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Is There Any Link Between Cattle Milk Price and Beef Production? Empirical Evidence from Turkey

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Abstract

Purpose: This study aims to investigate the impact of cattle milk prices on beef production from 1970 through 2018 for Turkey.
Design/Methodology/Approach: The structural properties of the series and prior tests refer to that cointegration analysis should be conducted to establish the impact of cattle milk prices on beef production. In this context, the bounds testing approach is employed to analyze the long-run relationship between variables. Following the long-run cointegration relationship between variables is confirmed, the econometric model of the study is estimated by using the autoregressive distributed lag (ARDL) approach.
Findings: The findings of the bounds testing approach indicate that the existence of the cointegration relationship between cattle milk prices and beef production in the long run. According to the estimation results of the ARDL model, beef production decreases owing to higher milk prices. The negative effect of cattle milk prices on beef production may be explained that as milk prices increase, the number of dairy cows dispatching to slaughter decreases, and hereby beef production cuts down. On the other hand, cutting down milk prices leads to an increase in dispatching of dairy cows to be slaughtered, which results in harming the production of male calves (the main fattening material) and the dairy market. Therefore, policy measures to prevent the fluctuations in milk prices will able to support beef production as well.
Originality/Value: The study is, to the best of our knowledge, the first one which focuses on the link between cattle milk prices and beef production for Turkey.
Key words: Cattle Milk Price, Beef Production, ARDL Cointegration Approach.

Sığır Sütü Fiyatı ile Sığır Eti Üretimi Arasında Bir Bağlantı Var mı? Türkiye'den Ampirik Bulgular

Özet

Amaç: Bu çalışmanın amacı Türkiye'deki sığır sütü fiyatlarının sığır eti üretimi üzerindeki etkisini 1970-2018 dönemi kapsamında analiz etmektir.
Tasarım/Metodoloji /Yaklaşım: Çalışmanın ekonometrik modelinde yer alan serilerin yapısal özellikleri ve önsel testler, sığır sütü fiyatlarının sığır eti üretimi üzerindeki etkisini belirlemek için eşbütünleşme analizinin yürütülmesi gerektiğine işaret etmektedir. Bu bağlamda ekonometrik modelde yer alan değişkenler arasındaki uzun dönem eşbütünleşme ilişkisi sınır testi yaklaşımı kullanılarak analiz edilmektedir. Değişkenler arasında uzun dönem eşbütünleşme ilişkisi tespit edildikten sonra çalışmanın ekonometrik modeli gecikmesi dağıtılmış otoregresif sınır testi (ARDL) yaklaşımı kullanılarak tahmin edilmektedir.
Bulgular: Sınır testi yaklaşımından elde edilen bulgular, sığır sütü fiyatları ile sığır eti üretimi arasında uzun dönemli eşbütünleşme ilişkisinin varlığını doğrulamaktadır. ARDL modeli tahmin sonuçlarına göre sığır eti üretimi sığır sütü fiyatlarındaki artış nedeniyle azalmaktadır. Sığır sütü fiyatlarının sığır eti üretimi üzerindeki negatif yönlü etkisi, süt fiyatlarındaki artış dolayısıyla daha az sayıda süt ineğinin kesime gönderilmesi kanalıyla açıklanabilmektedir. Diğer taraftan, süt fiyatlarındaki düşüş daha çok sayıda süt ineğinin kesime gönderilmesine yol açmakta ve dolayısıyla erkek buzağıların üretimine (ana besi malzemesi) ve süt pazarına zarar verebilmektedir. Bu nedenle, süt fiyatlarındaki dalgalanmaları önlemeye yönelik politika önlemlerinin et üretimini de destekleyebileceği düşünülmektedir.
Özgünlük/Değer: Bildiğimiz kadarıyla bu çalışma Türkiye'deki sığır sütü fiyatları ile sığır eti üretimi arasındaki bağlantıya odaklanan ilk çalışma olma özelliği taşımaktadır.
Anahtar kelimeler: Sığır Sütü Fiyatı, Sığır Eti Üretimi, ARDL Eşbütünleşme Yaklaşımı.

