Journal of Economics and Sustainable Development
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.5, No.27, 2014

Onion Market Integration: The Case Of Harar, Dire Dawa And Central Markets

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Abstract
The objective of this study was to analyze the integration of onion market among the spatially separated secondary market to onion producers and the central market. Pearson correlation coefficient, unit root test, Co-integration test and Error correction model were employed to know linear relationship among these markets, non stationary or stationary series, OLS estimation for the long run relationship and short run relationship between these markets respectively. Monthly price series for a period of five years from September 2006 – August 2011 was used for the study. Accordingly, the result portrayed that, there is a strong relationship between the two secondary markets like Harar and Dire Dawa than central market. After conducting the DF/ADF test the residual from OLS estimation obey stationary and known that co-integration between the two regional markets to each other than the central market. From the ECM model, it was concluded that there is a slower adjustment of the system towards the equilibrium after a shock.
Keywords: Onion, market integration, stationary, spatial price transmission, unit root test, error correction model

Introduction

Ethiopia's agriculture where the majority of population relied on has characterized by inefficient market system. It is based on old tradition which has inconsiderable integration among geographically separated market places and has been criticized of high transaction costs and risks to date whereby only one-third of output reaching the market and transaction has a tendency to trade only with those they know, to avoid the risks of being cheated. Lack of access to appropriate information and low volume of production is also the main factors resulted in poor integration among these markets. Production is harvested from small unit of area. As identified by reports of ECX 2009, these small-scale farmers who produce 95% of Ethiopia's output come to market with little information and are at the mercy of merchants in the nearest and only the market they know and unable to negotiate better price or reduce their market risk. However, recently these issues are getting a great attention from government side and awareness creation and mechanisms on how to boost productivity in a way enable small holders to bring together their produce for gaining the better bargaining power. This supposed to contribute for the well-integrated and price responsive markets found in different locations. In a competitive market structure, the price difference between any two regions with regard to homogeneous commodities is expected to be equal to the transaction cost at equilibrium level. When the price difference exceeds the transaction cost between the two markets, arbitrage opportunities will be created and profit-seeking traders will exploit such opportunities by transporting commodity from a low-price to a high-price area. however, without efficient spatial integration, price signals will not be transmitted from food deficit to food surplus areas, prices will be more volatile, agricultural producers will fail to specialize according to a long-term comparative advantage and the gain from trade will not be realized(Chirwa, 2000).

Kombolicha district is one of the horticulture production site particularly onion in eastern part of the country. Onion produced in this area has different outlets and the areas advantage is defined in terms of proximity to urban centers like Dire Dawa and Harar and available infrastructures are better opportunities. Small scale farmers residing in this area producing onion have the advantage of accessing to these towns market despite the poor market linkage and price transmission observed different from the central market of the country. According to the studies conducted elsewhere in Ethiopia, it was indicated that the product marketing is imperfect due to intermediary's malpractices and other reasons (Bekabil, 2004; Wolday, 1994). The situation in this selected market under study might be similar or different which requires further investigation to determine its situation. Dawit (2005) also identified the constraints in a marketing system as it is characterized by poor infrastructure, transparency and follows a traditional form of transactions. Products flow through a chain without making value added. That is presence of too many intermediaries in a market merely keep on widening the chain. Lack of vertical and horizontal coordination and lack of integration of farmers to the marketing system, multiple tariffs charged at production area and the market centers, and poor connection with international markets are also inherent problems of the agricultural marketing systems. This reduces/decreases farmers profit or return from onion production. However, onion marketing systems particularly products of this area have not been studied exhaustively. The extent of integration across different market locations enables government to improve the design of its market liberalization policies. Then it creates a great contribution in designing appropriate marketing policies which would assist policy makers to make decisions on when and where to intervene. This study also provides basic information for any interested body to understand market integration and other researchers can also use it as a reference for further investigation and expansion of this research.

This study was, thus, proposed to investigate onion marketing integration of onion produce destination markets of the area with the central market which enable to know the extent to which local market prices respond to changes in central market prices of this particular commodity market system, and come up with recommendations.

The specific objectives of the study were:

- ✓ To analyse the existing onion price market integration of secondary and central market
- ✓ To know short-run and long-run price transmission among these markets.

