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[illegible]stical analysis of price differences in different Egyptian governorates.

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Introduction

The purpose of this research is to statistically examine price differenes of certain foodstuff items as between different Egyptian governorates. Distinction between governorates in upper and lower Egypt is taken into consideration as well as the distinction between [illegible] budget survey in A.R.E. (Sep. 78), C.A.M.&.S., table No. 22 P.79-91. Data is given for both quantity and value of family expenditure on different foodstuff items. Therefore, data for unit price can easily be derived.

Statistical methodology and findings

The present research makes use of Tukey's (HSD) Test, Fisher's test desinged for deciding whether one should reject the hypothesis for equality of means of (P-1) contrasts (where p is the number of variates) , as well as the variance analysis and (t) test.

1. Tukey's (HSD) Test.

This test may be used as complementary to the variance analysis. Tukey, J.W. has suggested a method for making all pairwise comparisons among means. This test is usually referred to as HSD (honestly significant difference) test or the (T) procedure. In order to use Tukey's test one should compute a single value against which one compares all differences. This single value is referred to as the (HSD), and is given according to the following formula ;

$$HSD = q_{\alpha, K, N-K} \sqrt{\frac{MSW}{n_j}} \qquad (1)$$

Where (q) is obtained from the tables for a significance level(α), (K) means in the sample, and (N - K) error degrees of freedom (MSW) is , of course, the mean square (within) Any difference between pairs of means that exceeds (HSD) is therefore declared to be significant. This test requires all sample sizes to be equal, $= n_j$. In applying the present test, one should firstly display the absolute values of the differences between means. The table provides the corresponding differences.

After determining the particular significance level, (α), the value of ($q_{\alpha, K, N-K}$) is obtained. Therefore the value of (HSD) is determined by using relationship (1). By comparing this value of (HSD) with values of differences given in the table in which the absolute values of the differences between means are displayed, one can therefore determine which values are significant and which are not being so. Let us conider the application of this test as regards prices of : Grain, Meat, Eggs, Oil & Fat, Milk & Cheese, Vegetables, Honey & Halawa. We firstly show in some detail the application of the test as regards Grain, (data given in table I)

Table (I)
(Grain)

Governorates	Lower Egypt		Govenorates	Upper Egypt	
	Urban	Rural		Urban	Rural
Damietta	0.067	0.064	Giza	0.070	0.056
Dakahlia	0.064	0.059	Beni-Suef	0.063	0.062
Sharkia	0.069	0.065	Fayum	0.064	0.056
Kalyubia	0.066	0.070	Menia	0.071	0.062
Kafr El-Sheikh	0.054	0.059	Asyut	0.061	0.052
Gharbia	0.064	0.063	Suhag	0.053	0.054
Munufia	0.060	0.059	Qena	0.048	0.047
Behera	0.063	0.062	Aswan	0.059	0.047
$\bar{X}_j$	$\bar{X}_1=0.063$	$\bar{X}_2=0.063$		$\bar{X}_3=0.061$	$\bar{X}_4=0.055$

At $\alpha=0.05$, with (4) means and (28) degrees of freedom the value of ($q_{0.05, 4, 28}$) equals 3.87.

The table of variance analysis is given as follows

Source	SS	D.F.	M.S.	F
Between	0.000393	3	0.000131	3.8[illegible]
Within	0.000942	28	0.000034	
Total	0.001335	31		

Since $F_{0.05,3,28} = 2.95$, we conclude that differences in means as between regions (after classifying them into urban and rural, belonging to upper and lower Egypt) are considered to be significant. Now, the (HSD) helps in determining the source of this significant difference. The value of (HSD) is determined, in case of

$$HSD = 3.87 \left(\frac{0.000034}{8} \right) = 0.0079$$

While the following table reveals the required information in accordance with the above reasoning.

	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$
$\bar{X}_1 = 0.063$	--	0.00	0.002	0.008*
$\bar{X}_2 = 0.063$		--	0.002	0.008*
$\bar{X}_3 = 0.061$			--	0.006
$\bar{X}_4 = 0.055$				--

Thus it is obvious that the above conclusion is being so because of the fact that unit price of Grain in rural regions of upper Egypt is significantly lower than that in regions of lower Egypt.

Similarly the analysis is being carried out as regards unit price of each of the other commodities.

Using data provided in the statistical appendix for other commodities, we obtain the following results.

