Asian Journal of Agricultural Extension, Economics & Sociology

38(3): 67-76, 2020; Article no.AJAEES.56026
ISSN: 2320-7027

Price Transmission and Factors Influencing the Price of Onions in Tanzania

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/AJAEES/2020/v38i330325
Editor(s):
(1) Dr. Zhao Chen, University of Maryland, USA.
Reviewers:
(1) Innocent Gumulira, University Malawi, Malawi.
(2) Husein Mohamed Irbad, Annamalai University, India.
Complete Peer review History: http://www.sdiarticle4.com/review-history/56026

Original Research Article

Received 02 February 2020
Accepted 09 April 2020
Published 12 April 2020

ABSTRACT

This article analyzes the transmission of prices between marketing agents and the factors affecting onion prices at the consumer level. The Error Correction Model-Engle Granger (ECM-EG) was used to test the price transmission by including the impact of the rise and fall of producer, wholesale and retail prices in past periods. The Error Correction Model (ECM) was applied to the factors affecting onion prices. The test results showed that price transmission was asymmetrical in the short and long-run. With regard to factors, the results show that consumer price in the short-run was influenced by wholesale prices, producer prices and the price of fuel while in the long-run it was influenced by wholesale prices, producer price, price of fuel and consumer prices in the previous period (t-1). These results suggest the existence of a short-term adjustment cost and a long-term market power which distorts price transmission.

Keywords: Price transmission; onion market analysis; long-run; short-run equilibrium.

1. INTRODUCTION

Horticulture is one of the fast growing agricultural sub-sectors in Tanzania due to climatic condition favorable to its development [1]. The sector makes a significant contribution to food security, nutrition improvements and economic growth [2-3]. From an economic point of view, horticultural

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products have a high economic value, so they can be used as a source of smallholder income and country's export earnings [4]. Fruits and vegetables are part of the horticultural subsector with high demand. Statistics on total food consumption in sub-Saharan Africa show that fruits and vegetables are the second most important food expenditure both for urban (21.02%) and rural households (19.54%) [5]. However, spending differs across countries according to different livelihood levels and gender groups.

In Tanzania, onion is one of the main horticultural crops. The country produces approximately 189,604 metric tonnes of onions per year, which ranks it 12th among the onion producing countries in Africa and 49th worldwide [6]. The crop is mainly produced in the northern and southern highlands and the central plateau. FAO statistics [6] show that the average yield of onions in the country is around 10.06 tonnes/ha while the world average is 19.31 tonnes/ha. The cultivation is mainly practiced by small farmers who sell on local markets with little export to neighboring countries.

However, the sector suffers greatly from price fluctuations and market losses caused by the flooding of produce on the market, especially during the harvest. Due to the heavy dependence on rain-fed agriculture, most farmers grow onions in the same season, causing an imbalance between supply and demand for the selected commodity. Tanzania is experiencing an influx of onions around May as most varieties ripen around this time. Large fluctuations in onion prices lead to increased marketing margins and lower prices received by farmers [7]. According to Nyange et al. [8] such a trend occurs because fluctuating prices give traders the opportunity to distort price information. These problems affect the price transmission process from producers to consumers.

In addition, the price transmission process is also linked to the behavior of the marketing institutions involved in the distribution of a commodity. In the price formation process, the behavior of farmers and traders has an important role as it is linked to the price they receive or offer. In this case, each market player adjusts their behavior towards the market structure to obtain the maximum profit. For an agricultural market system to be effective, there must be perfect market integration and full price transmission, with instantaneous adjustment of prices to internal or external changes to the system. Such a system would allow producers, intermediaries, and consumers in the marketing chain to derive maximum benefit. This would help to eliminate unprofitable arbitrage and integrate spatially differentiated markets and would also guarantee an efficient allocation of resources in space and time [9].

Therefore, this study aims to examine marketing efficiency in relation to the onion market behavior. In particular, it focuses on the transmission of prices between marketers and the formation of prices through the analysis of price determinants.