1.INTRODUCTION

Nowadays, the main problem in human nutrition is unbalanced nutrition and related human disorders (Aktaç et al., 2019). In this context, animal proteins play an important role in balanced nutrition (Cevger et al., 2008). According to the Ministry of Health of the Republic of Turkey (2019), animal source foods such as milk and meat should be absolutely in a person's daily diet. Besides milk and meat production constitutes the basis of healthy nutrition, it is an important line of business and source of income within agricultural enterprises. In addition to crop production, animal production not only helps to meet the current costs of the agricultural enterprise by providing regular cash flow, but it also serves as an important risk management tool and helps the agricultural enterprise survive (Hayran and Gül, 2015). Bayramoglu et al. (2018) estimated that the number of cattle in Turkey for the realization of beef consumption should be increased 55.49% compared to 2016 in the next decade. In this respect, it is important to investigate the barriers to meat and milk production and to develop policy recommendations to support production. However, while implementing these support policies, it should be taken into account that beef milk and beef production are complementary production branches.

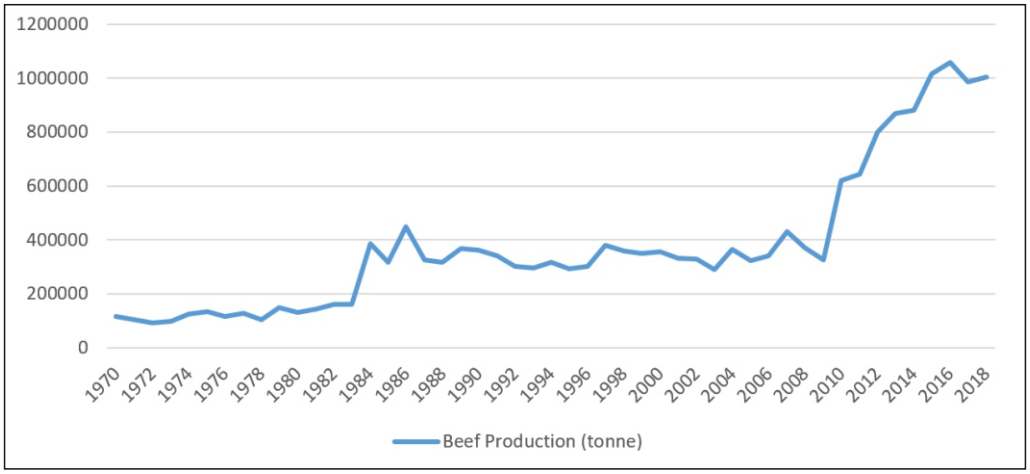
In literature, the relationship between the changes in the prices of vegetal/animal products and the production amounts of these products has been studied in detail. Some of these studies are; for the sunflower production and its price by Berk (2017), for the wheat production and its price by Özçelik and Özer (2006), for the meat production and its price by Akgül and Yıldız (2010), for the strawberry production and its price by Çobanoğlu (2010), for the cow milk production and its price by Ozsayın (2017), for the garlic production and its price by Hasan and Khalequzzaman (2015). Akgül and Yıldız (2016) investigated the relationship between meat production and its prices in Turkey. According to their findings, meat production is influenced by its prices over the past six years. Ozsayın (2017) investigated the relationship between cow milk production and its price, according to the results of the research, milk production was dramatically affected by the increase/decrease in milk prices. Saghaian et al. (2013) analyzed the interaction and causality of milk and beef prices. As a result, the authors reported that milk prices had a significant effect on beef prices.

The above studies showed that a decrease in milk prices will lead to a decrease in both milk production and meat prices. The decrease in meat prices as a result of the decrease in milk prices may be the result of an increase in meat production. This may be the result of the farmers sending milk cows to slaughter as a consequence of the reduction of farm capacity and/or the abandonment of milk production by farmers who have difficulty in meeting their current costs in the face of the decrease in milk prices. In this study, the validity of this hypothesis was examined. The influence of milk production as a result of the decrease in milk prices directly affects the production of beef. The fact that farmers who give up milk production as a result of decreasing milk prices send dairy animals to slaughter increases meat production in the short term, but, it will be possible to obtain and sustain the fattening material in the long term with the continuation of milk production. In another study conducted in Adana Province of Turkey, on average, 27% of dairy cattle breeders answered the question "what do you do against the decrease in milk prices" as "I send milk cow to the slaughter" (Hayran, 2015). So, it is a vital issue that investigating the interaction between cattle milk prices and beef production.

In this study, the influence of the fluctuation of cattle milk prices on beef production is analyzed. The rest of the study is organized as follows: section 2 is dedicated to explaining of materials and methodology used in the study. Research findings and discussions are presented in section 3. The study ends up with section 4 involving the conclusion and policy recommendations.

