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ORIGINAL PAPER

Assessing the comparative advantage of Hawaii's agricultural exports to the US mainland market

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Abstract It is conventional economic wisdom that a region produces and exports products that have a comparative advantage (CA). While CA is dynamic, the common measures of CA (such as Balassa's revealed comparative advantage index and its variants) are static and not comparable over time. This paper adopts an alternate measure to assess the dynamics of CA, utilizing the normalized revealed comparative advantage (NRCA) index. By applying Hawaii's agricultural exports to the US mainland market as a case study during the period of 1995–2005, this paper illustrates how the NRCA index can systematically assess CA from three perspectives: (1) the *static CA patterns*, identifying which Hawaii agricultural products have comparative advantage; (2) the *changes in CA*, identifying which Hawaii agricultural products gain or lose CA; and (3) the *trends of CA*, identifying which Hawaii agricultural products exhibit statistically significant trends in gaining or losing CA.

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1 Introduction

Hawaii's agricultural products are generally at a competitively disadvantage position due to the high cost of factor inputs (labor, land and energy), small scale of operations,[1] and isolated geographic location. As a small isolated chain of islands, it is arguable that it makes economic sense for Hawaii to maintain its agriculture sector in the long run, despite the declining transportation costs in the past few decades. Nevertheless, agriculture remains a vital and steady contributor to Hawaii's economy. In 2005, Hawaii's agriculture sector contributed to 2.7% of total sales value, 1.7% of GDP, 3.4% of employment and 2.0% of labor income (Leung and Loke 2008). The major components of Hawaii's agriculture, however, have experienced considerable change since the 1990s. The large-scale plantation production of sugarcane and pineapple, which used to be Hawaii's dominant agricultural crops, has been declining for several decades. It is estimated that during the period of 1997–2005, total production value of sugarcane and pineapple declined at an annual rate of 4.6% and 1.8%, respectively (Leung and Loke 2008). The number of sugarcane plantations dropped from 55 units producing 6.5 million tons of cane in 1990 to only two operations producing 2.1 million tons of cane in 2002 (Cai and Leung 2004). The land used for pineapple cultivation declined from 22,000 acres in 1993 to 14,000 acres in 2005. Diversified crops such as vegetables, melons, flowers, coffee, macadamia nuts and seed crops, on the other hand, have become the mainstay of Hawaii's agriculture. Sales value of diversified agriculture constituted over 70% of Hawaii's total farm production in 2005 (Leung and Loke 2008).

As Hawaii's agriculture enters a new era of diversification, conventional economic wisdom would suggest that Hawaii's farmers should utilize scarce resources to produce agricultural products that have a comparative advantage, i.e., Hawaii products that are relatively more competitive and stand a better chance to survive and thrive in the long run. However, comparative advantage (CA) is dynamic. The historical trajectory of CA is thus a more meaningful way of illustrating the CA situation. Unfortunately, conventional measures of CA (such as Balassa's revealed comparative advantage (RCA) index and its variants) are static and not comparable over time. Hence, they are not suited for assessing CA over time (Yu et al. 2008a).

In this paper, we adopt the normalized revealed comparative advantage (NRCA) index proposed by Yu et al. (2008a) as an alternate measure to systemically assess the CA situation of the major Hawaii agricultural products destined for the US mainland market during the period of 1995–2005. In particular, we are interested in determining if the major Hawaii agricultural products are gaining, losing, or maintaining their CA in the US mainland market. The assessment results from the NRCA index are consistent with the findings from the previous studies on Hawaii's agriculture (e.g., Cai et al. 2007; Yu et al. 2008b). It confirms that during the period of 1995–2005, Hawaii's diversified crops such as coffee, seed corn, and dendrobiums have exhibited significant trends in gaining CA in the US mainland market, while the traditional sugarcane and

[1] An important feature of Hawaii's diversified agriculture is its dominance by small farms. According to the 2002 Census of Agriculture (United States Department of Agriculture (USDA) 2003), 63% of farms in Hawaii are less than 10 acres in size compared to only 8% for all of the US.

pineapple products have exhibited significant trends in losing CA. This understanding helps to identify, for example, the agricultural products in which Hawaii stands a better chance to thrive in the long run.