2. THEORY AND EVIDENCE

The theory of market integration and price transmission approaches are used to examine transmission at the producer level, wholesalers and retailers of onions in Tanzania. According to price theory, the price of a commodity is the result of an interaction between the seller and the buyer [10]. On the buyer's side, the more the demanded goods will increase the price, while on the seller's side, the more the supplied goods will reduce the price. However, for food/agricultural products, price formation is largely influenced by supply (supply shock) than demand shock, and this is because in short-run demand side tends to be stable as a result of developed consumption trends [11]. In addition to being influenced by internal supply and demand factors, commodity prices can also be influenced by prices on international markets. Under the free trade regime, domestic commodity prices will move to follow international prices.

Several studies have been carried out to assess the transmission of price variations between farmers and wholesalers and between wholesalers and retailers on different types of agricultural products [12-15]. Onyuma et al. [12], Jayasinghe-Mudalige [13] and Honfoga et al. [16] found that retailers' responses to a price increase at the wholesale level were faster than their responses to price decrease, while price decrease at the wholesaler was transmitted more quickly to farmers than the rise. They also found that price changes at the upstream level influence price decisions at the wholesale and retail levels.

With regard to price determinants, Minot [17] found that traders tend to be asymmetrical in using information to raise and lower prices. Scarcity and rising marketing costs are the main

drivers behind the decision to increase prices. However, according to Mutayoba [2], the cost of marketing is not the only major factor in determining prices. The sales strategy adopted by most retailers of agricultural produce is to reduce retail margins rather than reducing costs, especially during periods of high supply in order to compete with each other for consumers. In addition, Bassey et al. [18] in their research in Nigeria explained that traders generally communicate with each other for prices and other marketing information. So, when setting the price, each trader pays attention to the prices of other traders.

3. MATERIALS AND METHODS

3.1 Data Sources

The study uses secondary data in the form of monthly time series data from January 2004 to December 2018 consisting of; the average price of onion in producer centers, at the wholesale level, and at the retail level in Tanzania shillings per 100 kg bag. It also includes the supply of onion to the wholesaler (tonnes) and the price of fuel as a proxy for transportation costs (Tsh/liter). Data were obtained from the Tanzanian Ministry of Industry and Trade, Ministry of Agriculture, and the Regulatory Authority for Energy and Water Services (EWURA). The descriptive results of onion prices among producers (Arusha region), wholesalers and consumption centers (Dar es Salaam region) are presented in Table 1.

3.2 Analytical Framework

This study relies on the Error Correction Model-Engle Granger (ECM-EG) to analyze price transmission between marketing agents and the Error Correction Model (ECM) to analyze the factors affecting prices of onions at the final consumer [19]. The ECM-EG model is specified as in equations 1 and 2.

Where PW indicates price of onion at wholesale, PP price of onion at producers, and PC price of onion at consumers. Asymmetrical price transmission testing in the short run uses the following hypothesis $H_0: \beta_{1i} = \beta_{2i}$, while in the long run is observed through ECT^+ and ECT^- coefficients or $H_0: \pi_1 = \pi_2$. The plus $(+)$ and minus $(-)$ signs indicate an increase and decrease in price.

Unit root is tested using Augmented Dickey Fuller (ADF) regression as proposed by Dickey and Fuller [20] Cointegration test is then performed to see whether there is a long-term relationship between the variables used in the model. Furthermore, the optimal interval length in the model is performed to capture the effect of each variable on other variables in the system. This is be done by estimating the parameters of each model in every possible lag p. The optimal p value is determined based on the Schwarz Criterion (SC) value. Granger Causality approach is used to empirically investigate the presence of price series which affect other price levels.

To analyze the factors influencing the price of onion at the level of Tanzanian consumers, we use the ECM model. The ECM method is used to balance the short-term economic relations of variables that already have a long-term economic relationship. The ECM model is specified as in equation 3.

Where PC is price of onion at consumer level, PW price of onion at wholesale, PP price of onion at producer, S supply of onion at wholesale, PF price of fuel, ECT error correction term, t time, and e_t error term.