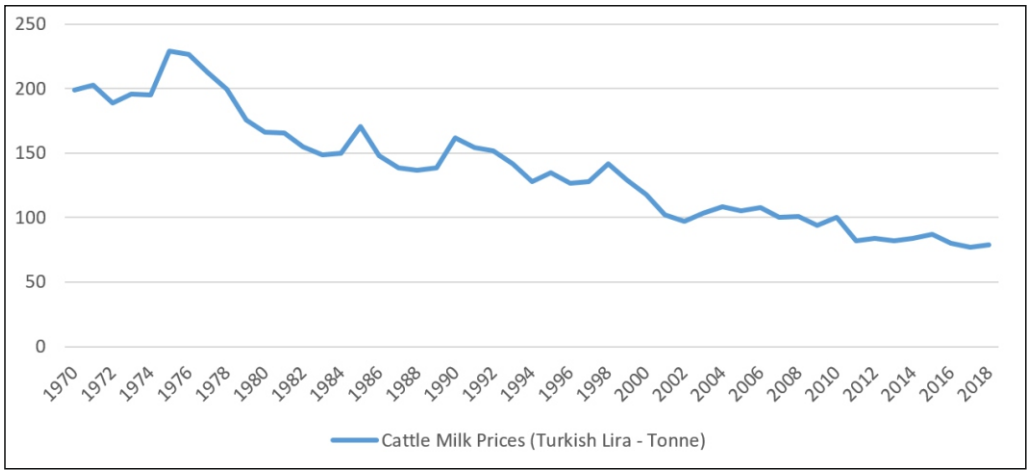
2.MATERIALS and METHOD

In the study, mainly the impact of the cattle milk prices on beef production is analyzed for Turkey from 1970 to 2018. However, to test the mediation effect of the cattle milk production in the association between cattle milk price and beef production, the study also analyses the impact of cattle milk prices on cattle milk production. Herewith, the study estimates two econometric models. All the variables were transformed in the logarithmic form to avoid possible heteroscedasticity. This procedure also enables interpreting the parameter coefficients as elasticity. The data of beef production, cattle milk prices, and cattle milk production were obtained from the Food and Agriculture Organization of the United Nations (FAOSTAT) database. The 2008-2009 global financial crisis was also included in every two models as a control variable. In Figures 1, 2, and 3, for the 1970-2018 period, the development of beef production, cattle milk prices, and cattle milk production in Turkey are presented, respectively.



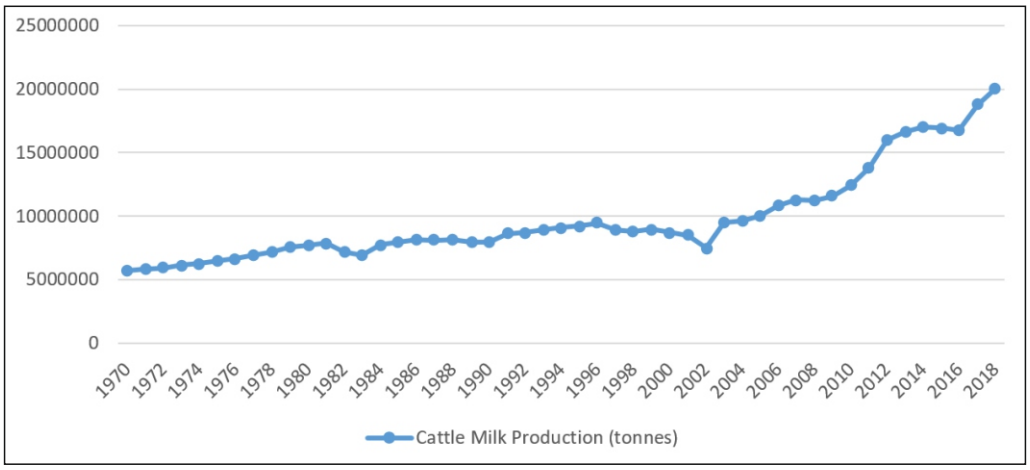
Source: FAOSTAT (2020).

Figure 1. Beef Production in Turkey: 1970-2018



Note: Cattle milk prices deflated by consumer price index are in 2010=100 based index.
Source: FAOSTAT (2020).

Figure 2. Cattle Milk Prices in Turkey: 1970-2018



Source: FAOSTAT (2020).

Figure 3. Cattle Milk Production in Turkey: 1970-2018

According to Figures 1, 2, and 3, while beef production and cattle milk production keeps increasing trend, whereas cattle milk prices have a decreasing trend. Descriptive statistics of the variables are presented in Table 1. Pairwise correlation results show that while the correlation coefficient between cattle milk prices and beef production is -0.887, the coefficient of correlation between cattle milk prices and cattle milk production is -0.897.

