# SPATIAL INTEGRATION OF BEEF MARKETS AT THE RETAIL LEVEL IN CENTRAL JAVA, INDONESIA

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## ABSTRACT

**The study aimed to analyze the degree of market integration and price asymmetry of the beef markets in the province of Central Java, Indonesia. Monthly retail beef prices were gathered from the Central Java Animal Husbandry Office and Central Java Trade and Industry Office. Ten regional markets and one central market were selected as the study areas. The Augmented Dickey Fuller method was used to determine the stationary of the data. The Johansen co-integration was used to test the market integration between 16 market pairs of cattle markets in Central Java. Results of the study revealed that beef in retail markets were highly integrated with one another at the retail level. The retail prices were integrated because all of the markets are closed to each other. The Law of One Price (LOP) was found in all of the co-integrated cattle market pairs, implying that the retail prices were fully transmitted between these markets. The value of LOP revealed that the retail price in the central market was similar to the retail price in regional markets plus transportation cost. At the retail level, the price transmission from one market to the other market for all market pairs was symmetric. This is significant since it indicates that any increase or decrease in the retail prices is more efficiently transmitted to the other market. The result indicated that the high beef demand in the Central market (consumer area) drove the retail price in regional markets (producer area).**

Keywords: beef, market integration, price transmission, retail market, spatial integration

## INTRODUCTION

Central Java is the second largest beef cattle producer in Indonesia. It plays an important role as beef supplier in the area and in other neighboring provinces. Cattle population in Central Java showed an increase from 1.16 million heads in 1990 to 1.46 million heads in 2007. The top ten cattle producing areas in Central

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Java are Blora, Grobogan, Rembang, Pati, Boyolali, Pati, Klaten, Kabupaten Semarang, Sragen and Wonogiri. The annual growth rate of live cattle population in these areas was about 0.9% (Animal Husbandry Office, Central Java Province, 1990-2008).

In an integrated market, prices are determined simultaneously in different locations, *i.e.*, prices in different markets do not behave independently. The absence of market integration has very important implications on economic welfare and efficiency (Nga, 2006). An integrated and efficient market could not allow price differences to persist in the long run since price movements in one market make adjustment to regain the equilibrium relationships among prices observed in geographically-separated markets. According to Vinuya (2006), adjustments may come from two sources, namely: (1) suppliers can adjust their behavior based on their profit, maximizing goal by shifting supplies toward markets that pay higher prices; and (2) on the demand side where consumers can switch to different sellers and substitute away from the more expensive suppliers.

Market integration is important from a theoretical point of view, since the correct specification and calibration of economic management models require a good understanding of the size and linkages in relevant markets. Market integration can be done in three ways: (1) vertical market integration which includes different stages in marketing and processing channels; (2) spatial integration which relates to spatially distinct markets; and (3) inter-temporal market integration which refers to arbitrage across periods of time (Barret as cited by Uchezuba, 2005). Meanwhile, Rivera and Helfand (2001) reported that a market within a district location will be considered integrated if physical flows of goods and services exist among locations and there is evidence of a long run relationship. These criteria are important in identifying the sets of locations that are directly or indirectly spatially linked by trade. Barret and Li (2002) explained that spatial market relationships can be described by prices, trade volumes or both.

Market integration is at the heart of welfare analysis in economics. Markets gather together demand and supply across actors that are located in different points of geographical space (Cirera and Arndt, 2008). In well-integrated markets, regions with excess supply are able to transfer production to regions with excess demand as a response to price signals (Cirera and Arndt, 2008).

Since Central Java province is known to be the second largest beef cattle producer in Indonesia, an understanding of market integration is very important especially for the farmers, traders and consumers. Better integrated beef markets mean faster price transmission. Nga (2006) explained that an integrated market can guide farmers on how to improve production decision and increase their bargaining power. Hence, this study was conducted to be able to analyze the spatial integration of beef markets at the retail level in Central Java, Indonesia.

## MATERIALS AND METHODS

The study was conducted in Central Java, one of the important beef-producing provinces in Indonesia. It is a major supplier of live cattle to Jakarta, the

capital of Indonesia and some islands in the country. The study covered 10 regional markets (producer area) and one central market (consumer area) in Central Java Province. The regional markets are located in Blora, Rembang, Pati, Grobogan, Sragen, Semarang Regency, Boyolali, Klaten, Wonogiri, Magelang while the central market is located in Semarang.

Secondary data from government agencies such as the Central Java Animal Husbandry Office, Central Java Trade and Industry Office, Central Bureau of Statistics of Central Java, and the Directorate General of Livestock, Ministry of Agriculture in Indonesia were utilized in this study. Monthly retail beef prices covering the period 1990 to 2008 were collected from monthly and annual reports of Central Java Animal Husbandry Office and Central Java Trade and Industry Office.