Research Methodology

Data Sources

Secondary data used for this research were five years monthly onion price of central market and secondary local market which covers the period from September 2006 – August 2011 collected from CSA (Central Statistical Authority).

Method of Data Analysis

An econometric analysis like correlation coefficient, co-integration and error-correction-model analysis were employed to analyze market integration.

Correlation coefficient

Research on market integration was focused on measuring the co-movement of two price series in distinct markets. The correlation coefficient is a relative measure of the linear association between two series. It is one of the most popular, frequently used and easy to calculate tools, though there exists some limitation in using correlation coefficient to express the relationship between time series variables (Dahlgram and Blank, 1992; Tschirley, 1991). It can indicate the strength of the relationship between two series. A low correlation coefficient is an indicator of a weak or non-integration of the two markets. More specifically, correlation coefficient of above 60 percent is an indicator of strong connection, between 30 and 60 percent, a weak connection, and below 30 percent no connection between the variables (Goetz and Weber, 1987). The estimate of the correlation coefficient of price series between two markets can be estimated as:

$$\hat{\rho}_{xy} = \frac{\hat{\sigma}_{xy}}{\hat{\sigma}_x \hat{\sigma}_y} \qquad (1)$$

Where:

ρ_{xy} – is correlation coefficient between markets (Harar, Dire Dawa and Addis Abeba)

σ_{xy} – is the covariance between markets (Harar, Dire Dawa and Addis Abeba)

σ_x – is a standard deviation of x (Harar or Dire Dawa or Addis Abeba) and

σ_y - is a standard deviation of y (Harar or Dire Dawa or Addis Abeba)

Co-integration and Error-Correction Model

Stationary and Non-stationary time series

The first step in using co-integration approach for market integration analysis is to determine the order of integration of the price series. A time series X_t is stationary if the joint probability distribution of X_t and X_{t+n} is independent of time (t), though it does depend on the lags. That is having a constant mean and variance. A stationary time series process is one whose distributions are stable over time. That is any collection of random variables in the sequence and then shift that sequence a head t time periods; the joint probability distribution must remain unchanged. A non-stationary series is integrated of order I (0); while a stationary series is integrated of the order I (1). These play an important role in the analysis of time series.

Due to non-stationary nature of many economic time series, the concept of co-integration has become widely used in econometric analysis. The concept of co-integration is related to the definition of a long-run equilibrium. The fact that two series are co-integrated implies that the integrated series move together in the long run (Golleti and Tsigas, 1991). Therefore, testing co-integration of two price series is sometimes believed to be equivalent to detecting long-run market integration that Engle and Granger (1987) has developed its framework. To know market integration, three steps were followed:

(1) Testing stationarity of the price series

(2) Testing long-term price integration with co-integration analysis

(3) Testing short-run integration: measuring speed of adjustment.

Dickey-Fuller (DF) test

Used to pre-test the integrating orders of the series, i.e., each price series is tested for the order of econometric integration, that is, for the number of times the series need to be differenced before transforming to a stationary series. A series is said to be integrated of order I (d), if it has to be differenced'd' times to produce stationary series (Gujarat, 2003).

$x_{1t}= \alpha_o+\beta_o x_{2t}+e_t \qquad -1 \leq \beta_o \leq 1$ (2)

Where: x_{1t} is price of Harar or Dire Dawa market; x_{2t} is price of central market (Addis Abeba)

H_o:σ=0;non stationary and H_1:σ<0;stationary. If β_o=1, that is the case of unit root means a non stationary stochastic process. For theoretical reason: subtract x_{t-1} from equation (6) to obtain:

$\Delta x_{1t}= \alpha_o+\sigma\, x_{1t-1}+e_t$ (3)

Where: Δx_{1t} is price change; x_{1t-1} is lagged value of the price series; σ= (βo-1) and Δ as usual; is the first difference operator. Then to test this Ho: σ=0; if σ=0, then β_o=1, that is we have unit root, meaning the time series under consideration is non stationary. Regressing P_{x1t} on P_{x1t-1} from the two equation, and observing the scope coefficient in the regression (=σ) is zero or not. If zero, x_{1t} is non stationary series. To find out if the estimated coefficient of x_{1t-1} is zero or not, Dickey and Fuller test will be used in this research. If the t-statistics for the coefficient β_o is greater in absolute value than a given critical value, then the null hypothesis is rejected, and the alternative hypothesis of stationary is accepted. One of the main difficulties in using simple DF test that it is based on the assumption that the variable follows a simple first order autocorrelation and that the disturbance term is independently and identically distributed. However, in most economic time series the problem of series correlation is common. This leads us to use the ADF test.