While the NRCA index has been shown theoretically comparable over space and time, this is the first empirical application. This paper provides a case study illustration on how a systematic assessment of CA can be conducted, using the NRCA index. The remaining paper is organized as follows: Sect. 2 introduces the NRCA index and the regression model for detecting the CA trend; Sect. 3 describes the data; and Sect. 4 presents the results of the CA assessment; Sect. 5 highlights the advantages of the NRCA index in comparison to Balassa's index; Sect. 6 suggests possible extension of the present study and concludes the paper.

2 Method

Comparative advantage is generally not directly observable. The "revealed comparative advantage" (RCA) index can be used to uncover the underlying CA through observable trade patterns (Balassa 1965). Ballance et al. (1985, 1986) and Bowen (1983, 1985, 1986) provided the theoretical underpinning for the RCA indices as the indirect measurement of CA by linking the RCA index to opportunity cost. Nevertheless, to trace the historical trajectory of CA, we need a RCA index which is comparable over time. Among the variety of RCA indices, e.g., the Balassas's RCA index and its variants, the normalized revealed comparative advantage (NRCA) index is the only one that has been shown comparable across space and time (Yu et al. 2008a,b). The present study is the first application of NRCA in analyzing the dynamic CA pattern over time.

Let E_j^h denotes the supply of agricultural product j in the US mainland market from Hawaii, E_j denotes the total supply of agricultural product j in the US mainland market from Hawaii, US mainland and foreign producers, E^h denotes the total supply of all agricultural products under investigation in the US mainland market from Hawaii, and E denotes the total supply of all agricultural products in the US mainland market from Hawaii, US mainland and foreign producers. According to the NRCA index, the extent of CA that Hawaii has in agricultural product j can be measured by the following formula:[2]

$$\mathrm{NRCA}_j^h = \frac{E_j^h}{E} - \frac{E_j}{E}\frac{E^h}{E} \tag{1}$$

[2] The NRCA index for the US mainland and foreign import can be constructed by a formula analogous to Eq. 1. The NRCA score indicates the extent of deviation from the average competitiveness level of the product/producer package under investigation. Hence, the choice of the product/producer package affects the NRCA score. $\mathrm{NRCA}_j^h > 0$ indicates Hawaii has comparative advantage in agricultural product j, i.e., Hawaii is relatively more competitive in this product; and $\mathrm{NRCA}_j^h < 0$ indicates that Hawaii has comparative disadvantage in agricultural product j, i.e., it is relatively less competitive in this product; and $\mathrm{NRCA}_j^h = 0$ indicates that Hawaii has neither comparative advantage nor comparative disadvantage in agricultural product j.

The NRCA index possesses two cardinal properties that are particularly desirable for a comparative study. First, the sum of Hawaii's (or US mainland's or foreign import's) NRCA scores for the set of agricultural products under investigation is constant and equal to zero, i.e., $\sum_j \text{NRCA}_j^h = 0$ (where j is an index representing the various agricultural products under investigation). This property suggests that if Hawaii gains CA in some agricultural products, it must lose CA in some other agricultural products. Hence, the change in NRCA score could reveal the shift of Hawaii's CA among the set of agricultural products under investigation. Second, the sum of the NRCA scores for a particular agricultural product is constant and equal to zero, i.e., $\sum_i \text{NRCA}_j^i = 0$ [where i is an index representing the various suppliers under investigation; i.e., $i = h$ (Hawaii), f (foreign imports) and m (US mainland)]. This property suggests that if Hawaii gains CA in a particular product, other suppliers to the US mainland market (e.g., US mainland and/or foreign import) must lose CA in this product. Hence, the change in NRCA score could also reveal the shift of CA among Hawaii and its competitors (e.g., US mainland and foreign import) in the US mainland market.