4. RESULTS AND DISCUSSION

4.1 Price Transmission

Before analyzing price transmission, one must test the stationary of price series and cointegration. This helps to see the consistency of time series data movement and prevent spurious regression. To address this, Dickey and Fuller [20] proposed a test to detect the non-stationarity of series using the Augmented Dickey-Fuller test (ADF). Table 2 depicts the results of unit root test based on ADF statistics on levels and first difference of the variables. The null hypothesis of the ADF test is that the variable has a unit root (non-stationary). The results of unit root tests reveal that all series are I (1)

$$\Delta PW = a_0 + \sum_{i=1}^{n} \beta^- \Delta PW_{t-i}^- + \sum_{i=0}^{n} \beta^- \Delta PP_{t-i}^- + \pi_1 Z_{t-1}^- + \sum_{i=1}^{n} \beta^+ \Delta PW_{t-i}^+ + \sum_{i=0}^{n} \beta^+ \Delta PP_{t-i}^+ + \pi_2 Z_{t-1}^+ + \quad (1)$$

$$\Delta PW = a_0 + \sum_{i=1}^{n} \beta^- \Delta PC_{t-i}^- + \sum_{i=0}^{n} \beta^- \Delta PW_{t-i}^- + \pi_1 Z_{t-1}^- + \sum_{i=1}^{n} \beta^+ \Delta PC_{t-i}^+ + \sum_{i=0}^{n} \beta^+ \Delta PW_{t-i}^+ + \pi_2 Z_{t-1}^+ + e_t \quad (2)$$

$$PC_t = a_0 + a_1 PW_t + a_2 PP_t + a_3 S_t + a_4 PF_t - \gamma ECT(-1) + e_t \quad (3)$$

Table 1. Descriptive results of the nominal producer, wholesale and consumer onion prices

	Log(Producer price)	Log(Wholesaler price)	Log(Retailer price)
Mean	11.658	11.454	11.730
Median	11.717	11.544	11.752
Maximum	12.307	12.246	12.365
Minimum	10.744	10.481	10.764
CV	0.036	0.042	0.030
Std. Dev.	0.416	0.483	0.356
Skewness	-0.470	-0.491	-0.362
Kurtosis	2.026	2.144	1.988
Observations	180	180	180

Notes: CV, coefficient of variation

Table 2. Unit root tests

	ADF	
	Level (constant, no trend)	**First difference (constant, no trend)**
Producers	-2.168	-10.262***
Wholesalers	-1.720	-11.159***
Retailers	-1.550	-10.446***

*Notes: *** reject the null of unit root at 1% significance level*

Table 3 presents the result of Johansen cointegration test between producers, wholesale and retail prices of onions in Tanzania. The testing is determined based on the SC criterion, where the assumption chosen is intercept (no trend) and the optimum lag length is also based on the SC criteria where the lag used is lag 1. The findings shows that there is a long-term relationship between variables. The cointegration of the relationship also shows that price changes at the upstream level are transmitted to the level above (downstream).

The results of the causation tests are presented in Table 4. The null hypothesis of non-causality between price movements at the upstream level and price movements at the downstream level has been rejected. Table 4 shows that both wholesale and producer prices affects each other, however the magnitude of wholesale price on produce is higher than that of producer on wholesale price. In the wholesale-consumer relationship, this shows that wholesale prices affect prices at the retail level while retail prices do not affect prices at the wholesale level. Thus, showing price formation between onion marketing institutions in Tanzania is more supply-side than demand-side. According to Vassalos [21], the demand for agricultural products, especially basic food products such as onions, tends to be stable. Although pressure on the demand side may occur, the degree is relatively low. Pressure on the demand side comes only from an increase in population and income. Both of these factors are more easily suppressed, compared to weather and season factors that affect the supply side.

Table 3. Cointegration between producer, wholesale and retail prices of onions

Rank	Producers - Wholesalers	Wholesalers – Retailers
0	32.816*	28.858*
1	3.137*	3. 494*

*Note: * Significant at the 5% level*

Table 4. Granger causality test

Causality	Number of lags	t-statistic
Wholesaler → Producer	1	-3.714*
Producer → Wholesaler	1	-1.562*
Wholesaler → Retailer	1	-5.248*
Retailer → Wholesaler	1	-1.492

*Note: * significance level at 5%, → direction of causality*

Table 5 presents the results of the asymmetric error correction model. In short-run price transmission, the results reject the null hypothesis $H_0: \beta_{1i} = \beta_{2i}$. This implies that the wholesale price adjusts differently in the short-run to positive contemporaneous produce price changes compared to negative contemporaneous producer price changes. A significant value meaning both when there is an increase and decrease in the price of onion in the producer level at time t, will be responded by wholesalers. Again, the result implies that wholesale prices adjust differently to past positive and negative changes in producer prices. The significant value is only observed in the decline in producer prices. This means that only the increase in prices at producer level $(t-1)$ is responded by wholesalers. In addition, the negative value of the coefficient means that when prices drops at the producer level during the previous period, traders will respond by raising prices.