Augmented Dickey-Fuller (ADF) test

The most commonly employed test for stationary and order of integration is the Augmented Dickey Fuller (ADF) test. In conducting DF test it will be assumed that the error terms (e_t) are uncorrelated. But if correlated, ADF is used. H_o: is unit root (β_o=1 or σ=0). This involves the following regression:

$$\Delta x_{1t}=\alpha_o +\beta_o x_{1t-1} +\sum_{K=1}^{n} \beta_k\, \Delta x_{1t-k} + e_t \qquad (4)$$

The null hypothesis in the ADF test is also unit root (β_o=1 or σ=0) and it follows the same asymptotic distribution as the DF statistics, so the same critical values can be used. If null hypothesis is rejected, then the price series are stationary and it is possible to conduct the co-integration regression. If the alternative hypothesis is that x_t is stationary mean zero, then no deterministic term should be included. This alternative is not appropriate for most macro time series. If H_1 is that x_t is stationary with unknown mean, then the constant should be included. This alternative is appropriate for time series which exhibit a consistent tendency to grow or shrink over time. If the alternative is that, x_t is trend stationary, then the constant and linear trend should be included (Gujarati, 2003).

The t- test statistics on the estimated coefficient of x_{1t-1} is used to test the null and alternative hypotheses. The null hypothesis is that the series x_{1t} is integrated of order 1 and the alternative hypothesis is that the series is of order 0. In short, H_0: x_{1t} is I (1) Versus H_1: x_{1t} is I (0). If the t-statistics for the coefficient β_o is greater in absolute value than a critical value given by the ADF critical value, then the null hypothesis is rejected, and the alternative hypothesis of stationary is accepted. If the null hypothesis is not rejected, then one must test whether the series is of order of integration higher than just 1, possibly of order 2. In this case the same regression equation (8) is applied to the second difference, i.e. the test will be repeated by using (Δx_{1t} in place of x_{1t}) i.e. by applying the regression:

$$\Delta^2 x_{1t}=\alpha_o +\beta_o x_{1t-1}+\sum_{K=1}^{n} \beta_k \Delta^2 x_{1t-k} + \gamma \qquad (5)$$

Where: $\Delta^2 x_{1t} = \Delta\, (\Delta x_{1t-1})$ and Δ^2 denotes second difference. The ADF statistic therefore, tests the following hypotheses. H_0: Δx_{1t} is I (1) versus H_1: Δx_{1t} is I (0) i.e. H_0: x_{1t} is I (2) versus H_1: x_{1t} is I (1), respectively. If the ADF statistic is not large and negative, H_0 is not rejected.

Engle and granger co-integration test

After stationarity is identified, the next step followed is formulation of co-integrating regression equation from which the residuals are used to test that the markets are co-integrated. Two markets x_1 and x_2 by themselves are non-stationary at their level and must be differenced once to generate stationary process. Then estimate the long-run equilibrium relationship of the two time series, which are of the same order of integration (co-integrating regression). This equilibrium error of the co-integration equation has to be stationary for co-integration between two integrated variables to hold good.

A linear transformation of the two original price series can result in a series that is stationary, at the same order of integration I(d). Consider two price series, x_{1t} and x_{2t}, which by themselves are non-stationary at their level and must be differenced once to generate stationary process. Engle and Granger (1987) develop formulation tests on residual from the co-integration regression. The formula:

$$x_{1t}= \alpha_o+\beta_o x_{2t}+e_t \quad (6)$$

Where: x_{1t} and x_{2t} are prices series of a specific commodity in two markets x_1 and x_2, t is time (for this specific study it is month) and e_t is the residual error term assumed to be distributed identically and independently. The residuals from the above equation are considered to be temporary deviation from the long run equilibrium. The ADF unit root tests are then conducted on the residual e_t.

$$\Delta e_t =\alpha + \sigma e_{t-1} + \sum_{K=1}^{n} \sigma i\Delta e_{t-1} + \epsilon_t \quad (7)$$

Where Δe_t is the ordinary least square residual that can be interpreted as the deviation of x_{1t} from its long-run path. In order to conclude that the price series are co-integrated, the residual from OLS estimation have to obey stationary process if the linear combination of two series is stationary (co-integrated).