Table 1: Descriptive Statistics

Variables	Mean	Std. Dev.	Max.	Min.	Jarque-Bera*	N
BEEFPRO	5.480	0.297	6.043	4.961	0.998	49
MILKPRICE	1.078	0.136	1.321	0.848	2362	49
MILKPRO	6.965	0.141	7.301	6.757	5.726	49

The linear logarithmic model which analyzes the impact of changes in cattle milk prices on beef production in Turkey is as follows:

$$\ln MILKPRO_t = \delta_0 + \delta_1 \ln MILKPRICE_t + \delta_2 CRISES_t + u_t \quad (1)$$

In equation 1, BEEFPRO and MILKPRICE denote the beef production and cattle milk prices, respectively. While ln, t, and ε symbolize the natural logarithm operator, time, and error term, β is the coefficient of the parameter to be estimated. Following the estimation of equation 1, the impact of cattle milk prices on cattle milk production is shown in equation 2.

$$\ln BEEFPRO_t = \beta_0 + \beta_1 \ln MILKPRICE_t + \beta_2 CRISES_t + \varepsilon_t \quad (2)$$

In equation 2, MILKPRO and MILKPRICE show the cattle milk production and cattle milk prices, respectively. While ln, t, and u symbolize the natural logarithm operator, time, and error term, δ is the coefficient of the parameter to be estimated. Before estimating the econometric models in equations 1 and 2, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) stationarity tests were applied to all series and the results are presented in Table 2.

Table 2: The Results of ADF and PP Unit Root Tests

Variables		ADF		PP	
		Test stat.	Prob.	Test stat.	Prob.
lnBEEFPRO	Level	-0.799	0.811	-0.799	0.810
	First Difference	-9.416*	0.000	-9.417*	0.000
lnMILKPRICE	Level	-0.561	0.869	-0.055	0.948
	First Difference	-7.175*	0.000	-10.65*	0.000
lnMILKPRO	Level	0.911	0.994	1.181	0.997
	First Difference	-6.636*	0.000	-6.636*	0.000

*Note: * denotes statistical significance at 1% level. Optimal lag length is determined by Schwarz Information Criterion.*

The results in Table 2 indicate that all the variables are not stationary at the level according to both ADF and PP tests. On the other hand, the first differences of the series were found to be stationary. According to unit root test results, the ordinary least squares method leads to spurious regression. At this point, the appropriate estimation technique is cointegration analysis. By applying cointegration analysis, it may be observed whether the series are co-integrated or not in the long run. If the cointegration relationship between series confirms, then long-run coefficients of parameters are estimated.

The long-term relationship between first-differenced variables is analyzed using the autoregressive distributed lag (ARDL) approach which was developed by Pesaran et al. (2001). ARDL technique has some advantages compared to other cointegration techniques (Halicioglu, 2004): Firstly, the weak test power and endogeneity problem encountered in the Engle-Granger method in estimating long-term parameter coefficients do not exist in this method. Secondly, short and long-term parameter coefficients could be estimated simultaneously. Thirdly, in the ARDL technique, there is no limitation that all variables must be at the same integration level. Thus ARDL is superior to other cointegration techniques. However, there is still a need to make the unit root analysis. The distribution of F statistics in the ARDL cointegration test assumes that the series are integrated at the I(0) or I(1) integration level. In other words, the series should be at maximum first-order stationary (Yazici and Islam, 2014, p. 346). ARDL model indicating the impact of cattle milk prices on beef production is shown as follows:

$$\Delta BEEFPRO_t = \beta_0 + \sum_{i=1}^{m} \beta_1 \Delta BEEFPRO_{t-i} + \sum_{i=0}^{m} \beta_2 \Delta MILKPRICE_{t-i} + \beta_3 BEEFPRO_{t-1} + \beta_4 MILKPRICE_{t-1} + \varepsilon_t \quad (3)$$

ARDL model indicating the impact of cattle milk prices on cattle milk production is shown as follows:

$$\Delta MILKPRO_t = \delta_0 + \sum_{i=1}^{m} \delta_1 \Delta MILKPRO_{t-i} + \sum_{i=0}^{m} \delta_2 \Delta MILKPRICE_{t-i} + \delta_3 MILKPRO_{t-1} + \delta_4 MILKPRICE_{t-1} + u_t \quad (4)$$

