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Costs of Transporting Fresh Fruits and Vegetables to Honolulu from Hilo and Los Angeles

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Hawai'i being a chain of islands and a noncontiguous state makes transportation cost a factor of prime economic importance. The significance of transportation cost cannot be overemphasized, as 80 percent of goods consumed in the state are imported from the U.S. mainland and foreign countries.[1] Furthermore, in contrast to the 48 contiguous states, where rail and truck transportation are the predominant means of moving goods within and across states, Hawai'i has to rely on ocean and air freights to get its supply of goods, both from other states or countries and to move goods from island to island within the state.

Adding to Hawai'i's transportation cost challenge is the increasing cost of fuel. In 1995, the average price of oil per barrel was $23.71.[2] With an annual average increase of about 14 percent, it climbed to $91.35 per barrel in 2008.[3] Factors such as increase in demand and supply disruptions due to war and natural calamities have contributed to the upsurge in the price of oil. Since fuel consumption is an unavoidable and significant component of the operating costs of freight companies, they have passed a portion of the burden of increasing fuel costs to consumers through fuel surcharges. Table 1 displays the rates of Matson Navigation Co., Hawai'i's largest ocean shipper, in selected years and for selected fresh agricultural products. In 1995, Matson did not impose a fuel surcharge, but when fuel prices underwent sharp increases starting in 1999, Matson started to impose one. In 2008, its fuel surcharge was 31.6 percent of the base price, representing about 21 percent of total charges. Notable also is that while the base price increased by only 10 percent (an average annual rate of merely 1.2%) from 2000 to 2008 (from $3,860 to $4,232), the fuel surcharge increased by 980 percent (an average annual rate of 34.6%) from 3.2 percent of base price to 31.6 percent in the same period.

Transportation cost therefore represents a significant factor of Hawai'i's cost of living, in particular of food expenses. Based on the U.S. Bureau of Labor Statistics' Consumer Expenditure Survey in 2004–2005 of selected Metropolitan Statistical Areas (MSAs), a typical household's average annual food expenditure in Honolulu was $8,089. This is higher than the national average of $5,856; and every region in the nation: $6,280, $5,404, $6,430, and $5,672 in the West, South, Northeast, and Midwest, respectively. In fact, Honolulu's typical household spent the most for food among all the MSAs in the survey; San Francisco, New York, and Boston followed with $7,581, $7,283, and $7,223, respectively. Furthermore, based on the Official USDA Thrifty Food Plans in 2009, the weekly food budget at home for a family of four in Hawai'i was $217.70, which is higher by about 63 percent than the national average of $133.40. These findings

1 Hawaii Department of Transportation, Ports and Harbors Division (http://www.hawaiiharborsplan.com).
2 U.S. Energy Information Administration; inflation adjusted in 2008 prices.
3 U.S. Energy Information Administration; inflation adjusted in 2008 prices.

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Table 1. Matson's rates for fresh fruits and vegetables, 1995–2008.

	1995	2000	2005	2008
Average fuel surcharge	(%, applied to base price)			
	0.0	3.2	11.1	31.6
Fresh fruits and vegetables (refrigerated)				
	(cost in US$)			
Base price	3,801	3,860	4,220	4,232
Total wharfages	150	174	179	179
Terminal handling charge	-	-	265	600
Fuel surcharge average	-	124	466	1,338
Total charges	3,951	4,158	5,131	6,349

Source: Matson Navigation Co.
Note: Costs are end-of-year prices for a 40-ft standard-height container traveling between Los Angeles (Long Beach) and Honolulu.

reflect the important influence of transportation cost on food prices in a non-contiguous state like Hawai'i.[4]

These issues have prompted some sectors to contend that Hawai'i should try to become more self-sufficient in food. The analysis reported in this publication attempts to find out if such a supposition is warranted.In addition, this analysis puts transportation costs side by side with retail price, farm gate price, and farm-retail price spread to derive important relationships and possible policy implications. The focus of the investigation is on various fresh fruits and vegetables imported to O'ahu from the island of Hawai'i and California. According to a report prepared by John M. Knox & Associates, Inc., Markrich Research, and HTDC-MEP[5] for the Hawaii Agribusiness Development Corporation in 2008, 68 percent of Hawai'i's de facto population is on O'ahu but only 5 percent of the state's farmland is on O'ahu. Sixty percent of the state's farmland is on Hawai'i, 14 percent is on Kaua'i, and 21 percent is on Maui.[6] This underscores the need for O'ahu to import fresh fruits and vegetables from the neighbor islands and other states, and thus to face high transportation costs.