Commodity	MS	F	HSD
Meat	0.00779	2.45	0.12
Eggs	0.000004	5.25*	0.003
Oil & Fat	0.00112	49.87*	0.045
Milk & Cheese	0.00019	6.38*	0.019
Vegetables	0.000028	3.93*	0.007
Honey & Halawa	0.001265	0.62	0.049

* sig. at the 5%

It can be seen that the calculated (F) is significant in the case of : Eggs, Oil & Fat, Milk & Cheese, and vegetables. The following tables show the differences in means for the foregoing commodities in accordance with the above reasoning.

Eggs

	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$
$\bar{X}_1 = 0.024$	--	0.002	0.002	0.004*
$\bar{X}_2 = 0.022$		--	--	0.002
$\bar{X}_3 = 0.022$			--	0.002
$\bar{X}_4 = 0.020$				--

Oil & Eat

	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$
$\bar{X}_1 = 0.278$	--	0.005	0.173*	0.077*
$\bar{X}_2 = 0.273$		--	0.178*	0.082*
$\bar{X}_3 = 0.451$			--	0.096*
$\bar{X}_4 = 0.355$				--

* sig. at the 5%

Milk & Cheese

	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$
$\bar{X}_1 = 0.148$	--	0.024*	0.002	0.019*
$\bar{X}_2 = 0.124$		--	0.022*	0.005
$\bar{X}_3 = 0.146$			--	0.017
$\bar{X}_4 = 0.129$				--

Vegetables

	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$
$\bar{X}_1 = 0.070$	--	0.008*	0.003	0.007*
$\bar{X}_2 = 0.062$		--	0.005	0.001
$\bar{X}_3 = 0.067$			--	0.004
$\bar{X}_4 = 0.063$				--

* sig. at the 5%

The above results lead to the following conclusions in addition to conclusions arrived at in the case of grain.

1. Differences in price of eggs are significant - This is due, as suggested by the (HSD) test, to the fact that prices in urban governorates of lower Egypt are higher than prices in rural governorates of upper Egypt.

2. Differences in price of Oil & Fat are significant. This is due to the fact that prices in urban and rural governorates of upper Egypt are higher than prices in urban and rural governorates of lower Egypt.

3. Differences in price of Milk & Cheese are signifcant. This is due to the fact that prices in rural governorates are lower than prices in urban governorates.

4. Differences in price of vegetables are significant. This is due to the fact that prices in Urban governorates of lower Egypt are higher than prices in rural governorates of both upper and lower Egypt.

In addition to the above argument we test the difference in prices between different urban governorates as well as between different rural governorates, each taken separately. As regards urban regions we have included both Cairo and Alexandria (10) governorates with 7 different commodities). As for rural regions we have (16) governorates. The results are given as follows.

	Urban regions				Rural regions			
Source	SS	dF	MS	F	SS	dF	MS	F
Between	0.065	17	0.004	0.087	0.086	15	0.006	0.128
Within	4.975	108	0.046		4.469	96	0.047	
Total	5.040	125			4.555	111		
	K=18	N=(18)(7)=126			K=16	N=(16)(7)= 112		
		n_j = 7				n_j = 7		
HSD	5.0 $\left[\frac{0.046}{7}\right]^{1/2}$ =0.41				HSD=5.0 $\left[\frac{0.047}{7}\right]^{1/2}$ =0.41			

The (F) test reveals that there is no difference in prices of commodities as between different Urban regions.

The same is also true as far as differences in prices of commodities between rural regions, is concerned. This result leads to considering the Fisher's test as developed by Rao, C.R.

2. The Fisher's test.

The above finding calls for constructing certain contrasts between urban and rural regions belonging to upper and lower Egypt. The test helps to decide whether one should reject the hypothesis of equality of means of different contrasts after determining the best contrast as suggested by data. The following approach has been presented by Rao, C.R.(1)

(1) Rao, C.R., "Advanced Statistical Methods in Biometric Research." John Wiley , 1952.

Let (x_{1i}, x_{2i}, ..., x_{pi}) be the observations on the i th item, thus they could be replaced by a linear compound,

$$z_i = l_1 x_{1i} + \cdots + l_p x_{pi}$$

Where l_i satisfy the condition,

$$l_1 + \cdots + l_p = 0$$

The problem of determining the best contrast reduces to that of determining the compounding coefficients $l_1 + \cdots + l_p$ such that the ratio of mean (Z) to standard deviation of (Z) is a maximum. Alternatively, by arbitrary choice of contrasts one may construct (p-1) independent linear combinations of the variables $x_1, \ldots, x_p$,

$$y_i = m_{1j} x_1 + \cdots + m_{pj} x_p$$

Such that,

$$\sum_i m_{ij} = 0 \qquad \text{for } j = 1, \ldots, (p-1)$$

Choosing a linear compound of (x) with coefficients adding to zero is the same as choosing a linear compound of (y) without any restriction on the compounding coefficients. If the linear compound is ,

$$\lambda_1 y_1 + \lambda_2 y_2 + \cdots + \lambda_{p-1} y_{p-1}$$

then the quantity to be maximized is,

$$v = \frac{(\lambda_1 \bar{y}_1 + \cdots + \lambda_{p-1} \bar{y}_{p-1})^2}{\sum\sum \lambda_i \lambda_j w_{ij}}$$

where,

$$w_{ij} = \frac{1}{N-1} \sum_{r=1}^{N} (y_{ir} - \bar{y}_i)(y_{jr} - \bar{y}_j)$$