3.FINDINGS and DISCUSSION

Applying in the first stage of the ARDL cointegration approach, the bound test procedure is based on Fisher (F) or Wald test statistics. While the H0 hypothesis on these tests points to no cointegration relationship, the alternative hypothesis points to cointegration relation. F test here does not have a standard distribution. Therefore, two sets of critical values (upper and lower) were developed by Pesaran et al. (2001). In this sense, there is a cointegration relationship between the variables if F statistics exceeds the upper critical value. On the contrary, there is no cointegration relationship if F statistics are lower than the lower critical value. If the F statistics are between these two critical values, the power of the test is weak. F test (bound test) estimation results on the beef production model are shown in Table 3.

Table 3: F Test (Bounds Test) Results

Dependent Variable: Beef Production			**Critical Values**		Ramsey RESET Test Statistic= 0.116
F Test	**k**		**Io**	**I1**	Prob. (RESET test) = 0.736
3.976	2	10%	2.63	3.35	R^2=0.938 F stat. = 59.602
		5%	3.10	3.87	Prob. (F-statistic) = 0.000
		1%	4.13	5.00	

Note: ARDL (4,1,2) model was used in cointegration analysis. The model selection procedure was shown in the appendix.

The F test results presented in Table 3 show that there is a long-term cointegration relationship between beef production and cattle milk prices at 10% and 5% probability levels. Accordingly, long-run coefficients of variables were estimated, and the results were presented in Table 4.

Table 4: Estimation Results of ARDL Model: Long-Term Parameter Coefficients

	Variables	**Coefficients**	**Std. Err.**	**t_stat.**	**Prob.**
Dependent Variable: Beef Production ARDL (4,1,2)	C	7.425	0.347	21.38	0.000*
	MILKPRICE	-1.741	0.319	-5.445	0.000*
	CRISES	0.197	0.328	0.601	0.552

*Note: * shows that statistics are significant at the level of 1%.*

The sign of the estimated parameter coefficient of cattle milk price is consistent with theoretical expectations and statistically significant. Accordingly, a 1% increment in cattle milk prices decreases beef production by 1.741% in Turkey. Besides, there is no significant impact of the 2007-2008 global financial crisis on beef production.

The results indicate a decrease in beef production owing to higher cattle milk prices. Because there is a negative relationship between cattle milk production and beef production. When cattle milk prices have decreased, producers deliver their animals to slaughter because they cannot meet production costs, and thus beef production increases. In this regard, in addition to the main analysis of the study, here the long-term relationship between cattle milk prices and cattle milk production is analyzed. As in the previous analysis, the long-run relationship between cattle milk prices and cattle milk production was analyzed by the ARDL cointegration technique. The results of the bounds testing approach were presented in Table 5.

Table 5: F Test (Bound Test) Results

Dependent Variable: Cattle Milk Production			**Critical Values**		Ramsey RESET Test Statistic= 2.309
F Test	**k**		**Io**	**I1**	Prob. (RESET test) = 0.136
4.876	2	10%	2.63	3.35	R^2=0.972 F stat. = 186.063
		5%	3.10	3.87	Prob. (F-statistic) = 0.000
		1%	4.13	5.00	

Note: ARDL (1,4,0) model was used in cointegration analysis. The model selection procedure was shown in the appendix.

The bounds testing results presented in Table 5 show that there is a long-term cointegration relationship between cattle milk production and cattle milk prices at 10% and 5% levels. Accordingly, long-run coefficients were estimated, and the results were presented in Table 6.

Table 6: Estimation Results of ARDL Model: Long-Term Parameter Coefficients

Dependent Variable: Cattle Milk Production ARDL (1,4,0)	Variables	Coefficients	Std. Err.	t_stat.	Prob.
	C	7.238	0.021	3.095	0.000*
	MILKPRICE	0.065	0.021	3.095	0.004*
	CRISES	-0.505	0.063	-0.843	0.571

*Note: * shows that statistics are significant at the level of 1%.*

The sign of the estimated parameter coefficient of cattle milk price is consistent with theoretical expectations and statistically significant. Accordingly, a 1% increase in cattle milk prices rises cattle milk production by 0.065% in Turkey. Consequently, increasing cattle milk prices cause a rise in cattle milk production, and therefore a decrease in beef production. This result, which may be evaluated as a robustness test for the negative association between cattle milk prices and beef production, supports the mediation effect of cattle milk production in the relationship between cattle milk prices and beef production.