The other alternative test for stationary (Co-integration) is the standard Durbin Watson test statistic from the first stage ordinary least square (OLS) estimate of the co-integrating regression. It is designated as:

$$CRDW = \frac{\sum_{t=2}^{T}\left(\hat{e}_t - \hat{e}_{t-1}\right)^2}{\sum_{t=1}^{T}\hat{e}_t^{\,2}} \quad (8)$$

The null hypothesis of no co-integration is rejected for values of CRDW, which are significantly different from zero.

Error correction model (ECM)

ECM enables to differentiate between long-run and short run relationship of time series analysis. As the series show long-run relationship, the ECM needs to be applied to investigate further on short-run interaction between variable. It involves the dynamic error correction representation of the co-integrated variables. If two variables are integrated of the same order and thus can be co-integrated, then there exists an error correction representation of the variables where the error corrects the long-run equilibrium. This is also known as Granger Representation Theorem (Sinahory and Nair, 1994). The dynamic model is obtained by introducing the residuals in to the system of variables in levels. Therefore, the Error Correction Model (ECM) is represented by the formula:

$$\Delta x_{1t} = \alpha + \sum_{K=1}^{n} \beta_1 \Delta x_{1t-k} + \sigma\Delta e_{t-1} + \sum_{K=1}^{n} \beta_2 \Delta x_{2t-k} + \beta_3 \Delta x_{2t} + \epsilon_t \quad (9)$$

Where β_1, β_2 and β_3 are the estimated short-run counterpart to the long-run solution, k represents the lag length of time, σ represents the speed of adjustment parameter, which indicates how fast the previous moves back towards the equilibrium and ϵ_t is stationary random process that capture other information not contained in either lagged values Δx_{1t} or Δx_{2t}.

Results and discussion

This section presents the econometric analyses. It was used to identify the integration within and between the secondary and central market respectively testing sequentially using tools like Correlation Coefficient, Unit root test, Co-integration test and Error correction model.

Correlation Coefficient

The correlation coefficient is a relative measure of the linear association between two series. Though there exists some limitation in using Pearson correlation coefficient to express the relationship between time series variables, it is still one of the most popular, frequently used and easy to calculate tools (Dahlgram and Blank, 1992; Tschirley, 1991).

The coefficient can indicate the strength of the relationship between two series. A low correlation coefficient is an indicator of a weak relationship between two markets. A correlation coefficient of above 60% is an indicator of strong connection, between 30 and 60%, a weak connection, and below 20% no connection between the variables (Goetz and Weber, 1987 in Admasu 1998). The result reveal that the correlation between price of Addis Ababa and Dire Dawa: Addis Ababa and Harar; Dire Dawa and Harar is 0.83, 0.82 and 0.90 respectively. This indicated that there was a strong relationship between onion price markets of Addis Ababa, Dire Dawa and Harar. But there is a very strong relationship between Dire Dawa and Harar.

Table 1. Pearson correlation coefficient between markets

Market	Harar	Dire Dawa	Addis Ababa
Harar	1		
Dire Dawa	0.9051	1	
Addis Ababa	0.828	0.8339	1

Source: own computation, 2012

Market Integration Analysis

Co-integration and error correction models, introduced by Engle and Granger (1987) were used to determine the market integration which was applied to the price series of sample markets. To do these STATA software was used. The data used in this research were monthly onion price of three markets: Addis Ababa, Dire Dawa and Harar. The data used for this study was five years monthly price data obtained from CSA. The first step was to determine whether onion price data were stationary at their levels. If they were not, other investigations should be undertaken to determine their order of integration by differencing the price series until they reach their stationarity.

Unit root test

A non-stationary series is integrated of order I (0), while a stationary series is integrated of the order I (1). The examination of market integration was done in three markets: Addis Ababa, Dire Dawa and Harar. All price series were tested, and the results were as table follows.