In the long-run transmission between producers and wholesalers, the study observed a similarity between the signs of coefficient ECT^+ and ECT^-. The coefficient on ECT^+ is negative with a value of 0.834 while ECT^- with a value of 0.562. The ECT^+ coefficient shows that when the difference is greater than the equilibrium line, the price of onions at the wholesale level will adjust down. The balance adjustment period is based on the value of the coefficient, which is approximately 9 months. However, since the value is not significant, the deviation will not affect the price of onions at the wholesale level. The ECT^- coefficient shows that the deviations that occur when it is above the equilibrium line will certainly return to the equilibrium line. The balance adjustment period is based on the value of the coefficient which is approximately 6 months. In other words, when there is a deviation due to price increases at the producer level, wholesale prices will increase and return to equilibrium over the next 6 months. According to the sign and significance of the coefficient variables of ECT^+ and ECT^- it can be concluded that the transmission of onion prices at the producer level to wholesale prices is symmetrically. Although deviations due to rising onion prices at the producer level (ECT^-) will be corrected faster than deviations due to an increase in price at the producer level.

Furthermore, in the wholesale-consumer relationship, the significance of the coefficients of price transmission in the short term between wholesale and consumer shows that changes in price increase are transmitted differently from changes in price decline. This means both increase and decrease in the price of onion in the producer level at time t, will be responded by retailers. For wholesale prices in the previous period $(t-1)$, result shows different response by consumer to positive and negative changes in wholesale prices with insignificant values. This means that despite the difference in response, the response will not affect the formation of prices at the consumer level.

In the long-term relationship between wholesalers and consumers, the value of the ECT shows a significance relationship only in the ECT^- coefficient (-0.212). The two negative coefficient signs $(ECT^+ \; and \; ECT^-)$ indicate that when the price deviation is above the balance line, will certainly return to the equilibrium condition. The ECT^- coefficient shows that the deviation caused by an increase in the price of onion at the wholesale level will occur in the next 2 month period at the consumer level. This means that if there is an increase in wholesale prices, then after 2 months of wholesale prices, the prices at the retail level will increase. Meanwhile, the coefficient on ECT^+ with insignificant coefficient of -0.895 indicates that when there is a fall in prices at the wholesale level, prices at the retail level will adjust down in the next 10 months. However, with an insignificant value, the deviation will not affect the price of onions at the consumer level. Furthermore, the percentage of price changes due to changes in the supply side between marketing institutions are presented in Table 6.

Table 6 shows that when there is a decrease in prices at the producer level by 10% the wholesaler will respond by reducing prices by 4.91%, whereas when there is a decline in prices at the wholesale level by 10%, the retailer will reduce the price by 2.12%. On the other hand, when there is a 10% increase in producer prices, wholesalers will respond to a 7.35% increase in prices, whereas when there is a 10% increase in wholesale prices, retailers will respond by 3.55% increase. This shows that in the Tanzanian onion marketing chain, wholesalers are more responsive to price changes.

In addition, the transmission elasticity of prices between producers and wholesalers when prices fall is less than when producer prices increase. The elasticity value at the farmer's price increase greater than 1 indicates the transmission between the two is elastic. This means that if

there is a change in prices at the farm level, the prices at the wholesale level will immediately change while the transmission of prices at the farm level when experiencing a decrease is inelastic. Conversely, the price transmission elasticity between the wholesaler and consumers is greater when price increase than when the price drops in the short term with a value greater than 1. This shows that the onion retailer will change quickly to changes in the price of the onion at the wholesale level.