4 www.bls.gov/cex/csxmsa.htm and www.cnpp.usda.gov/USDAFoodPlansCostofFood.htm.

5 High Technology Development Corporation, Manufacturing Extension Program

6 National Agricultural Statistics Service. 2010. Statistics of Hawaii Agriculture 2008. www.nass.usda.gov/Statistics_by_State/Hawaii/Publications/Annual_Statistical_Bulletin/all2008.pdf.

Farm gate price, retail price, and marketing margin

Farm gate price, or farm price, refers to the price at the point of sale by farmers, while retail price is what final consumers pay. The difference between the two is called the farm-retail price spread. From farmer to consumer, fresh fruits and vegetables go through several channels in the supply chain—the assembler and/or wholesaler, and the retailer. Consequently, marketing costs are incurred, which include labor, storage and handling, transportation, and distribution costs, among others. Thus, the farm-retail price spread is the marketing cost.

Figure 1 shows the allocation of a consumers' dollar in 2006 for domestically produced food. Of total food expenditures, farmers received 19 cents of the dollar. Of the balance, 39 cents went to labor (48 percent of the cost of marketing was labor). The remaining marketing costs were divided among packaging, transportation, fuel and electricity, corporate profit, and miscellaneous.[7] Notable is that transportation cost is only four cents of the food dollar, on average, for the entire nation. However, this statistic reflects only intercity rail and truck costs. Since Hawai'i is dependent on ocean and air transportation, a greater portion of the marketing cost in Hawai'i is expected to be spent on transportation. In addition, fresh fruits and vegetables generally have large marketing costs due to perishability and the labor and equipment required to handle them.[8] Special equipment is needed to store and transport perishable products. Likewise, the energy costs associated with refrigeration is costly.

Table 2 shows the retail prices in Honolulu, the farm gate prices on the island of Hawai'i and in California, and the comparison of spreads for selected fruits and vegetables from the island of Hawai'i and from California.[9] In commodities where comparison was possible, the

7 Includes depreciation, rent, advertising and promotion, interest, taxes, licenses, insurance, professional services, local for-hire transportation, food service in schools, colleges, hospitals, and other institutions, and miscellaneous items.

8 USDA, ERS. 1996. Food cost review, 1950–1997. Agricultural Economics Report 729.

9 A limitation of our analysis is that we do not account for the structure of the market. It is possible that the degree of market power may affect farm and retail prices, and different components of marketing cost (transportation cost, in particular). We do not downplay the significance of such effects. In our analysis, however, we take transportation cost to be a given and investigate its relation to retail prices. The impacts of market structure certainly warrant future investigation.

Figure 1. Allocation of a consumer's food dollar in 2006.

Source: USDA, ERS (www.ers.usda.gov/Data/FarmToConsumer/Data/componentstable.htm)

