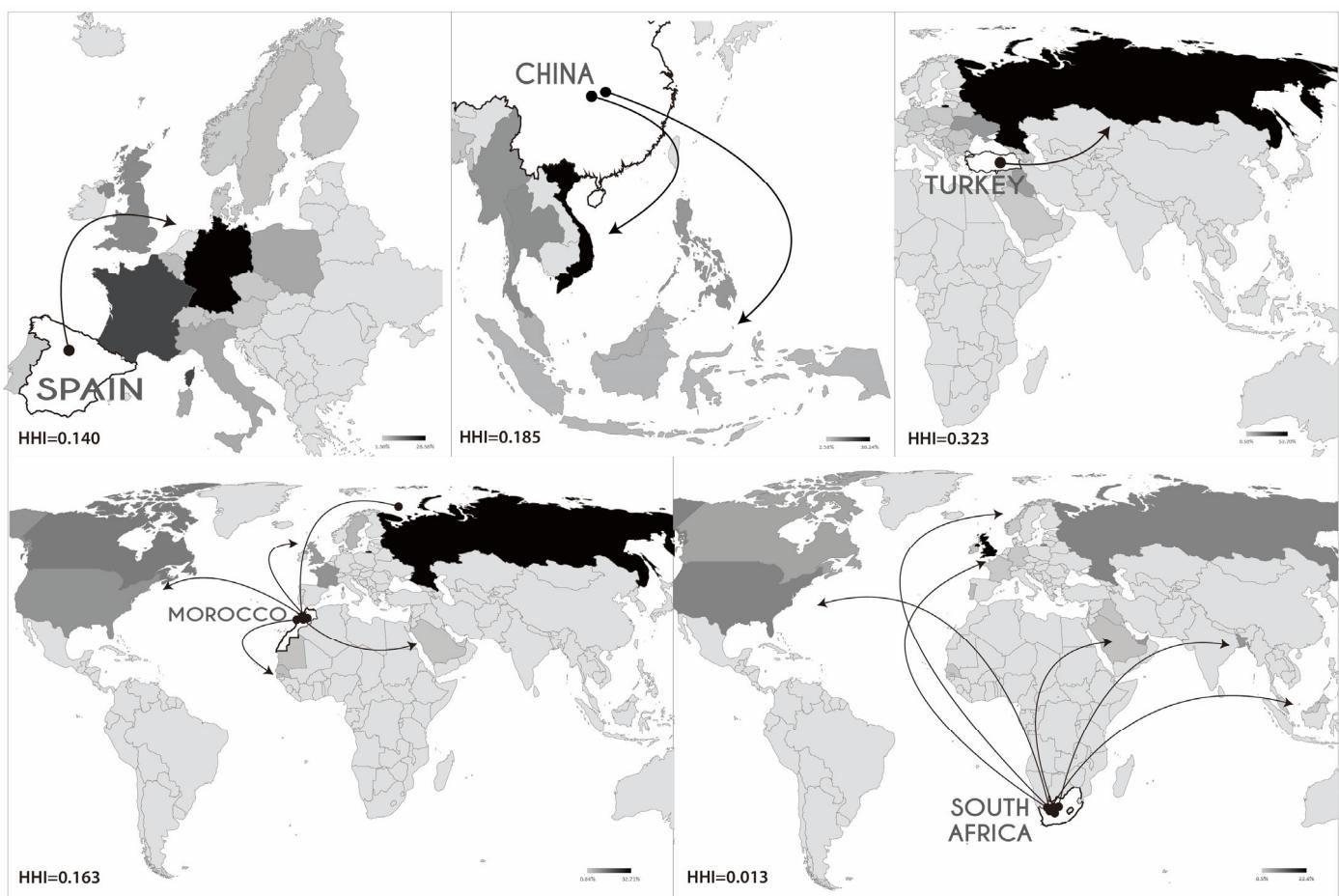


Figure 2. Target markets of major tangerine-exporting countries worldwide (2020). (Note: HHI—Herfindahl–Hirschman index).

3. Materials and Methods

3.1. Revealed Competitiveness: *RC*

Vollrath measured the relative comparative advantage of a country in exporting a target commodity compared with other trade-competing countries in the world. Under free trade conditions, RXA, RMA, and RC are proposed as alternative standards. The relevant formulae are as follows (Ferto & Hubbard, 2003):

$$RXA_{a,n}^{i,r} = \ln \left[\frac{XS_a^i/XS_a^r}{XS_n^i/XS_n^r} \right] \quad (1)$$

$$RMA_{a,n}^{i,r} = \ln \left[\frac{MD_a^i/MD_a^r}{MD_n^i/MD_n^r} \right] \quad (2)$$

$$RC = \ln RXA - \ln RMA \quad (3)$$

where *XS* represents exports, *MD* represents imports, superscript *r* refers to the rest of the world, and subscript *n* represents a commodity composite aggregate that excludes *a*. In this study, *i* represents citrus (tangerine) and *r* represents the entire fruit category.

The *RC* index is used to calculate the difference between the logarithms of each ratio. As the intervals associated with a comparative advantage are not of the same length as those associated with a comparative disadvantage, using logarithms can address the asymmetry problem. Therefore, the RXA and RMA ratios are symmetric around zero (Danna-Buitrago & Stellian, 2022).

Assessing a country's comparative advantage in global export competition can indicate its market's ability to defend itself from imports. Assuming that fair trade exists, when a country is relatively more export-competitive, its products are close to the prices displayed in the international market. The premium charged for imported products above the displayed price was relatively low.

3.2. Market Power of Residual Demand

In a perfectly competitive market, individual firms are price takers, and they set prices based on marginal costs and lack the market power to influence prices. By contrast, firms can demonstrate pricing dominance in an imperfectly competitive market setting, thereby owning market power. Market power is defined as a firm's ability to charge a price above its marginal cost (Go & Lau, 2024).