4.CONCLUSIONS and RECOMMENDATIONS

In this study, the relationship between beef production and cattle milk prices was investigated. According to our results, cattle milk price fluctuations directly affect beef production in Turkey. As a result of the decrease in cattle milk prices, beef production increasing. This short-term increase may be the result of sending animals to slaughter. But, this increase is not sustainable in the long run. On the contrary, it is a situation that will affect, negatively, both meat production and milk production and the industry connected to milk and meat production in the long term. This short-term increase in meat production may be because farmers who give up milk production or reduce farm capacity in the face of the decrease in milk prices send milk cows to slaughter. Milk production in Turkey is a dual structure. In dairy farms, both milk and male calves (basic fattening materials) are produced. As a result of the decrease in milk production, it will not be possible to produce male calves in the long term. As a result, long-term problems in meat production will arise. Consequently, precautionary policies to support milk production will have a positive effect on beef production in the long term as a natural result.

Contribution Rate of Researchers Declaration Summary

The authors declare that they have contributed equally to the article and have not plagiarized.

Conflict of Interest Declaration

The authors of the article declare that there is no conflict of interest between them.

Appendix

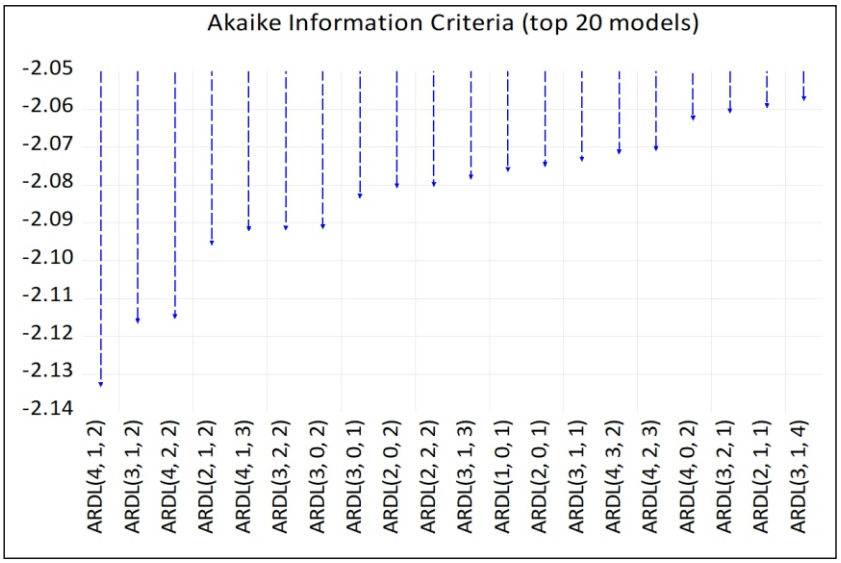


Figure 1. Model Selection Procedure (Beef Production and Cattle Milk Price)

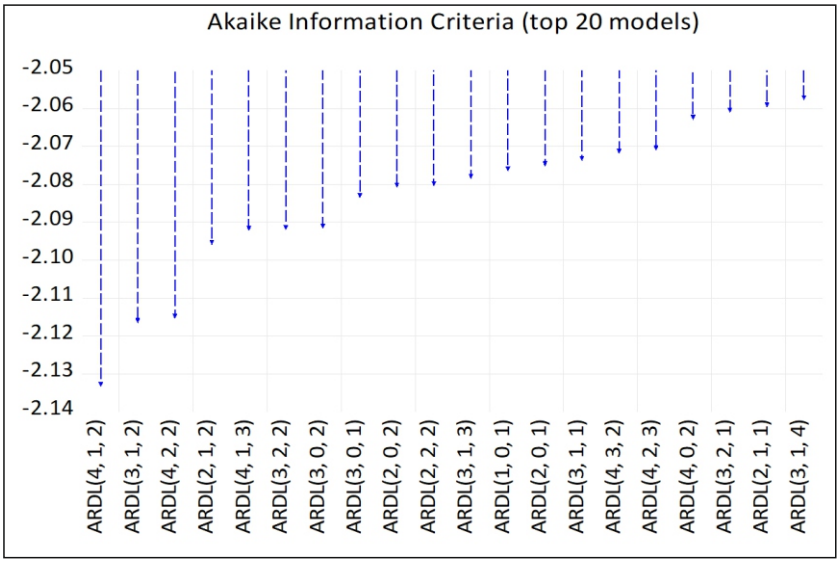


Figure 1. Model Selection Procedure (Beef Production and Cattle Milk Price)

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