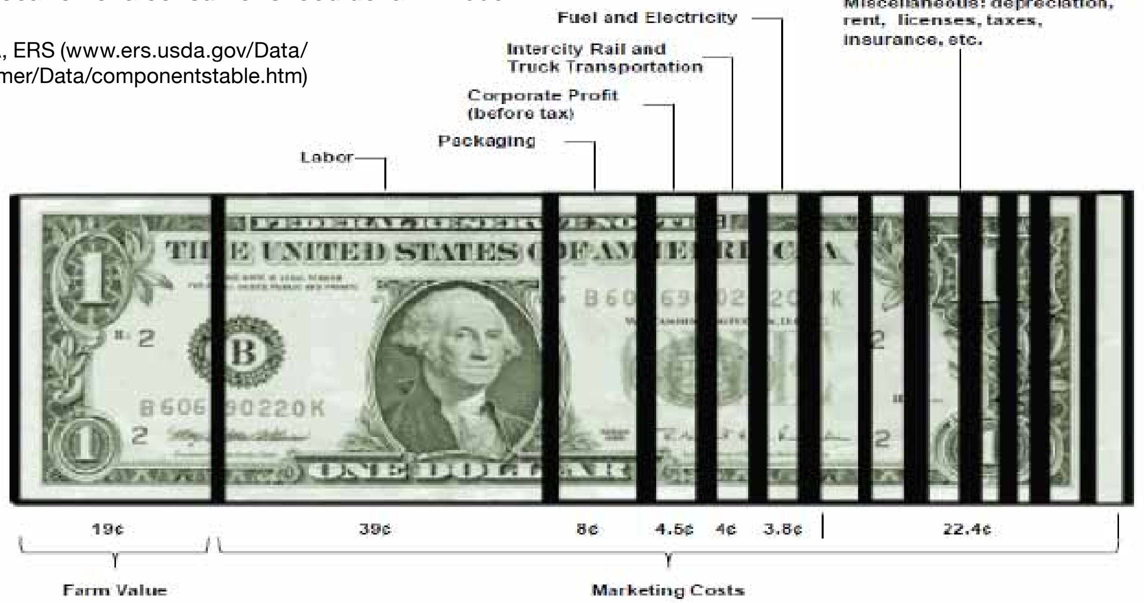

Table 2. Retail prices (on O'ahu), farm gate prices (on the island of Hawai'i and in California), and farm-retail spread of selected fresh fruits and vegetables, in US$ per pound.

	Retail	Farm gate		Spread	
Commodity	O'ahu	Hawai'i	CA	Hawai'i	CA
Vegetables					
Beans, snap	4.88	1.27	0.68	3.61	4.20
Bittermelon	3.22	0.90	(2)	2.32	
Broccoli	1.95	0.97	0.35	0.98	1.60
Burdock	3.52	(1)	(2)		
Cabbage,					
Chinese	1.37	0.36	0.15	1.01	1.22
Head	0.81	0.30	0.15	0.51	0.66
Mustard	2.65	0.70	(3)	1.95	
Carrots	1.22	(1)	0.23		0.99
Cauliflower	1.96	(1)	0.33		1.63
Celery	1.24	0.41	0.21	0.83	1.03
Corn, sweet	1.92	0.51	0.23	1.41	1.69
Cucumbers	1.46	0.82	0.22	0.64	1.24
Daikon	1.59	0.34	(3)	1.25	
Dasheen	2.89	(1)	(2)		
Eggplant	2.40	1.02	0.25	1.38	2.15
Ginger root	2.75	1.66	(2)	1.09	
Lettuce	1.62	0.61	0.22	1.01	1.40
Lotus root	3.79	(1)	(2)		
Onions, dry	1.07	0.78	0.09	0.29	0.98

	Retail	Farm gate		Spread	
Commodity	O'ahu	Hawai'i	CA	Hawai'i	CA
Onions, green	6.34	1.45	0.11	4.89	6.23
Peas, Chinese	8.01	(1)	(3)		
Peppers, green	4.65	0.71	0.25	3.94	4.40
Potatoes	1.21	(1)	0.11		1.10
Pumpkins	1.64	0.66	0.10	0.98	1.54
Romaine	1.81	0.61	0.24	1.2	1.57
Squash, Italian	1.86	0.70	0.25	1.16	1.61
Sweetpotatoes	2.58	0.67	(3)	1.91	
Taro	3.24	0.66	(2)	2.58	
Tomatoes	1.50	0.71	0.32	0.79	1.18
Fruits					
Avocados	2.48	0.73	0.94	1.75	1.54
Bananas	0.94	0.46	(2)	0.48	
Cantaloupe melons	1.00	(1)	0.13		0.87
Grapefruit	0.99	(1)	0.18		0.81
Grapes	2.80	(3)	0.40		2.40
Honeydew melons	1.22	(1)	0.17		1.05
Lemons	0.89	(1)	0.28		0.61
Limes	2.21	(1)	(3)		
Oranges	1.57	(1)	0.15		1.42

Sources: Hawai'i Department of Agriculture, Agricultural Development Division, Market Analysis and News Branch, 2009 (retail prices); Statistics of Hawai'i Agriculture, various years (Hawai'i farm gate prices or proxy derived from county or state aggregates); California Agricultural Resource Directory, 2009 (California farm gate prices).