Goldberg and Knetter pointed out that a residual demand curve for a country (market) can be derived from the difference between market demand and the supply curve at the edge of competition (Gafarova et al., 2023; Silveira & Resende, 2020; Son & Lim, 2019; Sun & Zhou, 2018). The exporting country can achieve a larger price difference if the curve is steeper, indicating lower elasticity. Therefore, the export source country's market power can be described by measuring the inverse of the residual demand elasticity (i.e., price elasticity) (Alamri & Saghafian, 2016; Uhl et al., 2019; Wan, 2017; Yan et al., 2023).

According to the GK model, assuming that a group of exporters wants to sell a homogeneous product to another foreign country through free trade, the demand function of the exporting country and its competitors can be expressed as follows:

$$p^k = D^k(q^k, Q^{-k}, P^j, P^{ex}, Z) \text{ where } j = 1, \dots, n \text{ and } j \neq k \quad (4)$$

The inverse demand function is $p = p(Q, Z)$, where Q is the quantity of output and Z is a vector of exogenous variables, such as income and the price of substitutes, which affect the industry demand curve but do not affect the product's marginal cost. In international markets, exchange rate fluctuations provide an ideal cost-shifting tool for identifying residual demand, which is a variable that measures competitors' relative costs. The trading price of goods in the importing country is the importing country's quotation of the exporting country's cost plus the freight adjusted by the exchange rate between the currencies of the two trading countries against the USD at that time. In any destination market, the first-order condition for exporter profit maximization implies that marginal cost equals the marginal revenue (Go & Lau, 2024):

$$p^{ex} = e \cdot MC_i^{ex} - q_i^{ex} \cdot D_1^{ex} \cdot \theta_i \cdot \phi \quad (5)$$

where p^{ex} is the marginal cost expressed in the currency unit of the export destination country, which represents the competitive behavior among domestic exporters. e is defined as the exchange rate. C is the cost in monetary units of the original export count. MC_i^{ex} is the marginal cost expressed in the currency unit of the country of origin, and $MC = g(Q, w)$, where w is a vector of exogenous variables—such as factor prices that affect marginal costs but not the demand function. D_n represents the partial derivative of the demand function concerning the n -th variable. θ represents the competitive behavior of each exporter in the source country. ϕ represents the competitive interaction between firms in the source country and foreign producers.

$$\ln p_{mt}^{ex} = \lambda_m + \eta_m \ln Q_{mt}^{ex} + \alpha_m \ln Z_{mt} + \beta_m \ln W_{mt}^N + \varepsilon_{mt} \quad (6)$$

Here, t represents the time, and ε is the random error term.

The residual demand function is $p_i = p(q_i, Q_{-i}, Z)$, and Q_{-i} is the output vector of all possible substitutes for q_i , including the output of all other firms in the industry and the possible output of some other industries; moreover, the output demand of any other firms can be expressed in the same manner. The absolute value of the coefficient indicates the size of the export country's market power. The larger the absolute value, the stronger the firm's ability to raise the price of its products above the marginal cost—that is, the stronger the profitability of dominating the market. Table 2 lists the model variables and data sources proposed in this study based on these observations.

Table 2. Variables type, symbols, and sources.

Variable Type	Variable Symbols	Variable Name	Data Sources
Dependent variable (y)	p_{it}^j	Import value (unit: 1000 USD/ton)	FAOSTAT database, calculations given
Core variables	Q_{it}^j	Import quantity (unit: ton)	FAOSTAT database
	RQ_{it}^j	The country's total import minus that of the importing country	FAOSTAT database, calculations given
Demand variable (Z_{it})	GDP_{it}	GDP per capita (constant 2015 USD) of the importing country	World Development Indicators
	PP_{it}	Domestic total population	World Development Indicators
The cos t transfer vector (W_{it}^j)	CPI_{kt}	Consumer price index (2010 = 100) for export-competing country	World Development Indicators
	ER_{kt}	Real effective exchange rate index (2010 = 100)	World Development Indicators
Other control variable (X_{ijt})	LC_{it}	Official exchange rate (LCU per USD, period average)	World Development Indicators
Time (T)	T	Time dummy, 2008 = 0, 2009 = 1, ...	Dummy

Note: The product item is "tangerines, mandarins, and clementines."

The residual demand function to be tested is expressed using Equation (7):

$$\ln p_{it}^j = \lambda + \eta \ln Q_{it}^j + \alpha \ln Z_{it} + \theta \ln W_{kt} + \beta \ln X_{ijt} + \delta T + \varepsilon_{ijt} \quad (7)$$

where subscript i represents the tangerine-import market, superscript j represents the tangerine-export market, and subscript t represents time. Due to the use of double logarithmic form, the coefficient η can be directly interpreted as the residual demand elasticity of the exporter's products in market j —that is, the market power. In the case of a non-perfectly competitive market, the expected sign of the coefficient η is negative. The flatter the elasticity of the residual demand curve, the lower the price–marginal-cost difference; conversely, the steeper the residual demand curve, the greater the market power of the exporting country—that is, the stronger its ability to raise the product price above the marginal cost and profit from it. A value of zero, or a value that is infinitely close to zero, means that the exporting country has no market power. α is the demand variable coefficient, θ is the price conversion variable coefficient, β is the real effective interest rate coefficient, and δ is the time coefficient.

3.3. Data Source

Considering the impact of the 2008 financial crisis on the trade purchasing power of countries worldwide, this study compiles international trade data from 2008 to 2021. We used data from all countries and regions that import and export tangerines, mandarins, clementines (HS08052100), and domestic fruits (HS08), which were obtained from the World Development Data Bank and the FAOSTAT database as secondary data.

4. Results

4.1. Relative Trade Competitive Advantage

As the above data show, countries that export citrus do not necessarily have the conditions for citrus production. Countries that import citrus also have export markets, which indicates that, in the international market—in addition to some countries with large trading volumes—there are still many trade opportunities for developing small-scale exporting countries with limited international marketing resources.

The RXA measures the proportion of a country's citrus exports relative to its total fruit exports and the corresponding exports worldwide. The RMA is the ratio of global imports. The RC index is the difference between the logarithms of the RXA and RMA. A positive RC value indicates that imports have a greater comparative advantage than exports. Therefore, this study uses the RC value to estimate the relative trade competitiveness of citrus-importing countries.

