**Overview of Demand**

**in Taiwan's Wholesale Fruit Market**

- Taking Banana, Pineapple, Belt fruit and Guava for Example

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1. **Introduction**

This research is motivated by the findings of Ahmadi‐Esfahani and Stanmore (1997), who identified an inelastic yet positive income elasticity of demand for vegetables in China, drawn from an analysis of data from the China Dazhongsi Agricultural Wholesale Market. This discovery suggested that the consumption for vegetables were likely to persistently rise with increasing incomes, revealing the necessity nature of vegetables to Chinese. Prompted by this revelation, the inquiry extends to the demand for fruits in Taiwan. Is there a comparable indispensability attached to fruits for the Taiwanese? Examining the data reveals that fruits, particularly bananas, pineapples, belt fruit, and guava, dominate the per capita annual consumption of agricultural products in 2022, reaching 115.21 kg. These fruits are prevalent in the consumer market and serve diverse purposes, including personal consumption, gifting, religious offerings, and more. Therefore, this study will focus on these four types of fruits and utilize data from wholesale markets across different cities to explore the demand for fruits among Taiwanese.

1. **Literature Review**

Zheng, Henneberry, Zhao, Gao (2019) connects with our selection of our demographic variables which demonstrated that with the ongoing increase in per capita incomes and the simultaneous upward trends in urbanization and population aging, the proportion of expenditures on foods at home would decrease. Moreover, the household food budget shares of grains would continue to diminish, while the shares allocated to animal-origin foods and fruits were expected to increase.

Analyzing fruit demand using Taiwan's wholesale market data through the AIDS model, Lu and Ye (2000) focused on pineapple, papaya, belt fruit, grape, and pear. To discern the consumption patterns of Taiwanese consumers, the model incorporated the total population of Taiwan (excluding Lienchiang County and Kinmen County) as demographic variable, and used nominal retail price, wholesale market transaction volume, fruits production, and fresh fruits import volume to generate the consumption share per household. The data spanned from 1996 to 1997 monthly. The findings indicated consumer's sensitivity to prices for pineapples and grapes, while other fruits showed non-significant responses to retail prices. Regarding cross-price elasticity, pineapples and grapes exhibited substitutability, whereas grapes and pears demonstrated complementarity. Concerning the impact of expenditure on fruit consumption, an increase in total expenditure led to higher consumption of all fruits except belt fruits. Consequently, distinct relationships were observed among different fruits.

1. **DATA SOURCES AND EXPLANATIONS**

Our data are based on three different databases: The first is “農產品交易批發市場”, it provides the annual annual average prices and quantities for the 4 fruits in each county; “內政部縣市人口統計” and “行政院家庭收支調查” provide all elements we used as the demographic variables. In order to catch the effect on urbanization, we simply the method from Zou and Huang (2003) with the definition of urbanized areas to generate an index in 0 to 1 for each county, the larger represents the higher urbanization.

1. **ESTIMATION PROCEDURES AND RESULTS**

To assess the demand system involving these four fruits, we initially conducted three tests—endogeneity, homogeneity, and symmetry—to ascertain the conformity of the data with the assumptions of the AIDS model. Let the log of average household income served as the instrumental variable (IV) for expenditure in the model, the test results indicated that the data is consistent with the null hypotheses of the last two tests which is homogeneous and symmetrical. However, a significant endogenous issue is observed at the 5% level, since the total expenditure is the sum of the total transaction value of the 4 fruits in each county wholesale market in each year, influenced by the fruits’ prices. Therefore, our AIDS model will incorporate the instrumental variable.

Observing the coefficients (Table 1), the level of county urbanization significantly impacts the demand for bananas, belt fruits, and pineapples, while only bananas experience a negative influence. Concerning the ratio of old people and children in the household, a family with a higher children ratio significantly and negatively affects the consumption share of pineapples. In terms of elasticity analysis, households exhibit a lack of significant sensitivity to the price of pineapples, despite the negative own-price elasticity. The price of belt fruits only influences consumers under uncompensated situation (Table 2a). Another interesting result we can find in own-price elasticities is the considerable sensitivity of consumers to the prices of bananas and guava, especially bananas. For the cross-price elasticities (Table 2b and 2c), the belt fruits and pineapples are substituted, likely due to their peak production periods occurring in different seasons—one in summer and the other in winter. In contrast to the relationship between belt fruits and pineapples, bananas and belt fruits, bananas and pineapples, and guavas and belt fruits exhibit complementary relationships.