Notes: To make prices comparable, Hawai'i island farm gate prices were CPI adjusted to 2009 prices. (1) Data were not shown to avoid disclosure of individual operations but were combined and included in "all other" vegetables/fruits. (2) No data available; either the vegetable/fruit may not be commercially produced in the state or is not produced at all. (3) Fruit/vegetable is produced in the state, but no data was reported, or it was included in "others" category.

farm gate price in California was always lower than on the island of Hawai‘i, while the farm-retail spread was always greater for fruits and vegetables coming from California, except for avocado.[10]

Table 3. Travel time of goods.

Route	Ocean	Air
Los Angeles–Honolulu	4 days	5 hours
Hilo–Honolulu	1.5 days	50 minutes

Sources: Hawaiian Airlines, Matson, and Young Brothers, Limited

Transportation cost

Goods may be transported to Honolulu from Hawai‘i (Hilo) and California (Los Angeles) either by ocean or air. Table 3 shows the travel time of goods from Los Angeles and Hilo to Honolulu via ocean and air. The obvious advantage of using air transportation is the speed at which goods reach their destination markets. This is especially important for perishable goods such as fresh fruits and vegetables. Although air transportation has a speed advantage, ocean transportation is the more popular mode of shipping goods to Honolulu, primarily due to cost considerations.[11]

Table 4 shows the ocean and air transportation cost per pound for each of the commodities supplied coming into Honolulu from Hilo and Los Angeles. Computation was based on standardized containers used for ocean and air freights (see Appendix). For all commodities, ocean shipping from Hilo to Honolulu is cheaper than from Los Angeles to Honolulu, as seen in columns 1 and 2. On average, ocean shipping from Hilo to Honolulu is six times cheaper than ocean shipping from Los Angeles to Honolulu. In contrast, air freight from Hilo to Honolulu is more expensive than from Los Angeles to Honolulu, as seen in columns 3 and 4. On average, air freight from Hilo to Honolulu is almost twice as costly as air freight from Los Angeles to Honolulu.

The cost of air shipping from Los Angeles to Honolulu exceeds the ocean shipping cost for the same commodity by 114 percent, on average. Meanwhile, the cost of air shipping from Hilo to Honolulu exceeds ocean shipment cost by 2,428 percent, on average. It is likewise notable that the maximum ocean transportation cost (0.315 per pound for shipment from Los Angeles) is almost equal to the minimum air transportation cost (0.305 per pound for shipment from Los Angeles). This further emphasizes why ocean shipment is the predominant mode of transporting goods to Hawai‘i.

10 According to the California Agricultural Resource Directory 2008–2009, the value of avocado production in California fell by 25 percent in 2007.

11 According to the Hawai‘i Department of Transportation, Ports and Harbors Division (http://www.hawaiiharborsplan.com), 98 percent of Hawai‘i's imports are shipped via ocean.

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Table 4. Transportation cost of selected fruits and vegetables between Hilo or Los Angeles and Honolulu.