As long as the ratios (λ) are uniquely determinable, the equations giving (λ) may be written,

$$\lambda \omega_{1i} + \cdots + \lambda_{p-1}\, \omega_{p-1\, i} = \bar{y}_i$$

$$i = 1, 2, \cdots, (p-1)$$

with solution,

$$\lambda_i = \omega^{1i}\, \bar{y}_1 + \cdots + \omega^{(p-1)i}\, \bar{y}_{p-1}$$

$$i = 1, 2 \;\ldots\ldots, (p-1)$$

Where the matrix (w^{ij}) is reciprocal to (ω_{ij}).
This provides the best linear compound of (y), which on trasformation to (x) gives the best contrast determinable from the data.

The maximum value of (υ) is given by

$$\Sigma\, \lambda_i \bar{y}_i = \Sigma \Sigma\, \omega^{ij}\, \bar{y}_i\, \bar{y}_j$$

If $\quad T_{p-1} = N \left(\Sigma \Sigma\, \omega^{ij}\, \bar{y}_i \bar{y}_j \right) / N-1$

then the following statistic,

$$T_{p-1}\, \frac{(N - p + 1)}{(p-1)}$$

can be used as a variance ratio with (p-1) and (N- P+1) degrees of freedom to test the hypothesis.
The statistic (T_{p-1}) is invariat for all sets of coefficients chosen to construct (y) from (x) ."

Let us apply the above procedure. We define ;

A = Average unit price of commodity in governorates of urban (lower Egypt).

B = Average unit price of commodity in governorates of rural (lower Egypt).

C = Average unit price of commodity in governorates of urban (Upper Egypt).

D = Average unit price of commodity in governorates of rural (upper Egypt).

Commodities considered are ; Grain, Meat, Oil & Fat, Milk & Cheese, Vegetables, Honey & Halawa. The unit of weight is (Kg) . Table (II) reveals basic data for carrying out the above test.

Therefore we may construct the following contrasts ;

Table (II)

Average unit price

Commodity	Governorates of Lower Egypt		Governorates of Upper Egypt	
	Urban A	Rural B	Urban C	Rural D
Grain	0.063	0.063	0.061	0.055
Meat	0.580	0.567	0.634	0.672
Oil & Fat	0.278	0.273	0.451	0.355
Milk &Cheese	0.148	0.124	0.146	0.129
Vegetables	0.070	0.062	0.067	0.063
Honey &Halawa	0.268	0.267	0.253	0.277

$$y_1 = A + C - (B + D) ,$$

$$y_2 = A - B , \text{ and ;}$$

$$y_3 = C - D.$$

The mean values and estimates of variances and covariances based on (5) degrees of freedom are ,

$\bar{y}_1 = 0.019 \qquad \bar{y}_2 = 0.008 \qquad \bar{y}_3 = 0.010$

$$W_{ij} = (10)^{-3} \begin{bmatrix} 2.22 & 0.06 & 2.17 \\ 0.06 & 0.08 & -0.02 \\ 2.17 & -0.02 & 2.19 \end{bmatrix}$$

The coefficients of the best linear function,

$$\lambda_1 y_1 + \lambda_2 y_2 + \lambda_3 y_3$$

are given by the following equations,

$$(10)^{-3}\left[2.22\ \lambda_1 + 0.06\ \lambda_2 + 2.17\ \lambda_3\right] = 0.019$$
$$(10)^{-3}\left[0.06\ \lambda_1 + 0.08\ \lambda_2 - 0.02\ \lambda_3\right] = 0.008$$
$$(10)^{-3}\left[2.17\ \lambda_1 - 0.02\ \lambda_2 + 2.19\ \lambda_3\right] = 0.010$$

Solving for λ'_s , we obtain,

$\lambda_1 = -100 \quad , \quad \lambda_2 = 201.4 \quad , \quad \lambda_3 = 105.5$