Statistical analysis revealed that 95% of the world's citrus import value comes from transactions in 40 countries and regions. This distribution is mainly concentrated in Europe, the United States, and Canada in North America, as well as in cross-continental Russia and two countries on the Arabian Peninsula in West Asia, inland Central Asia, and East Asia. Considering the vast impact of COVID-19 on the agricultural product trade system since its global outbreak in 2018, the average RC value was estimated for 2008–2018 (see Figure 3).

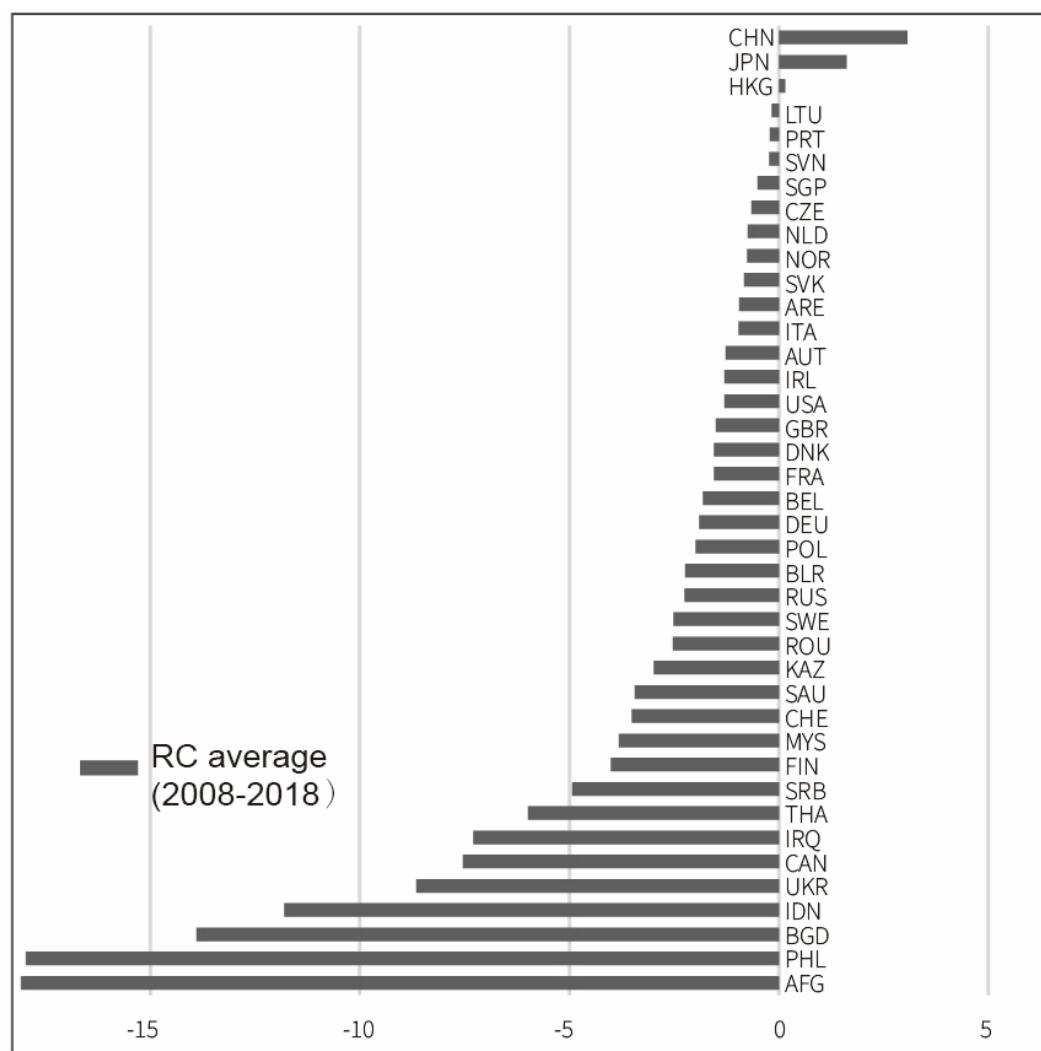


Figure 3. Import market RC average values for the period 2008–2018.

CHN, JPN, and HKG are the only three importing regions with an average $RC > 0$ ($RC = 3.07, 1.62$, and 0.15 , respectively). Although important market opportunities still exist, the region's export RXA is greater than its import RMA, implying that its import advantage is greater than its export advantage. Among them, China is the leading citrus-producing country (tangerine production accounts for 53% of the world's production), and Japan produces tangerines domestically (accounting for 2.64% of the world's production). The average RC values of the remaining 37 importing countries range from -0.17 to -18.10 .

The average RC values of the Asian importing countries, IDN, BGD, PHL, and AFG, were lower than -10 , with average RC values of $-11.81, -13.90, -17.98$, and -18.10 , respectively. Trade demand is the demand of an importing country relative to its trade competitiveness. Among the four importing regions, only IDN did not produce tangerines locally.

Russia has the highest citrus import share in the world, with an MS import share of 13.89% and RC value of -2.26 . France, Germany, the United States, and the United Kingdom have the second-largest shares of citrus imports at 9.78%, 9.77%, 7.85%, and 7.77%, respectively. These four importing regions are also exporters, and their relative trade competitiveness RC averages are $-1.55, -1.90, -1.30$, and -1.50 , respectively, indicating a comparative advantage over imports.

In summary, RC provides an overview of the relative trade advantages of citrus imports and exports worldwide. The addition of value to agricultural products during trading affects the selection of target markets (Bojne & Ferto, 2016). However, bilateral trade relations are often asymmetric in terms of price and volume, and because of dynamic supply and demand conditions, they often show consistent trade directionality. Therefore, gaining a deeper understanding of the attributes and characteristics of importing countries is necessary to identify niche markets that are suitable for developing exporting countries with different export supply conditions.