	Transportation cost (US$ per pound)				Cost difference (%)	
	Ocean		Air		Air vs. ocean	
	Hilo–Hon. (1)	LA–Hon. (2)	Hilo–Hon. (3)	LA–Hon. (4)	Hilo–Hon. (5)	LA–Hon. (6)
Vegetables						
Beans, snap	0.035	0.245	0.717	0.442	1,948	81
Bittermelon	0.031	0.214	0.717	0.408	2,247	91
Broccoli	0.045	0.315	0.717	0.648	1,493	106
Burdock	0.038	0.267	0.717	0.506	1,777	89
Cabbage, Chinese	0.040	0.282	0.717	0.553	1,678	96
Cabbage, head	0.029	0.202	0.717	0.419	2,389	108
Cabbage, mustard	0.035	0.245	0.717	0.442	1,948	81
Carrots	0.024	0.168	0.717	0.419	2,887	149
Cauliflower	0.036	0.252	0.717	0.553	1,891	120
Celery	0.023	0.160	0.717	0.383	3,029	139
Corn, sweet	0.040	0.280	0.717	0.627	1,692	124
Cucumbers	0.022	0.153	0.717	0.305	3,186	100
Daikon	0.028	0.196	0.717	0.419	2,460	114
Dasheen	0.035	0.245	0.717	0.442	1,948	81
Eggplant	0.037	0.261	0.717	0.525	1,820	101
Ginger root	0.036	0.250	0.717	0.483	1,905	93
Lettuce	0.025	0.176	0.717	0.419	2,745	137
Lotus root	0.029	0.206	0.717	0.472	2,341	129
Onions, dry	0.020	0.141	0.717	0.332	3,456	136
Onions, green	0.028	0.198	0.717	0.455	2,432	130
Peas, Chinese	0.030	0.211	0.717	0.483	2,275	129
Peppers, green	0.037	0.261	0.717	0.525	1,820	101
Potatoes	0.020	0.141	0.717	0.332	3,456	136
Pumpkins	0.026	0.180	0.717	0.419	2,688	133
Romaine	0.041	0.288	0.717	0.585	1,642	103
Squash, Italian	0.029	0.200	0.717	0.416	2,403	108
Sweet potatoes	0.023	0.157	0.717	0.370	3,086	135
Taro	0.028	0.196	0.717	0.419	2,460	114
Tomatoes	0.023	0.159	0.717	0.350	3,065	121
Fruits						
Avocados	0.024	0.170	0.717	0.357	2,858	111
Bananas	0.030	0.210	0.717	0.516	2,290	146
Cantaloupe melons	0.026	0.180	0.717	0.383	2,688	113
Grapefruit	0.024	0.167	0.717	0.379	2,895	126
Grapes	0.031	0.218	0.717	0.534	2,204	145
Honeydew melons	0.028	0.196	0.717	0.379	2,460	93
Lemons	0.024	0.167	0.717	0.347	2,895	107
Limes	0.024	0.167	0.717	0.347	2,895	107
Oranges	0.024	0.167	0.717	0.347	2,895	107
Average	0.030	0.208	0.717	0.441	2,428	114
Minimum	0.020	0.141	0.717	0.305		
Maximum	0.045	0.315	0.717	0.648		

Sources: Hawaii Department of Agriculture, Agricultural Development Division, Market Analysis and News Branch (2009); Armstrong Produce; Hawaiian Airlines; Aloha Air; Matson Navigation Co.; and Young Brothers, Limited. Notes: See Appendix for computation

Table 5 groups selected fruits and vegetables by retail price.[12,13] Parker and Zilberman (1993) and Rosen (1974)[14] argued that observed retail prices reveal the fresh produce's quality or value. First, consumers gain greater satisfaction if the fresh produce is of higher quality, and so they are willing to pay a higher price for the goods. Second, marketing firms realize a greater loss when higher-valued fresh produce is damaged. Thus, they are willing to spend more marketing dollars on higher-valued goods to prevent greater loss. These two results imply that as the value of fruits and vegetables increases, retail price increases as well.[15] Likewise, the table shows the average transportation costs as percentage of the retail price and spread, average spread and farm gate price as percentages of the retail price, and average weight.

Column 1 shows that among the fruits and vegetables included in the analysis, snap beans, green onions, Chinese peas, and green peppers are the highest-valued, with an average retail price of $5.97 per pound; bananas, head cabbage, cantaloupe melons, grapefruit, lemons, and dry onions are the lowest-valued, with an average retail price of $0.95 per pound. Column 1, together with columns 2–5, shows that as the value of fruits and vegetables increases or decreases, transportation cost takes a lower or higher percentage of the retail price. Average transportation cost as a percentage of spread decreases as the value of the commodity increases, as seen in columns 6–9.[16]

Meanwhile, column 1, together with columns 10 and 11, shows that as average retail price increases, average spread increases as well. Looking further to columns 12 and 13, farm gate price as a percentage of the retail price decreases as the value of the commodity increases. These data suggest that a smaller portion of the retail price goes to farmers and a larger portion is spent on marketing costs as the value of the commodity increases. However, since transportation cost as a percentage of spread decreases as the value of the commodity increases, this implies that a greater portion of the marketing cost is spent on items other than transportation as the value of the goods increase.[17]