1. **DISCUSSION**

In conclusion, our research indicates that household demand for the four types of fruits is influenced by factors such as pricing, the level of urbanization in the county, fruit seasonality, and the presence of children. It appears that households residing in highly urbanized counties tend to purchase fewer bananas but more pineapples. This trend may be attributed to the perishable nature of bananas, diminishing households’ willingness to purchase, whereas the demand for pineapples, with a pronunciation resembling "Wang Lai" in Taiwanese, is higher due to their frequent use in religious practices. In addition, households would purchase the fruits depending on the production periods, they would buy more during the seasons. Moreover, households with a higher ratio of children tend to exhibit decreased demand for pineapples, possibly because the fruit is challenging to store and handle, potentially causing inconvenience for mothers with children.

1. **REFERENCES**

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**Table 1. Descriptive Statistics for Data**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Obs** | **Mean** | **Std. dev.** | **Min** | **Max** |
| bana\_p | 65 | 25.16 | 5.55 | 11.96 | 41.84 |
| bana\_q | 65 | 4,264,491 | 4,536,910 | 61,008 | 14,900,000 |
| bana\_value | 65 | 113,000,000 | 123,000,000 | 1,196,813 | 486,000,000 |
| bana\_w | 65 | 0.2679 | 0.0611 | 0.1198 | 0.4160 |
| belt\_p | 65 | 54.62 | 14.84 | 28.78 | 96.97 |
| belt\_q | 65 | 1,602,429 | 1,744,790 | 14,764 | 5,323,673 |
| belt\_value | 65 | 89,200,000 | 98,800,000 | 806,733 | 353,000,000 |
| belt\_w | 65 | 0.1935 | 0.0674 | 0.0433 | 0.3423 |
| guva\_p | 65 | 28.94 | 5.54 | 19.04 | 40.86 |
| guva\_q | 65 | 5,099,793 | 6,947,191 | 31,269 | 23,800,000 |
| guva\_value | 65 | 149,000,000 | 212,000,000 | 796,109 | 757,000,000 |
| guva\_w | 65 | 0.2717 | 0.1005 | 0.0683 | 0.4891 |
| pine\_p | 65 | 20.51 | 3.81 | 12.51 | 28.90 |
| pine\_q | 65 | 5,496,095 | 5,752,015 | 52,136 | 19,600,000 |
| pine\_value | 65 | 114,000,000 | 124,000,000 | 935,498 | 469,000,000 |
| pine\_w | 65 | 0.2669 | 0.0865 | 0.1146 | 0.4596 |
| exp | 65 | 466,000,000 | 535,000,000 | 3,735,153 | 1,930,000,000 |
| fdexp | 65 | 115,741 | 22,285 | 70,523 | 162,847 |
| houses | 65 | 584,133 | 475,550 | 82,869 | 1,620,906 |
| h\_people\_1 | 65 | 0.33 | 0.03 | 0.25 | 0.39 |
| h\_people\_2 | 65 | 0.20 | 0.01 | 0.18 | 0.22 |
| h\_people\_3 | 65 | 0.18 | 0.01 | 0.16 | 0.19 |
| h\_people\_4 | 65 | 0.15 | 0.02 | 0.11 | 0.17 |
| h\_people\_5 | 65 | 0.14 | 0.03 | 0.09 | 0.25 |
| people\_unit | 65 | 2.62 | 0.17 | 2.37 | 3.18 |
| household\_income | 65 | 1,007,556 | 183,317 | 746,775 | 1,430,572 |
| h\_child\_ratio | 65 | 18.22 | 2.53 | 14.39 | 24.45 |
| h\_old\_ratio | 65 | 25.25 | 6.91 | 15.50 | 43.17 |
| urbanisation | 65 | 0.6910 | 0.3032 | 0.0590 | 1.0000 |
| ln\_house\_income | 65 | 13.81 | 0.18 | 13.52 | 14.17 |
| ln\_fdexp | 65 | 11.64 | 0.19 | 11.16 | 12.00 |
| exp\_h | 65 | 755.40 | 539.67 | 29.59 | 1,841.18 |