4.2. Heterogeneous Segmentation Variables of Potential Markets

The aforementioned 40 countries/regions account for 95% of the world's citrus imports. They should be considered target markets for any country with citrus export capacity seeking sustainable product demand. Therefore, we can conduct a market assessment based on the relevant socioeconomic data of these countries to determine whether they have comparative export advantages. Fader et al. (2013) used dynamic global vegetation and water-balance model simulations. They found that 16% of the world's population (950 million people) met their demand for agricultural products through international trade, suggesting that population growth significantly influenced international trade. Land area is a market indicator that affects international trade in agricultural products, and growth in the market size of an importing country also affects agricultural trade flows. Its gross domestic product per capita (GDP) can be considered a proxy variable for national factor endowment to analyze the country's purchasing power (Mizik, 2021).

Based on the above, this study conducted a cluster analysis based on three areas: (a) the market size of the importing country, measured by population and land area; (b) adequate purchasing power, measured by GDP; and (c) the trade competitiveness of agricultural products, measured by RC , as a variable for heterogeneous grouping.

Clustering is an unsupervised technique that groups elements into clusters, where elements within a cluster are highly similar and those belonging to different clusters are highly dissimilar (Asgharizadeh et al., 2019; Bai et al., 2016). Algorithmic partitioning is a soft clustering technique based on the minimization criterion and the minimization of an error function. The advantage of FCM is that it can form new groups from data points with

close membership values in existing categories. It has been applied in many fields and has become a popular research tool (Chi et al., 2023; Nayak et al., 2015).

Considering the applicability of World Bank and FAO data, this study analyzed 40 trading entities with the most significant global citrus import trade value from 2008 to 2021. Based on the grouping diagnosis provided by k-means clustering, the four most suitable clusters for analysis were selected in advance. Countries in the same cluster have similar citrus import market conditions, which provides a reference for small-scale exporters to evaluate citrus target markets, narrow down feasible targets and market scopes, and conduct effective marketing.

The competitiveness of each cluster can also be further understood using RC values (see Table 3). The RC values for the 11-year average (2008–2018) and 2021 for all clusters are negative, indicating that each group's citrus import trading entities are weakly competitive and that exports are not competitive, which aligns with the country's trade orientation towards imports. Based on the average value, the degree of disadvantage was ranked from light to heavy, as A, C, B, and D, and the standard deviation (SD) of each group was consistent with the average. Group A had the smallest SD, whereas Group D had the largest SD. Group A, which was mainly composed of European countries, had an RC value close to zero, indicating that these countries had no competitive advantage in citrus exports during this period. The variance is insignificant, indicating that the import market within the group is relatively stable. Cluster D had the most negative RC value, indicating that it did not have a competitive advantage in exporting citrus fruit.

Table 3. Statistical values of the RC index for each cluster (2008–2018).

Cluster	Mean	SD	Max	Min	RC 2021
A	−0.83	0.53	−0.49	−1.32	−0.87
B	−2.03	2.37	−0.97	−4.35	−2.08
C	−1.75	1.48	−0.85	−2.87	−1.62
D	−11.96	4.93	−3.69	−18.65	−11.77

The RC variation values of the countries in the group also vary significantly, and changes in indicative export disadvantages are noticeable. This indicates that their domestic production and sales markets may not be very stable, implying a specific risk of quantitative fluctuation. The differences are statistically significant. When examining the standard deviation of the competitiveness RC value for each group, the order from smallest to largest is consistent with the average value.

To further illustrate the relationship between the RC statistics in each cluster and its geographical location, Figure 4b shows the location of the world's prominent citrus-importing countries in Central and Western Europe, along with the A, B, and C clusters to which they belong. They can be characterized by smaller land areas and proximity to the sea, including the Netherlands, Belgium, Austria, the Czech Republic, and other inland Central European countries; moreover, these countries belong to Group A. Six countries are categorized into Group C, and they are located in the mountains or across the sea because of natural conditions, including Switzerland, the Scandinavian countries in Northern Europe, and Ireland. Other countries such as France, Germany, the United Kingdom, Italy, and Portugal, as well as eight other countries, belong to Group B.

The citrus import patterns of major Central and Western European countries can be roughly divided into the above three groups based on population, income (consumer purchasing power), land area, and the advantages and disadvantages of citrus export competitiveness.