Comparing columns 12 and 13, it is apparent that the average farm gate price as a percentage of the retail price is higher for the Hawai‘i island farmers than for California farmers. This suggests that farmers on Hawai‘i are at an advantage compared to their California counterparts, as they get a greater share of the retail price. One obvious source of the advantage of Hawai‘i farmers is their proximity to their market, which entails lower transportation costs and shorter travel time. In addition, one overlooked advantage is that farmers on Hawai‘i may have closer relationships with wholesale buyers and even retail buyers. These factors may lead to lower marketing costs for fruits and vegetables coming from Hawai‘i, which leads to lower spread, as seen when columns 10 and 11 are compared. Column 14, meanwhile, suggests that the value of a fruit or vegetable may be related to its weight per carton. As the average value of the commodity increases, the average weight per carton decreases. One possible explanation is that distributors and packers handle higher-valued fruits and vegetables differently than lower-valued ones. They may allocate more resources

12 Cluster analysis was used to determine the grouping of the data. (For a discussion of cluster analysis, see www.statsoft.com/textbook/cluster-analysis.)

13 One important caveat of our analysis is that it is based on one period only. Although it is more desirable to base our analysis on inter-temporal data, data limitations preclude us from doing so.

14 Parker, D.D., and D. Zilberman. 1993. Hedonic estimation of quality factors affecting the farm-retail margin. American Journal of Agricultural Economics 75: 458–466; Rosen, S. 1974. Hedonic prices and implicit markets: product differentiation in pure competition. Journal of Political Economy 82: 34–55.

15 This is the hedonic approach of explaining retail prices: the price of a commodity is determined by the attributes or quality it possesses. Although demand factors (e.g., income, living patterns) and supply factors (e.g., labor cost, rents, taxes, regulations, technology, supply shocks) are not explicitly used in this approach, the market price that emerges is still the outcome of the interaction between producers and consumers. Hence, production costs and consumer tastes are implicitly accounted for. (See for instance, Epple, D. 1987. Hedonic prices and implicit markets: estimating demand and supply functions for differentiated products. The Journal of Political Economy 95(1): 59–80.)

16 As discussed earlier, transportation cost is part of the price spread. Table 5, last row, column 8 shows a distinct case where air TC is more than 100% of the spread (173.47%). In this case, we do not expect air TC (from Hilo to Honolulu) to be used in shipping the products in the group. However, the percentage is still computed and presented for exploratory purposes.

17 Complete information on different components of marketing cost is desirable to ascertain what components take up other portions of the farm-retail spread and to whom the spread accrues. Schaffner et al. (1998) pointed out that fresh produce marketers incur the cost of product deterioration; thus retailers are expected to have a larger share of the spread, because they must bear marketing costs (Schaffner, D.J., W.R. Schroder, and M.D. Earle. 1998. Food marketing, an international perspective. Boston: McGraw Hill).

Table 5. Average retail price (US$ per pound); average ocean or air transportation cost (TC as percent of retail price and spread); average spread and farm gate price (as percent of retail price); and average weight (pounds per carton) of selected fruits and vegetables shipped from Hilo or Los Angeles to Honolulu.

			Percent of retail price				Percent of spread				Percent of retail price				Weight
		Retail	Ocean TC		Air TC		Ocean TC		Air TC		Spread		Farm gate price		(lb/ctn)
		O'ahu (1)	Hilo (2)	LA (3)	Hilo (4)	LA (5)	Hilo (6)	LA (7)	Hilo (8)	LA (9)	Hilo (10)	LA (11)	Hilo (12)	LA (13)	(14)
	Commodity group*														
Higher value	Beans, snap Onions, green Peas, Chinese Peppers, green	5.97	0.58	4.10	12.59	8.39	0.83	4.98	17.57	9.92	78.64	92.98	21.36	7.02	21
	Avocados Bittermelon Burdock Cabbage, mustard Dasheen Eggplant Ginger root Grapes Lotus root Sweet potatoes Taro	2.94	1.09	7.65	24.89	15.60	1.82	[1]	41.67	[1]	66.73	[1]	33.27	[1]	31
	Broccoli Cauliflower Corn, sweet Daikon Lettuce Limes Oranges Pumpkins Romaine Squash, Italian	1.81	1.76	12.26	40.00	26.43	2.95	14.81	63.81	32.03	64.78	87.16	35.22	12.84	35
	Cabbage, Chinese Carrots Celery Cucumbers Honeydew melons Potatoes Tomatoes	1.32	1.96	13.72	54.84	29.76	3.26	16.13	90.14	35.05	59.26	84.83	40.74	15.17	45
Lower value	Bananas Cabbage, head Cantaloupe melons Grapefruit Lemons Onions, dry	0.95	2.73	19.01	76.08	42.20	6.28	22.74	178.97	49.01	47.09	82.09	52.91	17.91	42

Sources: Refer to sources in Tables 2 and 4.