As the NRCA index is comparable over time, the change in Hawaii's CA for a particular product between 1995 and 2005 can be measured directly by the change of NRCA score between these two years. To detect the CA trend for a particular product, i.e., whether Hawaii exhibited a trend in gaining, losing, or maintaining CA in a product during the period of 1995–2005, we can use a simple time trend model as follows:

$$\text{NRCA}_{j,t}^h = \alpha_j^h + \beta_j^h t + \varepsilon_{j,t}^h \tag{2}$$

where α_j^h is the intercept; β_j^h is the slope coefficient that reveals the CA trend; t is the time index; and $\varepsilon_{j,t}^h$ is a random error term. Hawaii's CA in agricultural product j can be considered stable if the estimated β_j^h is not significantly different from zero (we use the significance level of 5%, i.e., p-value $<= 0.05$, as our cutoff point in this study). Otherwise, it would indicate some degree of instability. Specifically, $\beta_j^h > 0$ indicates a trend in gaining CA and $\beta_j^h < 0$ indicates a trend in losing CA. To detect the CA trend for US mainland and foreign import, we could simply apply a time trend model analogous to Eq. 2 to their corresponding NRCA scores.

3 Data

Besides the local market, the major destination of Hawaii's agricultural products is the continental United States. In 2005, the export value of Hawaii's agricultural products to the US mainland market reached a record high of $438 million, accounting for approximately 82% of Hawaii's total agricultural exports inclusive of the exports to foreign countries (Hudson 2007). The present assessment focuses on 11 selected agricultural products that Hawaii has a substantial shipment to the US mainland market, as well as where relevant data are available. It includes three fruit products (fresh papayas, fresh pineapples and processed pineapples), one sugarcane product (raw sugar), two tree nuts (coffee and macadamia nuts), one seed crop (sweet corn), and four floriculture products (fresh cut anthuriums, spray dendrobiums, potted orchids, and foliages). The

total sales value of these 11 products comprises over 80% of Hawaii's agricultural export value to the US mainland market. Supply to the US mainland market is decomposed into three sources: Hawaii's shipment to the US mainland, US mainland supply (equals US mainland production minus US mainland export), and US mainland import (US total import minus Hawaii's import).[3] Data on Hawaii's shipment to the US mainland market are either obtained directly from the USDA (United States Department of Agriculture) and Hawaii Department of Agriculture or derived from the annual production and export statistics published by these two agencies.[4] Data on US mainland production are from a variety of statistics published by the USDA.[5] Data on US mainland and Hawaii's exports and imports are from the State Trade Statistics published by the World Trade Atlas (2007). Details on the trade statistics for this assessment are presented in the Appendix.

4 Results

The CA situation of Hawaii's agricultural exports to the US mainland are examined from three perspectives: (1) the *static CA pattern*, identifying which Hawaii agricultural products have comparative advantage in 1995 and 2005, respectively; (2) the *change in CA*, identifying which Hawaii agricultural products gain or lose CA from 1995 to 2005; and (3) the *trend of CA*, identifying which Hawaii agricultural products exhibit statistically significant trends in gaining or losing CA during the period of 1995–2005.

4.1 Comparative advantage (disadvantage) in 1995 and 2005

The NRCA scores in Table 1 show that Hawaii in 1995 had comparative advantage in eight agricultural products, including macadamia nuts, processed pineapples, raw sugar, fresh papayas, fresh pineapples, anthuriums, potted orchids, and dendrobiums; and had comparative disadvantage in three products, including coffee, foliages and seed corn. At that time, Hawaii possessed strong CA in sugarcane and pineapple products, i.e., raw sugar (+35.58),[6] fresh pineapples (+12.19) and processed pineapples (+68.83). Moving forward to 2005, Hawaii had comparative advantage in only six agricultural products, including macadamia nuts, seed corn, processed pineapples, fresh papayas, anthuriums, and dendrobiums; and had comparative disadvantage in five products, including coffee, raw sugar, foliages, potted orchids and fresh pineapples.