Unit root tests for level

Table 2 Unit root test

Market	Test statistic	/ τ /
Harar	-2.172	0.2167
Dire Dawa	-2.557	0.1022
Addis Abeba	-2.739*	0.0675

* indicate significant at 10% significant level.
Source: own calculation, 2012

Accordingly, the result of the unit root test for the hypothesis showed that onion prices indicate that Harar and Dire Dawa price series were non-stationary at their levels with exception of Addis Ababa price series.

Unit root tests for 1st difference

The results of the unit root test show that prices were stationary at first difference in Harar and Dire dawa. This shows that the order of integration of Harar and Dire Dawa monthly prices is one, I (1). Thus, one can test for market integration between Harar and Dire Dawa onion markets. Since the price series for Addis Ababa was stationary process at its level, there was no need to have co-integration test as we know that they do not co-integrate with Harar and Dire Dawa markets. In other words Addis Ababa was stationary at level.

Table 3. First difference unit root test

Market	Test statistic	/ τ /
Harar	-7.571***	0.0000
Dire Dawa	-7.908***	0.0000

*** indicate significant at 1% significant level
Source: own calculation, 2012

Co-integration test

The Engle and Granger test uses a standard OLS estimation for the long run relationship between the pair market prices. Table 22 indicates the OLS co-integration estimate. When the price in Dire Dawa rises by 1%, there is a corresponding long run increase in the Harar price level by 1.019%.

Table 4. OLS co-integration test

Harar	Coef.	Std. Err.	t-value
Dire Dawa	1.019	0.052	19.43***
Constant	0.120	0.305	0.4

*** indicate significant at 1% significant level.
Source: own calculation, 2012

In order to conclude that the price series are co-integrated, the residuals from the OLS estimation have to obey stationarity. To confirm any stable equilibrium relationship between two prices, stationary test is conducted on the residual. The DF/ADF test is used to test for a longer co-integration relationship in the residual of the pair Harar and Dire Dawa markets. The co-integration tests on residual summarized in Table 23 confirm the existence of co-integration between the different regional markets. The result leads to conclude that Harar onion market has been integrated with Dire Dawa market. Thus, the test result supports the prediction under expectation that the prices are co-integrated. So, the markets are spatially integrated.

Table 54. Residual regression test on unit root

Residuals	ADF t-value	Mackinnon P-value	Critical value
Harar - Dire Dawa	-7.79***	0.0000	-3.57

Note: *** indicates significance at 1% significance level.
Source: own calculation, 2012

Error correction model

Co-integration is not a sufficient condition for full market integration or it does not imply full market integration. Since the series show long run relationship, Error correction model is applied to investigate further on short run relationship between markets. Error correction model is necessary to test for the full market integration. This is achieved through estimating by regressing the change in price series of current market price on current and lagged values of the change in price series on the first lagged of the residuals from the long run regression.

Table 6. Error correction model

Pair markets	α	β_1	σ	β_2	β_3	F	R^2
Harar – Dire Dawa.	-0.469	0.018	-0.258*	0.091	0.695***	16.34***	0.761
t-value	-1.59	0.16	-1.82	0.66	8.94		
p-value	0.118	0.872	0.075	0.511	0.000		

*** and * indicate the statistical significance at the 1% and 10% levels of significance respectively.
Source: own calculation, 2012

The result showed that the conditions for error correction were fulfilled; as the computed result of $\sigma < 0$. This is the speed with which the system approaches its equilibrium depends on the magnitude of the estimate σ, the closer it is to -1 the faster the system approaches its equilibrium. That is, $\sigma = -1$ means there is full integration, while $\sigma = 0$ means no integration. But, the computed result showed that $\sigma = -0.258$ which is far from -1. So, it is concluded that there is a slower adjustment of the system towards the equilibrium after a shock. This is the speed of price adjustment measuring the rate at which the price difference in period t-1 is corrected to achieve price equilibrium between the market pair. That is, the result of error correction shows that the coefficient of the lagged error term e_{t-1} was found to be negative. This means there is a short run effect of Harar price on that of Dire Dawa prices. But, the hypothesis for existence of short run/full market integration was rejected because the calculated value (16.34) exceeds the tabulated value at F (9, 46) which is 2.89.