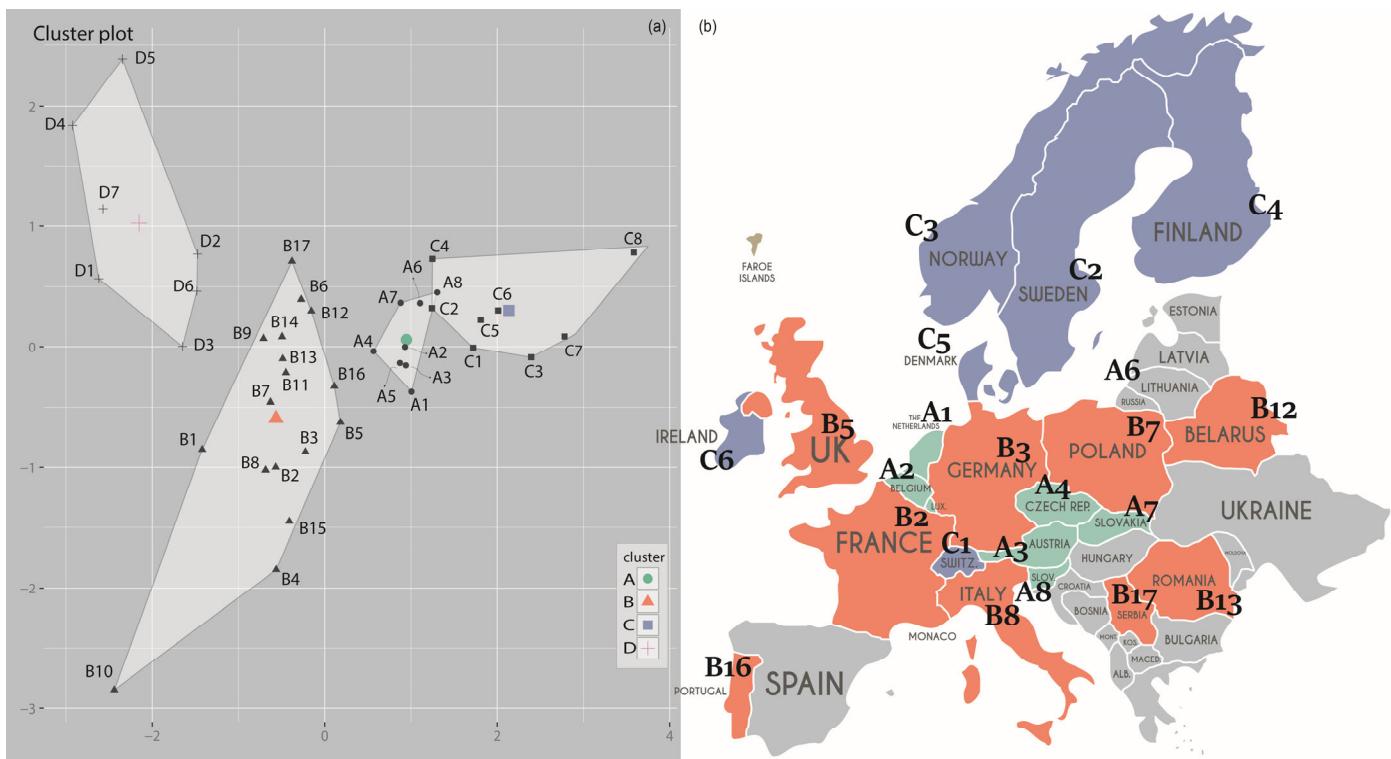


Figure 4. Cluster distribution of the top 40 major citrus importers in the world. (Note: (a) shows the FCM results using R, and (b) shows the locations of Central and Western Europe and the clusters—A, B, and C—to which they belong).

4.3. Empirical Tests and Analysis of RDE

Estimating market power in surplus demand mainly involves endogeneity between the cost conversion of production factors and the oligopolistic characteristics of the different competitors. Many studies use the IV approach to address endogeneity. The generalized method of moments (GMM) is an analysis method for related RDE models that uses moment conditions and instrumental variables to provide consistent and valid parameter estimates, combining the observed economic data with the information in the overall moment conditions to estimate the unknown parameters of the economic model (Felt et al., 2011; Go & Lau, 2024; Pall et al., 2014). We applied a generalized method of moments estimator to estimate the econometric model using EViews version 12.

The results showed that the Netherlands and the U.K. exhibit a good mix of models, with adjusted R-squared values of 0.522 and 0.889, respectively, and the USA had a value of 0.304. In Equation (7), the η elasticity of the exporter's (i.e., South Africa's) residual demand in the citrus market of the target country is consistent with economic theory, as the symbol of the three countries is a negative value. These results are significant, indicating that these three countries belong to a non-perfectly competitive market (Figure 5). Despite Moroccan competition, South Africa has market power over prices in all three importing countries, with South Africa having the lowest residual demand elasticity in the U.K. (-0.470). This means that South African importers have more market power in the U.K. than in other competitors, followed by the USA (-0.358) and the Netherlands (-0.292). This means that South Africa can increase profits by adjusting the prices in the citrus markets of these three countries (Wang et al., 2023). When the import market space after deducting its import volume increases, the import price can be increased in both the USA and U.K. markets, but the market of the Netherlands shows a decrease. However, this value is low, echoing South Africa's relatively low market power.

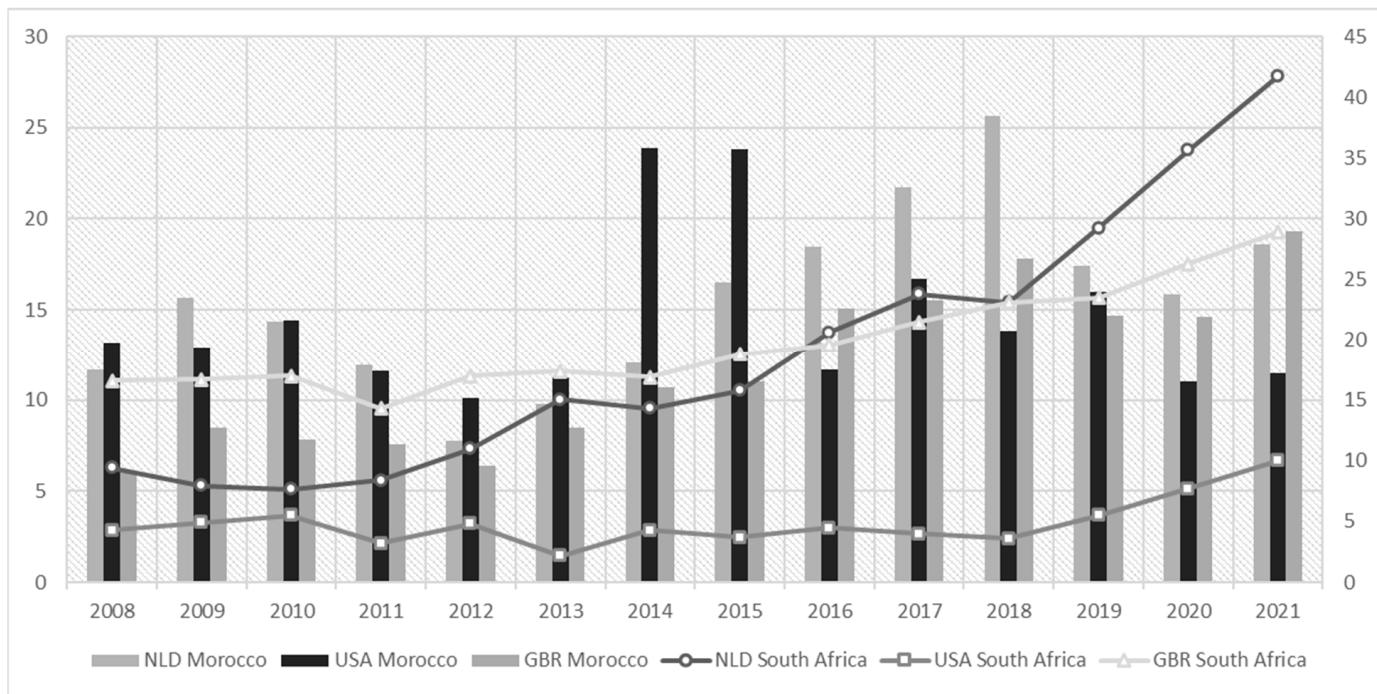


Figure 5. Market shares of South African and Moroccan tangerine in three countries.