[3] Possible transshipments of foreign imports from the US mainland to Hawaii are not considered in this assessment.

[4] Hawaii's shipment to the US mainland = Estimated Hawaii's total outshipment−Hawaii's export to foreign countries. Please see Appendix for more information.

[5] Data sources include various issues of Fruit and Tree Nuts Situation and Outlook, Statistics of Vegetables and Melons, Sugar and Sweeteners Outlook, Floriculture and Nursery Crops Situation and Outlook, and Agricultural Statistics.

[6] To facilitate the presentation of the results, we rescaled the NRCA scores with a constant of 10,000, which would not affect the interpretation of the results.

Table 1 Comparative advantage of selected Hawaii's agricultural exports to the US mainland market, (1995 and 2005)

Product	1995				2005				1995–2005	
	NRCA		BRCA		NRCA		BRCA		NRCA	BRCA
Papayas, fresh	19.08	(4)	5.31	(3)	7.96	(5)	1.69	(5)	−11.13	−3.62
Pineapples, fresh	12.19	(5)	2.85	(5)	−21.14	(8)	0.20	(11)	−33.33	−2.65
Pineapples, processed	68.83	(2)	2.69	(6)	22.18	(3)	1.43	(6)	−46.65	−1.26
Raw sugar, cane	35.58	(3)	1.10	(8)	−98.83	(10)	0.65	(8)	−134.42	−0.46
Coffee	−380.34	(11)	0.03	(11)	−271.23	(11)	0.20	(10)	109.11	0.17
Macadamia nuts	286.25	(1)	10.08	(1)	357.71	(1)	8.33	(2)	71.46	−1.75
Seed corn	−7.46	(9)	0.72	(9)	63.93	(2)	2.60	(4)	71.39	1.88
Anthuriums, cut	10.54	(6)	9.70	(2)	7.98	(4)	10.29	(1)	−2.56	0.59
Dendrobiums, spray	2.74	(8)	4.50	(4)	4.71	(6)	6.07	(3)	1.97	1.58
Orchids, potted	3.47	(7)	1.50	(7)	−3.81	(7)	0.83	(7)	−7.27	−0.68
Foliages	−50.89	(10)	0.26	(10)	−69.46	(9)	0.25	(9)	−18.57	−0.01

The numbers in parenthesis are the relative rank of the score
The numbers under "1995–2005" are the change of score from 1995 to 2005

The comparative disadvantage that Hawaii had in raw sugar (−98.83) and fresh pineapples (−21.14) are significant in 2005.

4.2 Change in comparative advantage between 1995 and 2005

The change of NRCA score in Table 1 between 1995 and 2005 shows Hawaii gained CA in four products, including coffee, macadamia nuts, seed corn, and dendrobiums, suggesting that Hawaii became relatively more competitive in these four products. In particular, Hawaii's CA status in seed corn increased from comparative disadvantage (−7.5) in 1995 to comparative advantage (+63.9) in 2005, indicating there is a significant improvement of competitiveness for Hawaii's seed corn in the US mainland market. In fact, seed corn has the second strongest CA among the 11 selected agricultural products, just next to macadamia nuts in 2005. Meanwhile, Hawaii lost CA in seven products, including raw sugar, processed pineapples, fresh pineapples, foliages, fresh papayas, potted orchids and anthuriums, suggesting that from 1995 to 2005 Hawaii became relatively less competitive in these seven products. As a result, Hawaii's CA status for raw sugar, fresh pineapples, and potted orchids dropped from comparative advantage to comparative disadvantage. It is clear that Hawaii lost significant CA in the traditional plantation-style crops such as raw sugar (−134.42), fresh pineapples (−33.33), and processed pineapples (−46.65), while it gained significant