Solomon (2004) and Rahima (2006) also obtained a comparable result of no integration between regional and central market as well as no short run and full market integration between markets on cattle and pepper price. Sixty nine percent changes in price of Harar market is due to the current price change in Dire Dawa. The speed at which the price approaches equilibrium depends on the magnitude of σ which is equal to -0.258 between the pair market. Negative sign indicated that the adjustment is towards the equilibrium. That is 25.8% disequilibrium were adjusted at two months and full adjustment requires four month time period (Full adjustment requires, approximately $(1-\delta)/\delta$ units of time of analysis, where δ is the positive coefficient of the lagged error term is adopted from Admasu, 1998).

Conclusion and Recommendations

According to the finding of this study, Pearson correlation coefficient revealed that there was a more strong relationship between secondary markets than secondary and central market. Integration research also depicted that central market (Addis Ababa) was not integrated with the regional markets (Dire Dawa and Harar). This implies that there was a poor information system and no trade to each other between central and secondary market. However, long run equilibrium relationships in pair markets (Harar and Dire Dawa) were shown co-integration over the sample period.

The result from short-run estimates indicated slower adjustment towards the long run equilibrium level market. From the results of onion market, it is evident that the prices in pair markets are co-integrated and follow a long run relationship. This result supports the hypothesis of integrated markets for onion in regional markets of the study area. However, the hypothesis of short run/full market integration was rejected. Around 26% disequilibrium requires four months period for full adjustment towards the equilibrium. Based on this result, secondary onion markets which are found nearest to production area were spatially integrated.

Efficient information flow is a contributing factor to increase market integration. So, it is better if awareness creation and provision of on time price information is conducted. On the other hand, good transportation also facilitates for better geographical relationship among different markets spatially far from each other. So, facilitation for minimum transportation cost is required to enhance better integration. To improve the integration of these markets, continuous involvement is desired, which increases the benefits of producers and then consumers.

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Journal of Economics and Sustainable Development www.iiste.org
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.5, No.27, 2014

Annex

Price series of onion in months collected from CSA which covers a period (2006-2011): Harar (HA), Dire Dawa (DD) and Addis Ababa (AA) markets.

Time	HA	DD	AA
1	2.50	2.57	2.67
2	2.50	2.59	2.47
3	2.14	2.50	3.93
4	2.33	2.57	4.26
5	2.67	2.59	2.92
6	4.17	3.86	3.88
7	4.00	4.19	4.09
8	3.50	3.01	3.57
9	3.00	3.21	2.85
10	3.00	3.26	2.62
11	3.67	4.06	3.42
12	4.00	4.55	3.57
13	4.50	4.78	5.06
14	4.00	4.08	4.23
15	4.50	4.00	4.42
16	3.83	4.50	4.11
17	5.00	4.50	3.90
18	3.00	2.33	2.24
19	2.50	2.00	2.04
20	2.33	2.00	1.78
21	3.00	2.50	2.03
22	3.00	3.50	2.78
23	4.00	5.00	3.90
24	5.00	4.33	5.46
25	4.50	4.50	5.25
26	4.50	4.00	3.82
27	4.50	4.00	3.73
28	5.00	5.00	4.19
29	5.00	5.00	4.16
30	5.00	4.67	4.26
31	5.00	7.00	6.03
32	6.50	7.00	6.51
33	8.00	8.00	7.30
34	7.00	7.00	5.54
35	5.17	5.00	4.53
36	5.00	6.00	5.01
37	7.50	7.00	6.68
38	6.50	5.00	4.92

39	5.83	4.17	4.10
40	5.67	4.50	3.88
41	5.00	5.00	3.09
42	5.19	5.00	3.95
43	4.98	5.00	4.30
44	6.91	6.00	5.72
45	6.00	6.38	4.86
46	7.75	8.00	7.07
47	8.25	8.00	9.03
48	7.40	7.66	5.94
49	13.66	15.00	10.43
50	15.00	14.00	9.88
51	11.83	9.00	8.84
52	11.16	8.00	8.06
53	9.16	9.00	7.06
54	8.53	6.00	4.87
55	10.00	6.65	5.80
56	6.24	6.65	4.54
57	5.08	5.00	3.05
58	4.47	6.00	2.90
59	5.36	4.83	4.00
60	6.39	5.00	5.98

Source: CSA