Wald test results show that in the short term there is an asymmetrical transmission of prices in the both farmer-wholesaler and wholesale-consumers' relationships. Therefore, the Wald test results support a descriptive test of the existence of different responses between positive shock and negative shock. Regarding this matter, Minot [17] explained that the asymmetrical price in the short run is caused by the additional amount of costs that businesses must incur to adjust the price. In economics these costs are known as adjustment costs or menu costs. Meanwhile, in the long run the positive and negative ECT coefficients show different results. In the farmer-wholesaler model it shows insignificant results while the wholesaler-consumer shows significant results. This implies that in the long-run there is an asymmetrical transmission to the wholesale-consumer relationship.

Overall, there are differences in factors that influence the price transmission process between onion marketing institutions in Tanzania. The producer-wholesaler relationship is more influenced by the adjustment cost while the wholesaler-retailer is caused by the existence of market power at the wholesale level. The difference in these factors is related to the consumers they face. The fundamental difference between price transmission caused by market power and cost adjustment is time. Adjustment costs that occur in the short term are only delaying the process of transmission or price adjustment, and in the long run there will be a perfect price adjustment [12,17]. While asymmetry caused by market power can last for a long time, because it not only affects the time of adjustment but also affects the magnitude of adjustment [21]. These results indicate that farmers and consumers are in a weak bargaining position and conversely intermediary traders are in a dominant position in the onion trade in Tanzania.

Table 5. Estimated results of the ECM-EG asymmetric model

Variable	Producer → Wholesaler	Variable	Wholesaler → Retailers
ΔPW_{t-1}^{-}	-0.163 (0.254)	ΔPC_{t-1}^{-}	0.382 (0.135)
ΔPW_{t-1}^{+}	0.456 (0.000)	ΔPC_{t-1}^{+}	0.023 (0.741)
ΔPP_{t}^{-}	1.147 (0.000)	ΔPW_{t}^{-}	0.615 (0.000)
ΔPP_{t}^{+}	0.415 (0.001)	ΔPW_{t}^{+}	0.582 (0.001)
ΔPP_{t-1}^{-}	-0.620 (0.003)	ΔPW_{t-1}^{-}	0.114 (0.323)
ΔPP_{t-1}^{+}	0.128 (0.531)	ΔPW_{t-1}^{+}	-0.278 (0.164)
ECT^{-}	-0.562 (0.006)	ECT^{-}	-0.212 (0.000)
ECT^{+}	-0.834 (0.000)	ECT^{+}	-0.895 (0.164)
Constant	108.632 (0.433)	Constant	-0.003 (0.762)
R^2	0.892	R^2	0.759
R^2-adj	0.886	R^2-adj	0.734
F-statistic	112.547 (0.000)	F-statistic	30.631 (0.000)
DW-Stat.	1.793	DW-Stat.	2.185

Note: Probability values in parentheses

Table 6. Price transmission elasticity with the ECM-EG model

Causality	Variable	Short-run	Long-run
Producer → Wholesaler	ΔPP^-	0.491	0.422
	ΔPP^+	0.735	0.318
Wholesaler → Retailers	ΔPW^-	0.212	0.452
	ΔPW^+	0.358	0.291

Table 7. Wald test estimation results

Hypothesis	F-statistic
$H_0: \Delta PP_t^- = \Delta PP_t^+$	2.531 (0.406)
$H_0: \Delta PP_{t-1}^- = \Delta PP_{t-1}^+$	4.215 (0.073)
$H_0: \Delta PW_t^- = \Delta PW_t^+$	0.092 (0.845)
$H_0: \Delta PW_{t-1}^- = \Delta PW_{t-1}^+$	2.383 (0.116)
$H_0: ECT^- = ECT^+$ (producer → wholesaler)	0.642 (0.217)
$H_0: ECT^- = ECT^+$ (wholesaler → consumers)	4.933 (0.035)