Table 2 Comparative advantage trends of selected agricultural products in the US mainland market, the NRCA index, 1995–2005

Products	Hawaii			Foreign import			US mainland		
	Beta	p-value	R^2	Beta	p-value	R^2	Beta	p-value	R^2
Papayas, fresh	−0.58	0.36	0.02	5.71	0.00	0.79	−4.96	0.00	0.70
Pineapples, fresh	−2.87	0.00	0.92	15.67	0.00	0.83	−12.09	0.00	0.77
Pineapples, processed	−2.66	0.02	0.47	14.60	0.00	0.63	−11.48	0.02	0.45
Raw sugar, cane	−12.95	0.02	0.34	11.45	0.35	0.10	4.22	0.76	0.01
Coffee	15.29	0.01	0.57	−32.93	0.03	0.42	15.52	0.16	0.21
Macadamia nuts	2.81	0.41	0.08	7.57	0.03	0.42	−11.40	0.00	0.63
Seed corn	6.28	0.00	0.93	−7.44	0.00	0.80	0.66	0.48	0.06
Anthuriums, cut	−0.16	0.32	−0.03	0.22	0.04	0.38	−0.07	0.60	0.03
Dendrobiums, spray	0.15	0.01	0.53	0.00	0.96	0.00	−0.17	0.02	0.49
Orchids, potted	−2.42	0.12	0.73	−4.84	0.00	0.83	5.68	0.00	0.85
Foliages	−2.90	0.02	0.43	−10.03	0.02	0.46	14.09	0.00	0.62

Beta is the estimated slope coefficient in Eq. 2 that reveals the CA trend

CA in several diversified agricultural crops such as coffee (+109.11), macadamia nuts (+71.46), and seed corn (+71.39).

4.3 Trend of comparative advantage from 1995 to 2005

According to the trend of NRCA scores (Table 2), during the period of 1995–2005 Hawaii exhibited a significant trend in gaining CA in three products, including coffee, seed corn, and dendrobiums. This suggests that Hawaii continued to become relatively more competitive in exporting these three products to the US mainland market during this period. During the same period, Hawaii exhibited a significant trend in losing CA in four products, including raw sugar, foliages, fresh pineapples, and processed pineapples. This suggests that Hawaii has continued to become relatively less competitive in exporting these four products to the US mainland market. While the change of NRCA score indicates that Hawaii gained CA in macadamia nuts and has lost CA in fresh papayas, anthuriums, and potted orchids during the period of 1995–2005, the CA trend analysis indicates that there is no statistically significant (p-value > 0.05) declining or increasing trend of CA in these four products. It suggests that Hawaii has been able to maintain the CA status in these four products during the period of 1995–2005. In summary, during the period of 1995–2005, Hawaii has been continuously shifting its CA from the traditional plantation-style crops such as raw sugar, fresh pineapples, processed pineapples, as well as foliages to the diversified agricultural crops such as coffee, seed corn and dendrobiums.

Table 2 also presents the CA trends for the US mainland and foreign imports. The results in general are consistent with the CA trends of Hawaii's agricultural products described previously. For example, the foreign imports of fresh pineapples and processed pineapples in the US mainland market exhibited a significant trend in gaining

CA during the period of 1995–2005, while Hawaii's exports of these two products to the US mainland market exhibited a significant trend in losing CA. Again, this suggests that there is a continuous shift of CA from Hawaii's growers to foreign growers with respect to their export of fresh pineapples and processed pineapples to the US mainland market during this period. Likewise, the foreign imports of coffee and seed corn in the US mainland market exhibited a significant trend in losing CA during the period of 1995–2005, while Hawaii's exports of these two products exhibited a significant trend in gaining CA. It suggests that during this period there is a continuous shift of CA from foreign imports to Hawaii's supply in the US mainland market for coffee and seed corn. Moreover, the US mainland and Hawaii, respectively, exhibited a significant trend in gaining and losing CA for foliages during the period of 1995–2005. Once again, it suggests the shift of CA in the US mainland market for foliages is from Hawaii's production to the US mainland production during this period.