**Table 2. Estimation with Homogeneity and Symmetry Constrained by AIDS Model**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Coefficient**  **(Std. err.)** | | | |
|  | **bana\_w** | **belt\_w** | **guva\_w** | **pine\_w** |
| gamma\_lnbanana\_p | -0.1088\*  (0.0471) | 0.0257  (0.0444) | 0.0087  (0.0574) | 0.0745  (0.0497) |
| gamma\_lnbelt\_p | 0.0257  (0.0324) | 0.1034  (0.0320) | 0.0353  (0.0414) | -0.1644\*\*\*  (0.0353) |
| gamma\_lnguva\_p | 0.0087  (0.0557) | 0.0353  (0.0548) | 0.0450  (0.0711) | -0.0889  (0.0597) |
| gamma\_lnpine\_p | 0.0745  (0.0615) | -0.1644  (0.0610) | -0.0889  (0.0791) | 0.1788\*\*  (0.0678) |
| beta\_lnx | 0.0259\*  (0.0108) | -0.0029  (0.0107) | 0.0025  (0.0139) | -0.0255\*  (0.0117) |
| rho\_vexp | -0.0307\*  (0.0123) | -0.0047  (0.0128) | -0.0008  (0.0166) | 0.0362\*\*  (0.0133) |
| alpha\_h\_people\_1 | 0.2741  (0.9587) | -0.1602  (0.9570) | 3.2670\*\*  (1.2423) | -3.3809\*\*  (1.0558) |
| alpha\_h\_people\_2 | -0.1476  (1.3409) | -2.7637  (1.3393) | -4.3564\*  (1.7386) | 7.2677\*\*\*  (1.4776) |
| alpha\_h\_people\_3 | 2.5143  (1.8042) | -1.0140  (1.8007) | -0.1620  (2.3375) | -1.3384  (1.9875) |
| alpha\_h\_people\_4 | 0.6859  (1.5167) | -3.6227  (1.5146) | 4.9893\*  (1.9663) | -2.0526  (1.6719) |
| alpha\_h\_people\_5 | 0.7919  (0.8843) | -0.0144  (0.8822) | -1.3203  (1.1453) | 0.5428  (0.9738) |
| alpha\_h\_child\_ratio | 0.0032  (0.0029) | 0.0035  (0.0029) | 0.0038  (0.0038) | -0.0105\*\*  (0.0032) |
| alpha\_h\_old\_ratio | 0.0004  (0.0009) | -0.0001  (0.0009) | 0.0008  (0.0012) | -0.0011  (0.0010) |
| alpha\_urbanisation | -0.2680\*\*\*  (0.05) | 0.1509  (0.0498) | -0.0665  (0.0646) | 0.1836\*\*  (0.0549) |
| alpha\_cons | -0.7484  (0.8662) | 1.2817  (0.9644) | -0.5790  (1.1221) | 1.0456  (0.9536) |
| N | 65 |  |  |  |

t statistics in parentheses

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

**Table 3. The Elasticities Estimation by AIDS Model**

1. PREDICTED SHARES, BUDGET AND (UN)COMPENSATED OWN-PRICE ELASTICITIES

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | shares | budget | u\_price | c\_price |
|  | b/se | b/se | b/se | b/se |
| bana\_w | 0.271\*\*\* | 1.096\*\*\* | -1.389\*\*\* | -1.093\*\*\* |
|  | (0.005) | (0.040) | (0.160) | (0.154) |
| belt\_w | 0.193\*\*\* | 0.985\*\*\* | -0.461\*\*\* | -0.271 |
|  | (0.006) | (0.056) | (0.167) | (0.166) |
| guva\_w | 0.272\*\*\* | 1.009\*\*\* | -0.837\*\*\* | -0.562\*\* |
|  | (0.008) | (0.051) | (0.259) | (0.263) |
| pine\_w | 0.264\*\*\* | 0.903\*\*\* | -0.259 | -0.020 |
|  | (0.006) | (0.045) | (0.247) | (0.248) |

\* p<0.1, \*\* p<0.05, \*\*\* p<0.01

1. UNCOMPENSATED CROSS-PRICE ELASTICITIES

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | bana\_p | belt\_p | guva\_p | pine\_p |
|  | b/se | b/se | b/se | b/se |
| bana\_w | -1.389\*\*\* | 0.072 | 0.010 | 0.211 |
|  | (0.160) | (0.119) | (0.202) | (0.221) |
| belt\_w | 0.131 | 0.461\*\*\* | 0.186 | -0.841\*\*\* |
|  | (0.225) | (0.167) | (0.281) | (0.311) |
| guva\_w | 0.033 | 0.127 | -0.837\*\*\* | -0.333 |
|  | (0.207) | (0.153) | (0.259) | (0.285) |
| pine\_w | 0.269 | -0.599\*\*\* | -0.314 | -0.259 |
|  | (0.180) | (0.133) | (0.225) | (0.247) |

\* p<0.1, \*\* p<0.05, \*\*\* p<0.01

(c) COMPENSATED CROSS-PRICE ELASTICITIES

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | bana\_p | belt\_p | guva\_p | pine\_p |
|  | b/se | b/se | b/se | b/se |
| bana\_w | -1.093\*\*\* | 0.284\*\* | 0.308 | 0.501\*\* |
|  | (0.154) | (0.119) | (0.204) | (0.223) |
| belt\_w | 0.398\* | -0.271 | 0.454 | -0.580\* |
|  | (0.217) | (0.166) | (0.285) | (0.313) |
| guva\_w | 0.306 | 0.323\*\* | -0.562\*\* | -0.066 |
|  | (0.199) | (0.153) | (0.263) | (0.287) |
| pine\_w | 0.513\*\*\* | -0.425\*\*\* | -0.068 | -0.020 |
|  | (0.173) | (0.133) | (0.227) | (0.248) |

\* p<0.1, \*\* p<0.05, \*\*\* p<0.01