Note: Probability values in parentheses

Table 8(a). ECM estimation results - short run

Variable	Coefficient	Std. error	Prob.
Wholesale price	0.356	0.057	0.000
Wholesale price (-1)	-0.042	0.064	0.592
Producer price	0.318	0.053	0.000
Fuel price	0.563	0.048	0.000
Fuel price (-1)	0.332	0.052	0.076
Consumer price (-1)	0.151	0.193	0.241
Onion supply	0.005	0.017	0.745
ECT (-1)	-0.695	0.182	0.000
Constant	-0.003	0.006	0.482
R^2	0.752		
R^2-adj	0.733		
F-statistic	34.620		
DW- stat	1.685		
Prob.	0.000		

Table 8(b). ECM estimation results - long run

Variable	Coefficient	Std. error	Prob.
Wholesale price	0.467	0.082	0.001
Producer price	0.321	0.073	0.000
Fuel price	0.344	0.065	0.000
Onion supply	-0.031	0.057	0.333
Consumer price (-1)	0.325	0.051	0.000
Constant	0.169	0.650	0.873
R^2	0.825		
R^2-adj	0.816		
F-statistic	197.624		
DW- stat	1.352		
Prob.	0.000		

4.2 Factors influencing Onion Prices at the Consumer Level

Table 8 (a) and (b) presents the empirical results of the Error Correlation Model on factors affecting the formation of onion prices at the consumer level in the short and long run. To run the model, we first checked for stationarity and cointegration. Estimation results show that wholesale price positively affects the consumer price of onion in the short run. The coefficient value of 0.385 in the period t means that each 10% increase in wholesale prices will increase the price of onions at the consumer level by 3.86%. The price increase is because wholesale prices are cost component for retailers who set prices based on the purchase price.

The variable producer price has a significant and positive effect in the short run on consumer prices. The coefficient value of this variable is 0.332 which means that a 10% increase in producer prices will increase consumer prices by 33.2%. This is consistent with the assumption that higher producer prices will increase purchasing costs which are passed on directly to consumers through wholesalers and retailers.

The price of fuel has shown a significant effect in the short t and long run $(t-1)$. The short-run coefficient is 0.563, which means that a 10% increase in fuel prices will increase the price of onions at the consumer level by 5.63%. This implied that the price of fuel used as a proxy of transport/distribution costs is an important factor in the formation of onion prices. The study used the price of diesel.

The supply of onions entering Dar es Salaam (large onion market) has no significant effect on the price formation of onions at the consumer level. This is because the retailer tends to adapt more to changes in wholesale prices than to quantity in the market. On the other hand, the price of onions at the consumer level shows insignificant value. This means that the current price formation of onion for consumers is not influenced by previous prices. The results also show that the model specifications used are valid. This is observed from the value of the error correction term (ECT) which is significant with a negative sign.

Of all the factors, the price of oil (cost of transportation) is the factor having the greatest influence on the formation of onion prices at the consumer level. This implies that any change in this variable will have a significant impact on the price of onions at the consumer level. The result is in line with Zafeiriou et al. [22] who argued that the impact of an increase in fuel prices on commodity prices and overall inflation is greater than other distribution factors. Furthermore, the factors that affect the price of onions at the consumer level in the long run are presented in Table 8(b).

5. CONCLUSION AND POLICY IMPLICATION

This article analyses the possible short and long-run relationship between different levels of onion supply chain and factors influencing price of onions in Tanzania. Causality analyses showed evidence of relationship between producer, wholesale and retail prices. Furtherer analysis highlighted inefficiency in onion marketing between producers and consumers. Inefficient marketing was observed from the asymmetric transmission of prices between onion marketing institutions where both producer-wholesaler and wholesaler-retailer relationships are asymmetric in the short-run while the wholesaler-retailers are asymmetric in the long-run. The formation of onion prices at the consumer level in the short-run is influenced by wholesale prices, producer prices and fuel price while in the long run is influenced by wholesale prices, producer prices, fuel, and consumer prices of onions in the previous time.

The results suggest that policy intervention for enhancing onion marketing efficiency in short and long run may take the form of improving market information systems, strengthening farmers marketing groups and networks, reducing number of informal fees in the onion supply-chain, improving road networks and transportation facilities, which may eventually reduce transport cost and ensure consumer's to get the product at a reliable price. Interventions should also focus on improving post-harvest handling practices at producer level and increasing capacity of farmers to engage in product value-chains activities.

6. DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for

any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/56026