5 Discussion

The identified CA trends for Hawaii's agricultural products during the period of 1995–2005 in general are consistent with the corresponding differences of CA between 1995 and 2005. Namely, the increasing (or declining) CA trend is associated with an improvement (or reduction) of CA between 1995 and 2005. However, a positive (or negative) variation in CA (in terms of its NRCA score) does not necessarily signify an increasing (or declining) CA trend. For example, the change of NRCA score indicates that from 1995 to 2005, Hawaii has gained CA in macadamia nuts and lost CA in fresh papayas, anthuriums and potted orchids, while the CA trend indicates that Hawaii has managed to maintain its CA (i.e., no statistically significant CA trend) in these four products during the period of 1995–2005. We believe that the historical trajectory of CA reveals the actual CA situation of Hawaii's agricultural products more reliably than the simple comparison of NRCA scores between 1995 and 2005, as it accounts for annual fluctuations and could mitigate possible measurement errors in trade statistics. The NRCA index allows us to conduct such trend analyses, something we were unable to do with the traditional RCA index.

Although theoretically flawed, the Balassa's RCA index (BRCA)[7] and its variants have been used in examining the change of CA in empirical studies (Yeats 1985; Cai and Leung 2007). Some studies argued that the biases of these conventional RCA indices in measuring CA are empirically unimportant when the focus is the relative rank or the long term trend of CA (Hiley 1999; Thongdee and Kunnatee 2003). The present case study, however, indicates that the CA patterns revealed by the BRCA index differ considerably from that of NRCA scores. For example, according to the change of BRCA scores showed in Table 1, Hawaii has the greatest improvement of CA in seed corn (+1.88), followed by dendrobiums (+1.58) and anthuriums (+0.59).

[7] Balassa's RCA index (Balassa 1965) is the first and most frequently used traditional RCA index in the literature. It is defined as: $\mathrm{BRCA}_j^h = \frac{E_j^h/E^h}{E_j/E}$, where E_j^h, E^h, E_j and E are defined in Eq. 1. Though the BRCA index has been shown not comparable over time, for the purpose of comparison, we still apply a time trend model analogous to Eq. 2 to the series of BRCA index.

Table 3 Comparative advantage trends of selected agricultural products in the US mainland market, the BRCA index, 1995–2005

Products	Hawaii			Foreign import			US mainland		
	Beta	p-value	R^2	Beta	p-value	R^2	Beta	p-value	R^2
Papayas, fresh	−0.31	0.00	0.73	0.09	0.00	0.68			
Pineapples, fresh	−0.22	0.00	0.83	0.08	0.01	0.56			
Pineapples, processed	−0.09	0.00	0.70	0.05	0.02	0.50			
Raw sugar, cane	−0.04	0.01	0.58	−0.01	0.31	0.12	−0.02	0.27	0.14
Coffee	0.02	0.05	0.37	0.04	0.10	0.27			
Macadamia nuts	−0.20	0.00	0.68	0.04	0.00	0.73			
Seed corn	0.15	0.00	0.86	0.00	0.93	0.00	−0.11	0.00	0.63
Anthuriums, cut	0.01	0.86	0.00	0.00	0.41	0.08			
Dendrobiums, spray	0.07	0.21	0.17	0.00	0.86	0.00			
Orchids, potted	−0.07	0.00	0.87	0.03	0.00	0.67	−0.07	0.05	0.37
Foliages	0.00	0.20	0.18	0.01	0.01	0.51	−0.08	0.05	0.38

The BRCA score for zero supply is constant and equal to zero
The US mainland has no production of fresh papayas, fresh pineapples, processed pineapples, coffee, macadamia nuts, anthuriums and dendrobiums
Beta is the estimated slope coefficient in Eq. 2