On the demand side, only the gross domestic product (GDP) coefficient for the United States was positive and significant (2.426), indicating that the economic growth of the United States during the study period resulted in an increase in income and the consumption of citrus, which was also related to an increase in the price of citrus imports from South Africa. The effect of population on prices is divergent in the Netherlands and the United States, where the same population increase caused a decrease in the price of citrus imports from South Africa. However, in the USA, the same factors contribute to the prices of the same commodity.

On the cost side, the consumer price index of a competitor country indicates the country's cost-of-living pass-through factor, which indicates whether the product offered by the exporter is a complete or incomplete substitute. A positive coefficient indicates that the competing importing country offers the perfect alternative. Morocco's consumer price index (CPI) of export competitors from 2008 to 2021 was statistically significant only for the U.K., with a positive coefficient value (0.047), indicating that competition in the U.K. constrains South African importers. In other words, the cost increase observed for the competitor (Morocco), as shown by its cost transfer factor, means that the exporting countries of interest can charge higher prices. The demand in Morocco affects the price of South African citrus exports to the United States and the United Kingdom. However, the impact was limited because the coefficient value was insignificant.

The results of this study echo Goldberg and Knetter's proposal that the exchange rate is an ideal instrumental variable for the cost transfer of competing exporters and that the expected sign of the exchange rate is negative, indicating that a competitor's currency appreciation will increase the cost of the competitor in the destination market. The results show that the exchange rate of the competitor country (Morocco), with respect to the three target markets, is statistically significant, with the Netherlands (-1.096) and the United Kingdom (-0.766) being negative and the United States (3.747) being positive.

In terms of other control variables, a significant negative correlation is observed between the real effective exchange rate of the USD against competing exporters (Morocco) and the import prices of the Netherlands and the United Kingdom, indicating that these

two countries' trade markets are relatively open. The coefficient values of the time trend variables in the Netherlands and the United States were statistically significant. However, the price of imports to the Netherlands is increasing annually, whereas imports to the United States are decreasing. (see Table 4)

Table 4. Market share changes in the main import source countries (unit %).

Destination	Exporting Country	2008	2010	2012	2014	2016	2018	2020	2021
NLD	South Africa	9.4	7.66	10.97	14.3	20.62	23.14	35.67	41.72
	Morocco	11.68	14.35	7.74	12.1	18.47	25.64	15.84	18.57
	Peru	5.83	6.45	9.62	8.64	7.73	9.95	10.61	11.91
	Spain	41.07	41.65	42.74	39.97	33.38	15.86	14.54	9.76
	Others	32.02	29.89	28.93	24.99	19.8	25.41	23.34	18.04
USA	Chile	14.7	25.2	37.1	29.6	41.4	48.3	44	46.4
	Peru	7.9	10.4	12	16.8	19	19.7	26.3	21.4
	Morocco	13.2	14.4	10.1	23.9	11.7	13.8	11	11.5
	South Africa	4.3	5.5	4.8	4.3	4.5	3.6	7.7	10
	Spain	48.3	38	30.7	18.2	8.7	3.4	0.1	0.1
	Others	11.6	6.5	5.3	7.2	14.7	11.2	10.9	10.6
GBR	Spain	46.5	43.8	48.4	45.4	44.1	38	37.7	33.8
	South Africa	16.6	17	17	16.9	19.6	23.1	26.3	28.9
	Morocco	6.1	7.8	6.4	10.7	15.1	17.8	14.6	19.3
	Peru	5.4	5.6	8.5	8.4	8.4	10	8.1	10.4
	Others	25.4	25.8	19.7	18.6	12.8	11.1	13.3	7.6

5. Discussion

5.1. Grouping the Revealed Competitiveness Index and Its Implications

This study drew on the K-line chart (also known as the candlestick method), which was adopted in investment technique analyses to represent the change in RC from 2008 to 2018 relative to the value in 2021, thus representing changes in countries' imports over the years (see Figure 6). Each country's K-line has four data points: the 11-year average, minimum, maximum, and 2021 values. Vertical lines represent the 11-year minimum and maximum values. The 11-year average and 2021 values were considered the opening and closing prices, respectively, and the difference between them was regarded as the direction of subsequent market trends. When the 2021 value is higher than the average value, it is indicated by a long white bar. The longer the bar, the more limited the country's scope for citrus imports because of its competitive export advantage. This indicates that the country's likelihood of importing citrus fruit is diminishing. Conversely, when the RC value for 2021 is lower than the average value, a long black bar is used to indicate that the country's exports are not competitive. The longer the bar, the greater the competitive disadvantage in exports, and the greater the likelihood of importing citrus.

After clustering, the countries included in Cluster A (except for the United Arab Emirates) are all members of the European Union, and most of them have small land areas and higher incomes. It can be observed from the K-line that the RC values of the countries in this group are relatively stable and have not changed significantly, except for the increase in the export competitive advantage of A5 (the United Arab Emirates). The average RC of China and Japan in Cluster B is positive, indicating that they have similar import market attributes after considering population, GDP, and geographical land area.

In addition to Hong Kong and Singapore, which are located in Southeast Asia, the remaining five countries in the C cluster are located in Europe, primarily in the Nordic countries. The export competitive advantage countries are also relatively stable. In addition (except for Ukraine), the eight trading entities in cluster D are all distributed in West Asia and Southeast Asia, which belong to the United Nations classification of developing and

low-development countries. All countries exhibit noticeable changes, indicating that the countries in this cluster may have unstable market supply and demand, coupled with the relatively low income level of such countries, indicating that the average purchasing power may be insufficient and perhaps that more caution in the consideration of the target market is needed.