So that the best contrast is,

$\lambda_1(A + C - B - D) + \lambda_2(A - B) + \lambda_3(C - D)$

$= -100\ (A+C-B-D) + 201.4\ (A-B) + 105.5\ (C-D)$

$= 101.4\ A + 5.5\ C - 101.4\ B - 5.5\ D$

The statistic for testing the hypothesis of equality of means is ; $T_{p-1} = \frac{N}{N-1}\left[\lambda_1\bar{y}_1 + \lambda_2\bar{y}_2 + \lambda_3\bar{y}_3\right]$,

$$= \frac{6}{5}\left[-100(0.019) + 201.4(0.008) + 105.5(0.010)\right]$$

$$= 0.9194$$

$$T_{p-1}\frac{(N-P+1)}{(P-1)} = 0.9194\ \frac{(6-4+1)}{3} = 0.9194$$

The quantity 0.9194 is a variance ratio with (3) and (1) degrees of freedom, is insignificant at the 5% , so that the evidence supplied by the data is not sufficient to reject the hypothesis that unit prices of commodities in the different regions, taken simultaneously together as represented by the above contrasts, can be considered nearly uniform. This finding does not contradict the previous one when we applied the Tukey's test. This is being so since the Tukey's test compares only one particular region with another for each commodity but the Fisher's test takes all regions and all commodities simultaneously, together.

5. Testing differences in prices between different regions with different population densities.

It is perhaps interesting to enquire into the differences in prices between different regions with different population densities. Superficially , it may appear that prices in governorates with the lowest population density tend to be lower than prices in governorates with the largest population densities.

According to 1966 Census, we have distinguished between governorates with the lowest and with the largest population densities. The number of governorates for each is (7) . We have also distinguished between urban and rural regions. Table (III) provides information as regards this distinction together with the average price ($\bar{p}$) of (6) commodity categories. These are ; Grain, Meat, Oil & Fat , Milk & Cheese, Vegetables, Honey & Halawa . The test in this case is a (t) test. It is known that when testing a hypothesis concerning the difference between the means of two normal populations with unknown variances if one cannot justify the assumption that the variances of the two populations are equal, there does not exist an exact test in this case.

Table (III)

Rural

Low pop. density. Region	$\overline{P}$	High pop. density. Region	$\overline{P}$
Aswan	0.181	Suhag	0.289
Damietta	0.209	Gharbia	0.251
Fayum	0.275	Munufia	0.248
Kafr-El-Sheikh	0.206	Menia	0.259
Beni-Suef	0.266	Dakahlia	0.217
Kalyubia	0.260	Beheira	0.233
Giza	0.262	Sharkia	0.211
$\overline{X}$	0.237	$\overline{X}$	0.244

Urban

Low pop. density. Region	$\overline{P}$	High pop. density. Region	$\overline{P}$
Damietta	0.209	Cairo	0.277
Beni-Suef	0.284	Alexandria	0.235
Munufia	0.247	Gharbia	0.245
Aswan	0.213	Giza	0.276
Kafr-El-Sheikh	0.210	Dakahlia	0.233
Qena	0.244	Sharkia	0.245
Fayum	0.292	Kalyubia	0.249
$\overline{X}$	0.243	$\overline{X}$	0.251

In such a case it is known that if sampling is accomplished from two independent normal populations and replacing (σ_1^2) and (σ_2^2) by their respective unbiased estimators ($\hat{\sigma}_1^2$) and ($\hat{\sigma}_2^2$) , the resulting statistic is approximately distributed as a(t) statistic. The number of degrees of freedom associated with the approximate (t) statistic is determined by (k') where it is given as ;

$$k' = \frac{\left[\hat{\sigma}_1^2/n_1 + \hat{\sigma}_2^2/n_2\right]^2}{\frac{(\hat{\sigma}_1^2/n_1)^2}{n_1} + \frac{(\hat{\sigma}_2^2/n_2)^2}{n_2}}$$

This value will usually assume a noninteger value and it is agreed upon that a sufficient accuracy can be realized by using the nearest integer value as being the number of degrees of freedom. Table (IV) shows results of this test.