The change of NRCA scores on the other hand indicate that Hawaii has the greatest improvement of CA in coffee (+109.1), followed by macadamia nuts (+71.5) and seed corn (+71.4). Likewise, the change of BRCA scores indicates that Hawaii has the greatest reduction of CA in fresh papayas (−3.62), followed by fresh pineapples (−2.65) and macadamia nuts (−1.75), while the change of NRCA scores indicates that Hawaii has the greatest reduction of CA in raw sugar (−134.4), followed by processed pineapples (−46.7) and fresh pineapples (−33.3). For macadamia nuts and anthuriums, the BRCA index signified the exactly opposite direction of change in CA as that of the NRCA index (Table 1). Not surprisingly, the identified CA trends from the BRCA index (see Table 3) also differ considerably from those from the NRCA index, though some consistencies exist. For example, according to the BRCA trends, Hawaii exhibited a significant trend in losing CA in fresh papayas, macadamia nuts, and potted orchids during the period of 1995–2005. The NRCA trends on the other hand indicate that Hawaii maintained its CA in these three products during the same period. The BRCA trend also indicates that Hawaii maintained the CA in potted orchids during the period of 1995–2005, while the NRCA trend indicates that it has a significant trend in losing CA. Among the 33 series of RCA indices under investigation (11 products * 3 producers), the BRCA index signifies 17 CA trends that are inconsistent with the NRCA index, suggesting that these two indices could reveal significant different CA patterns even for a simple empirical case such as the present exercise. We certainly believe that the NRCA index reflects the CA situation more realistically, as the BRCA index in theory is not comparable over time (Hillman 1980; Hoen and Oosterhaven 2006).

6 Conclusion

This paper demonstrates the potential of the NRCA index in systematically assessing CA for a particular product/producer over time, something we were unable to do with the traditional RCA index, using Hawaii's agricultural products destined for the US mainland market over the last decade as a case study. The assessment evidently revealed the intrinsically dynamic nature of Hawaii's agricultural sector during the period of 1995–2005. The results supported the findings from earlier research, confirming that Hawaii's golden age of sugarcane and pineapple plantations has passed and technology-intensive products such as seed crops and specialty products such as Kona coffee and dendrobiums exhibit a promising chance for growth and success.

The next research effort is to examine the sources of comparative advantage for Hawaii's agricultural products. Comparative advantage is determined by the combination of many socioeconomic factors such as institutional arrangements, natural resources, human resources, transportation cost, economy-of-scale, policy, and technology. Using the time series of NRCA index, we now are able to detect the effects of these factors on CA and thus possibly to cast some lights on some long-time debates over the sources of trade, for example, what is the key determinant of comparative advantage, natural endowment or technology?

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Appendix

See Appendix Table 4.

Table 4 Data sources and assumptions

Product	Supplier	Trade code*	Description
Papayas, Fresh	Import/Export	HS0807200000	Papayas (papaws) fresh
	US Mainland		No production
	Hawaii		Out shipment of fresh papayas is available. FAS value
Pineapples, Fresh	Import/Export	HS0804304000	Pineapples, fresh or dried, not reduced in size, in crates or other packages
		HS0804306000	Pineapples, fresh or dried, reduced in size
		HS0804302000	Pineapples, fresh or dried, not reduced in size, in bulk