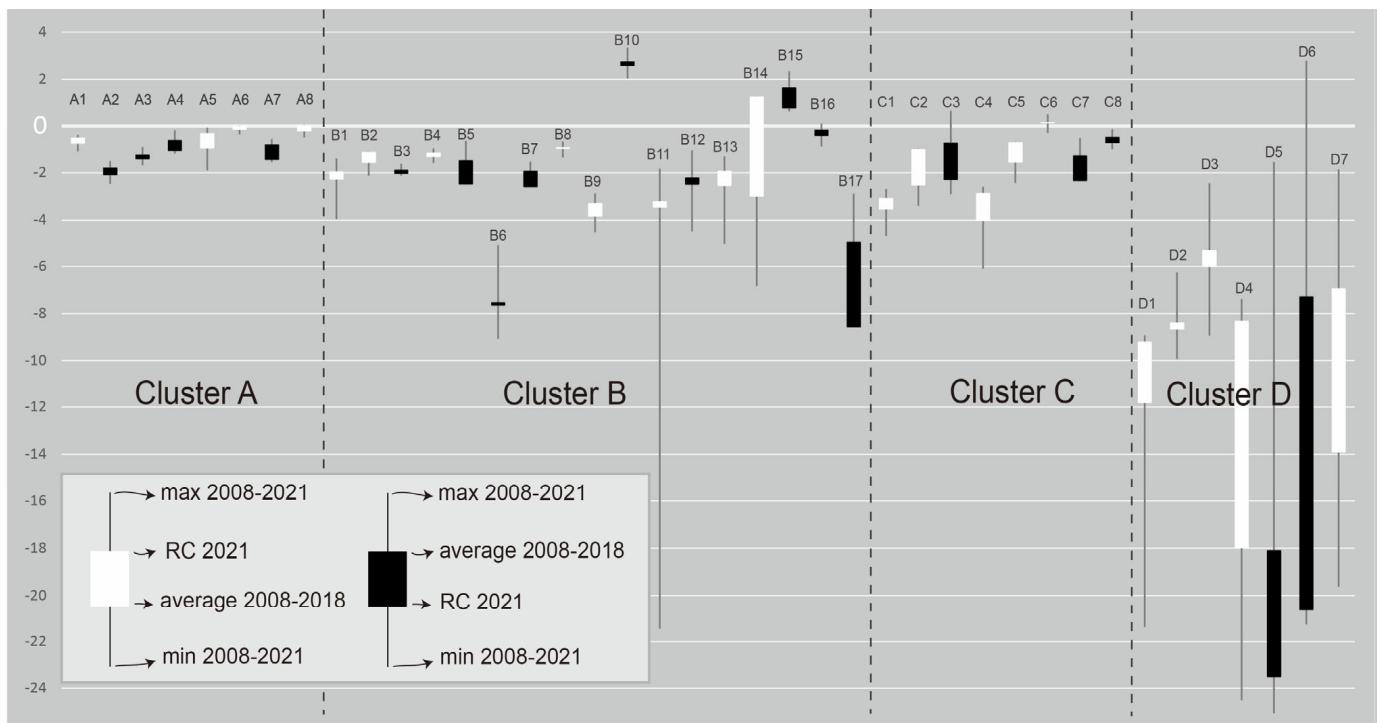


Figure 6. K-line plot of RC values for countries within each cluster. (Note: Each country has four data points: the average value over 14 years, the lowest value, the highest value, and the current year value in 2021. The vertical lines represent the lowest and highest values in the 14 years studied; and the 14-year average and 2021 values are the opening and closing prices, respectively).

The longer the difference between the maximum and minimum values of the period (i.e., the length of the corresponding straight line for each country), the more extensive the monthly observation of market movement. The seven countries in Group D showed significant changes from 2008 to 2018. Among them, five countries, D1 (Indonesia), D2 (Ukraine), D3 (Thailand), D4 (Philippines), and D7 (Bangladesh), showed enhanced competitive advantage, particularly in the Philippines and Bangladesh, and their export competitive advantage values increased significantly. Afghanistan (D5) and Iran (D6) have decreased their export competitive advantage, and the decline in export advantage also implies the possibility that imports may gain an advantage in the domestic market, resulting in a possible increase in the market share of imports. However, the RC values of the countries in this cluster change significantly, indicating that there may be an unstable supply and demand in the markets of this cluster. Therefore, there will likely be a market space opportunity for immediate import demands in the short term. However, there may also be the risk that opportunities will disappear in the next season. Thus, once residual market demand occurs, an opportunity for exporting countries to increase domestic exports and enter new markets arises.

This result also occurred in B14 (Kazakhstan) and B17 (Serbia), where clustering was applied to the B-type clusters. Compared to the average values in 2021 and 2008–2018 after the epidemic, a significant gap was found between different levels and the high and low values, indicating that the citrus import market in these countries was significant. However,

conditions such as income and the scale of fruit production and marketing have changed significantly, resulting in drastic changes in RC. However, seven of the eight countries in Group A are Central and Northwest European countries, which are characterized by small land areas and high income. It can be observed in the K-line that the RC of the countries in this group was relatively stable during the year, with few changes, indicating that the import volume and export trade were relatively stable.

5.2. Empirical Analysis of Market Power

According to Vollrath, a country's comparative advantage in exporting a target commodity relative to other global trade competitors under free-trade conditions provides new market opportunities for small-scale agricultural economies. However, demand-oriented market development also appears to influence consumer countries' prices and the quantity of traded goods.

As the global trade market becomes more open, the success of agricultural products entering new markets often depends on enterprises' ability to compete with existing suppliers for consumers at market prices (Bojneč & Ferto, 2016; Felt et al., 2011). The development of demand-oriented markets also results in the apparent influence of purchasing consumer countries on the prices and quantities of traded goods. The GK model proposes a framework for segmented export market competitiveness, indicating that the elasticity of residual demand determines exporter competition intensity. In other words, the differences in residual demand in different export destination markets are more likely to be a result of the availability of alternative supplies rather than the differences in the elasticity of market demand.