Table IV

	Rural: Low Pop. density	Rural: High pop. density	Urban: Low pop. density	Urban: High pop. density
$\bar{X}$	0.237	0.244	0.243	0.251
S_1^2	0.001189	0.000609	0.001035	0.000279
$\hat{\sigma}^2$	0.001387	0.000709	0.001207	0.000326

Rural: $k' \cong 13$; $\left[\hat{\sigma}_1^2/n_1 + \hat{\sigma}_2^2/n_2\right]^{\frac{1}{2}} = 0.0173$; $t = 0.405$; $t_{0.05,13} = 2.16$

Urban: $k' \cong 11$; $\left[\hat{\sigma}_1^2/n_1 + \hat{\sigma}_2^2/n_2\right]^{\frac{1}{2}} = 0.0148$; $t_c = 0.541$; $t_{0.05,11} = 2.20$

Neither value of (t_c) is significant, indicating that variation in population density by itself, has no significant effect upon average price. As a matter of fact, and at face value of it, it may be argued that this should not be so since variablity in population density reflects variability in demand pressure, and therefore in price. But this last assumption has not real justification since it neglects the conditions on the supply side. Therefore, although the average price in governorates with moderate population density is found to be numerically less than that in governorates with large population density, this difference is, however, statistically insignificant. This result is correct in case of both rural and urban governorates. It would have been useful to take the supply side of commodities into consideration, but data are not available. It would certainly be an interesting point for further research as data on the supply side become available. Without further data, some results of any statistical research could be only tentative.

Statistical Appendix
(Unit Price)

Table (A)
Urban Lower Egypt.

	Cairo	Alexandria	Damietta	Dakahlia	Sharkia	Kalyubia	Kafr-El-Cheikh	Gharbia	Munufia	Bohera
Grain	0.069	0.068	0.067	0.064	0.069	0.066	0.054	0.064	0.060	0.063
Meat	0.694	0.498	0.498	0.518	0.593	0.658	0.540	0.598	0.645	0.586
Eggs	0.028	0.028	0.028	0.023	0.023	0.024	0.022	0.024	0.022	0.023
Oil&Fat	0.406	0.368	0.192	0.277	0.308	0.310	0.231	0.330	0.303	0.273
Milk & Cheese	0.176	0.173	0.153	0.162	0.160	0.157	0.132	0.147	0.136	0.140
Vegetables	0.065	0.065	0.072	0.081	0.064	0.065	0.068	0.064	0.076	0.067
Honey & Halawa	0.249	0.238	0.271	0.293	0.275	0.240	0.233	0.266	0.259	0.309

* Rural Lower Egypt.

	Damietta	Dakahlia	Sharkia	Kalyubia	Kafr-El-Cheikh	Gharbia	Munufia	Bohera
Grain	0.064	0.059	0.065	0.070	0.059	0.063	0.059	0.062
Meat	0.435	0.493	0.522	0.721	0.489	0.634	0.702	0.541
Eggs	0.022	0.022	0.022	0.025	0.020	0.024	0.022	0.021
Oil & Fat	0.141	0.255	0.278	0.297	0.235	0.353	0.321	0.303
Milk & Cheese	0.120	0.144	0.116	0.145	0.114	0.120	0.122	0.110
Vegetables	0.069	0.055	0.056	0.064	0.061	0.066	0.058	0.065
Honey & Halawa	0.259	0.298	0.228	0.261	0.278	0.268	0.223	0.318

Table (B)

(Unit price)

Urban Upper Egypt.

	Gize	Beni-Suef	Fayum	Menia	Asyut	Suhag	Qena	Aswan
Grain	0.070	0.063	0.064	0.071	0.061	0.053	0.048	0.059
Meat	0.689	0.681	0.605	0.721	0.695	0.626	0.608	0.445
Eggs	0.027	0.022	0.021	0.022	0.020	0.023	0.018	0.019
Oil & Fat	0.394	0.467	0.537	0.486	0.525	0.483	0.404	0.314
Milk & Cheese	0.171	0.141	0.159	0.156	0.131	0.133	0.121	0.156
Vegetables	0.06[illegible]	0.060	0.072	0.068	0.063	0.066	0.067	0.075
Honey &Halawa	0.267	0.294	0.314	0.241	0.230	0.235	0.217	0.227

Rural Upper Egypt.

	Gize	Beni-Suef	Fayum	Menia	Asyut	Suhag	Qena	Aswan
Grain	0.05[illegible]	0.062	0.056	0.062	0.052	0.054	0.047	0.047
Meat	0.643	0.778	0.711	0.674	0.722	0.772	0.569	0.509
Eggs	0.020	0.020	0.021	0.021	0.019	0.020	0.019	0.018
Oil & Fat	0.31[illegible]	0.308	0.361	0.362	0.486	0.480	0.306	0.224
Milk & Cheese	0.14[illegible]	0.141	0.138	0.115	0.131	0.109	0.119	0.126
Vegetables	0.068	0.055	0.066	0.067	0.061	0.054	0.062	0.068
Honey& Halawa	0.34[illegible]	0.249	0.317	0.271	0.300	0.267	0.287	0.185

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