Notes: *Values in rows are averages for each commodity group. [1]Not able to compute due to too many missing values.

to prevent more fragile fruits and vegetables from being too much compressed in order to preserve their quality, especially for higher-valued produce.

Implications

The preceding discussions have important implications. First, because transportation costs have greater impact on lower-valued items than on higher-valued ones, this suggests that distributors who import more lower-valued fruits and vegetables are at a disadvantage when transportation cost increases. Likewise, consumers who put more lower-valued fruits and vegetables in their consumption baskets will be affected more when transportation cost increases.

Second, when distributors choose the transportation mode to be used, it is worthwhile to consider the value of the commodity. If transportation cost is but a small portion of the retail price, then the distributor could settle for air shipping, which is faster and extends shelf life but in general is more expensive than ocean shipping.[18] When choosing the transportation mode, the distributor has to consider that the explicit costs of transportation may be trumped by implicit costs such as timeliness and reliability.[19]

Third, since transportation cost is a smaller portion of higher-valued fruits and vegetables than lower-valued ones, this may suggest that Hawai‘i island farmers are more competitive in lower- than in higher-valued fruits and vegetables. When transportation costs increase, distributors will most likely continue obtaining higher-valued fruits and vegetables from California, because transportation cost is but a small portion of the retail price and spread of higher-valued fruits and vegetables. Distributors may decrease shipping of lower-valued fruits and vegetables from California because transportation cost is a greater portion of retail price and spread, and they may instead ship them from the island of Hawai‘i.

18 For instance, snap beans is a high-valued vegetable and is transported only through air by one of the distributors on O‘ahu.

19 Hummels, D. 2007. Transportation costs and international trade in the second era of globalization. Journal of Economic Perspectives 21(3): 131–154.

Fourth, transportation companies that provide special rates for inter-island shipping of locally produced fruits and vegetables, such as Hawaiian Airlines, Aloha Air Cargo, and Young Brothers, Limited, should be commended, because they help promote local production. However, some effort should be done to lower inter-island air shipping costs. This will further help local farmers to become more competitive.

Finally, although the preceding does not suggest that Hawai‘i can be self-sufficient, it does suggest that there is a case for (1) the state to shift attention to producing more lower-valued fruits and vegetables, in addition to producing for niche markets, especially when transportation costs are expected to increase in the long run; and (2) O‘ahu to produce more fruits and vegetables than currently, to decrease its dependency on other islands and the U.S. mainland. Whether these are feasible and worthwhile ventures will certainly depend on their economic viability.

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Appendix:
Computation of transportation cost (*TC*)

$$TC_{ij} = C_j / W_{ij}$$

where

i = specific vegetable or fruit

j = transportation mode used; if ocean, a 40-ft refrigerated container is used; if air, an LD2 refrigerated container is used (a 40-ft refrigerated container contains approximately 16 LD2 refrigerated containers)

W_{ij} = total weight (in pounds) of a container of vegetable or fruit i transported through j

C_j = cost of transportation mode j

W_{ij} was computed based on information (weight per carton) provided by Armstrong Produce for different fruits and vegetables. C_j was gathered from different transportation companies: Hawaiian Airlines, Aloha Air Cargo, Matson Navigation Co., and Young Brothers, Limited.

The formula above was used for computing ocean transportation cost for the Los Angeles, California / the Hilo–O‘ahu routes and air transportation cost for Los Angeles, California–O‘ahu route. LD2 containers are not used for air freight for the Hilo–O‘ahu route due to limited aircraft space; hence the formula was not used. Air freight charge for the Hilo–O‘ahu route is on a per-pound basis.