There is a correlation between the elasticity of the surplus demand curve and exporters' market power, as measured by the price–cost differential. If the exporter is completely restricted in exercising market power because of the presence of competitors, the residual demand curve will be completely flat, indicating a zero markup. In this case, the price charged by the group of exporters does not depend on its volume but is entirely determined by competitors' prices.

Table 5 summarizes the RDE analysis of South African citrus exports to the three target markets, along with the market share of competing exporters, Morocco, and other competitors. The estimates of the elasticity of residual demand measure the degree of external competition, with higher absolute values indicating greater elasticity and market power and a higher ability for South African exporters to increase prices.

Table 5. RDE analysis of South African citrus exports to target markets.

Destination	Residual Demand Elasticity	South Africa's Market Share (2021)	Morocco's Market Share (2021)	Other Competitors (2021)
NLD	−0.292	41.7	18.6	Peru (11.9), Spain (9.8)
USA	−0.358	10.0	11.5	Chile (46.4), Peru (21.4)
GBR	−0.470	28.9	19.3	Spain (33.8), Peru (10.4)

According to the U.K. equation, the results indicate that South African exporters possess considerable market power, with markups that approximate the elasticity of residual demand—higher than those for exports to the Netherlands and the USA. Their market pricing power is less constrained by their competitor, Morocco, as evident from Table 6, which confirms the year-on-year increase in South Africa's market share in the U.K. The import price exceeded that of the competitor ($1.365 > \text{USD } 1.009 \text{ thousand/mt}$). A similar pattern is observed in the Netherlands, where South Africa has a higher market pricing power ($\text{USD } 1.330 > 1.141 \text{ thousand metric tons}$) and a higher market share than Morocco.

Table 6. Generalized method of moments results on the full sample.

Destination	NLD		USA		GBR	
Variable	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
$\ln Q_{it}^j$	−0.292 **	−2.926	−0.358 ***	−5.769	−0.470 **	−2.935
$\ln RQ_{it}^j$	−0.189 *	−2.143	1.172 ***	5.976	0.301 ***	5.229
$\ln GDP_{it}$			2.426 **	2.897		
$\ln PP_{it}$	−21.322 **	−4.547	33.420 **	4.033		
$\ln CPI_{kt}$			0.021	0.797	0.047 ***	6.218
$\ln ER_{kt}$	−1.096 **	−4.627	3.748 ***	5.471	−0.767 **	−2.709
$\ln LC_{it}$	−1.507 **	−4.783			−0.469 **	−3.009
Time	0.181 **	4.613	−0.353 ***	−4.240		
Adj.R ²	0.522		0.304		0.889	

Note: *, **, and *** represent coefficients that are significant at the 10%, 5%, and 1% levels, respectively.

More interestingly, in the United States, South Africa's share of the USA market in 2021 was only 10% lower than that of its competitor (Morocco) and other major competitors. Although this study shows that South Africa had some influence, the share price did not increase ($1.268 > 1.594$ thousand USD/metric ton), indicating the real impact of exchange rate fluctuations on competing countries.

6. Conclusions

Given the complexity of agricultural competitiveness (Bahrami et al., 2023), the BAL-ASA index (Rousseau, 2019) and the logarithmic application of Vollrath's framework (Danna-Buitrago & Stellian, 2022)—which are both single-index rankings—cannot easily explain the multidimensional nature of trade flow.

This study contributes to the literature by analyzing the multipoint hierarchical state and trade competitiveness of global citrus production and trade based on Vollrath's explicit competitive advantage index framework, which differs from the index rankings utilized in previous studies.

The two main contributions of this study are as follows: First, cluster analysis was employed to categorize objects with similar attributes into the same subset, thereby facilitating the interpretation of the information and applications contained in the index. Second, market power was employed to empirically analyze the market price in the surplus demand market of second-tier supplier countries, with respect to the markets of major importing countries. The results of this study confirm that the market share of South African citrus in the Netherlands, the United States, and the United Kingdom is low. However, for all of these countries, it was found that the residual elasticity of demand is negative, indicating that South African exporters influence all three markets and significantly affect the prices of Moroccan products.

In practice, this approach can help exporting countries to access new markets, especially ones that have market mobility but a limited supply scale. It is advantageous for second- and subsequent-tier countries to find markets where they can promptly export fresh fruit and generate revenue before its quality deteriorates (Chi & Chien, 2023; Roosta et al., 2017). Exporting countries can utilize the framework model established in this study to evaluate the most suitable niche market according to favorable conditions, serving as a reference for export targets and informing effective marketing strategies. Through market residual demand elasticity, we found that, among the two second-tier citrus-exporting countries considered, the competitive behavior of residual demand among the major trad-

ing market countries is still quite obvious, and changes in the competitiveness of these countries can also be effectively analyzed.

Future research could explore how exporting countries might use the market classification groups proposed in this study to identify and enhance their competitive advantage based on their terms of trade and product characteristics. This includes strategies for mitigating the impacts of climate change on the quality and quantity of exported agricultural products, meeting the off-season demand for fresh fruits in various countries, and developing advanced cold chain technologies to establish competitive models with consistent price influence. Due to the volatility of the global political and economic situation, it is essential to adjust the framework model established in this study when a country encounters sudden changes in foreign trade policies, such as shifts in tariff barriers.

Author Contributions: Conceptualization, S.-Y.C. and L.-H.C.; methodology, S.-Y.C. and L.-H.C.; software, S.-Y.C. and L.-H.C.; investigation, L.-H.C.; resources, C.-C.C.; data curation, S.-Y.C. and C.-C.C.; writing—original draft, S.-Y.C. and L.-H.C.; writing—review & editing, S.-Y.C. and L.-H.C.; visualization, S.-Y.C.; supervision, L.-H.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available on the request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

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