Table 4 continued

Product	Supplier	Trade code*	Description
	US Mainland		No production
	Hawaii		Out shipment of fresh pineapples is available. FAS value
Pineapples, Processed	Import/Export	HS200820	Pineapples, prepared or preserved, NESOI
		HS200940	Pineapple juice, sweetened or not
		HS200941	Pineapple juice of Brix value<20,Nt Fort, Unfermnt
		HS200949	Pineapple juice, Nt Fort., Unfermnt, NESOI
		HS0811905000	Pineapples, uncooked or cooked by steaming or boiling in water, frozen, whether or not sweetened
		HS0812904000	Pineapples, provisionally preserved, but unsuitable in that state for immediate consumption
	US Mainland		No production
	Hawaii		Canned fruit, juice, and by-product. Local consumption is assumed small and negligible. FAS value
Raw Sugar, Cane	Import/Export	HS1701111000	Cane sugar, raw, in solid form, not containing added flavoring or coloring matter, NESOI, described in additional US note 5 (chapter. 17) & provisional
		HS1701115000	Cane sugar raw solid form, no added flavoring or coloring matter, NESOI
		HS1701110500	Cane sugar raw solid form, no added flavoring or coloring matter, NESOI, described in general US note 15 of the schedule & provisional
	US Mainland		Cane raw sugar. New York, duty-fee paid, price. Sugar and Sweeteners Outlook (USDA)
	Hawaii		Cane raw sugar. New York, duty-fee paid, price. Local consumption is assumed small and negligible
Macadamia Nuts	Import/Export	HS0802909810	Macadamia nuts, fresh or dried, shelled
		HS0802908010	Macadamia nuts, fresh or dried, in shell
		HS0802909010	Macadamia nuts, fresh or dried, shelled
		HS2008199010	Macadamia nuts, prepared or preserved NESOI
	US Mainland		No production
	Hawaii		Wet in Shell. 13% of the production is assumed consumed locally (authors' estimation). FAS value
Coffee	Import/Export	HS090111	Coffee, not roasted, not decaffeinated
		HS090112	Coffee, not roasted, decaffeinated
		HS090121	Coffee, roasted, not decaffeinated
		HS090122	Coffee, roasted, decaffeinated
	US Mainland		No production
	Hawaii		Parchment equivalent. Local consumption is assumed small. FAS value

Table 4 continued

Product	Supplier	Trade code*	Description
Seed Corn	Import/Export	HS0712908550	Sweet corn seeds of a kind used for sowing, dried
		HS0712908050	Sweet corn seeds of a kind used for sowing, dried
	US Mainland		The US mainland market is estimated based on the total crop acreage and average-seeding rate. Prices from Agricultural Statistics (USDA)
	Hawaii		Out shipment value is available
Anthuriums, Cut	Import/Export	HS0603107040	Anthuriums, fresh
	Hawaii's Export	HS0603100000	Cut flowers and flowers buds, fresh. Proportion of anthuriums is estimated based on the total outshipment (US mainland and foreign) of anthuriums and dendrobiums
	US Mainland		No production
	Hawaii		Out shipment (US mainland and foreign) value is available
Dendrobiums, Sprays	Import/Export	HS0603107050	Dendrobium orchids, fresh
	Hawaii's Export	HS0603100000	Proportion of dendrobiums is estimated based on the total outshipment (US mainland and foreign) of anthuriums and dendrobiums
	US Mainland		No production
	Hawaii		Dendrobiums sprays. Out shipment value (US mainland and foreign) is available
Orchids, Potted	Import/Export	HS0602902000	Orchids plants, live
		HS0602992000	Orchids plants, live
	US Mainland		Potted orchids, Floriculture Crops, NASS
	Hawaii		It includes potted dendrobiums, oncidium, phalaenopsis and others. Outshipment value (US mainland and foreign) is available
Foliages	Import	HS0604910080	Foliage, branches and parts of plants without flowers or buds, and grasses suitable for bouquets or for ornamental purposes, fresh, NESOI
	Export	HS0604910000	Foliage, branches and parts of plants without flowers or buds, and grasses suitable for bouquets or for ornamental purposes, fresh, NESOI
	US Mainland		Foliages. Floriculture and Nursery Crops situation and Outlook Yearbook
	Hawaii		It includes Ti leaves, other cut greens, and potted foliage. Outshipment value (US mainland and foreign) is available

*Harmonized tariff schedule of the United States and schedule B Export Codes. Imports and exports are in custom value

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