Data were analyzed using different statistical tools. Descriptive statistics was used to determine the mean, maximum, minimum, standard deviation, coefficient of variation and price correlation coefficients. The Pearson price correlation was used to examine the beef retail price series relationships between the central market and regional market and between and among the regional markets.

To examine the relationship of the price in different market locations and stages of the marketing channels, the Augmented Dickey Fuller (ADF) test was used to test for stationary of the presence of a unit root. The Engle-Granger Test is a Dickey-Fuller Test applied to the residuals ($e_t$) of the cointegrating equation but with some modifications. The test equation is:

$$\Delta \mathrm{e}_{\mathrm{t}} = \gamma e_{t-1} + v_t \quad (1)$$

where $v_t$ is a white noise. The null and alternative hypotheses are:

$$\mathrm{H}_0 = \gamma = 0$$
$$H_a = \gamma < 0 \quad (2)$$

The test statistics is the $\tau$ value for $\gamma$ but the critical values are not the Dickey Fuller critical values since these are valid only for unit root tests of data series and are invalid for estimated series like ($e_t$) (Danao, 2005).

The Johansen cointegration test which is based on a vector auto-regression (VAR) system was used to examine the market integration. The equation is as follows:

$$\mathrm{P}_{\mathrm{t}} = \sum_{i=1}^{k} \Pi_i P_{t-i} + \Pi_k P_{t-k} + \mu + e_t \quad (3)$$

where the vector $P_t$ contains the N price series to be tested for cointegration and assumed to be generated by the above unrestricted k order VAR in levels. Each of the $\Pi_t$ is a (NxN) parameter matrix, μ is a constant term, and $e_t$ is a (Nx1) vector of disturbances with mean zero, covariance matrix of θ, and i.i.d. normal overtime (Vinuya, 2006). Similarly, the Johansen testing framework was used to examine market integration for each retail price market pair and subject to two different null hypotheses: (1) there is no cointegrating vector between them, and (2) there is one cointegrating vector between them. Both Trace test and Max test statistics were also

used to justify the rejection of the null hypothesis.

The Akaike Information Criterion (AIC) was used to select the optimum lag length of the VAR system of the markets. The restriction of the Law of One Price (LOP) was imposed and tested for each market pair using the formulated VAR framework based on the identified integrated market pairs. The test of the null hypothesis of LOP held in each market pair was also based on the computed Chi-square statistics with the degrees of freedom equal to the number of restrictions. The Granger Causality test was used to examine the pattern of interdependence at the retail level.

## RESULTS AND DISCUSSION

### Descriptive analysis

During the period 1990-2008, nominal retail price grew at a modest annual growth rate of 5.8% in the central market and 5.0% in the other markets. The average beef retail price reached its peak at IDR 27,052 $kg^{-1}$ in the central market, and the lowest at IDR 23,467 $kg^{-1}$ in Boyolali (Table 1). As mentioned earlier, the central market is an importing region, since it does not produce a large number of cattle. The highest annual per capita beef consumption of 2 kg was recorded in this area and the lowest at 0.8 kg per year was reported in other areas.

### Price volatility

As shown in the coefficients of variation, retail prices in the regional markets (producer area) were higher than that in the central market (consumer area). The regional markets (Blora, Grobogan, Rembang, Pati, Kab. Semarang, Klaten, Boyolali, Sragen, and Wonogiri) have a higher CV than the central market. This indicates that beef retail price in the central market is more stable than that in the

Table 1. Average beef retail price and price volatility, Central Java, Indonesia,1990-2008.

| Market | Minimum | Maximum | Average price | S.E.M | CV % |
|---|---|---|---|---|---|
| | Rp/kg | | | | |
| Blora | 7,463 | 47,232 | 25,467 | 1378.6 | 42.35 |
| Grobogan | 7,367 | 45,052 | 25,074 | 1333.7 | 43.30 |
| Rembang | 7,315 | 40,540 | 23,966 | 1216.3 | 43.34 |
| Pati | 6,975 | 43,156 | 24,484 | 1283 | 42.60 |
| Kabupaten Semarang | 7,627 | 48,367 | 25,263 | 1405.6 | 41.30 |
| Klaten | 7,367 | 41,848 | 24,565 | 1255.7 | 42.43 |
| Boyolali | 6,523 | 41,367 | 23,467 | 1265.4 | 43.30 |
| Sragen | 6,963 | 44,232 | 24,309 | 1321.1 | 43.30 |
| Magelang | 7,175 | 43,963 | 24,503 | 1289.3 | 42.45 |
| Wonogiri | 6,963 | 46,136 | 24,694 | 1382.1 | 42.43 |
| Central market | 7,900 | 55,800 | 27,052 | 1592.3 | 38.20 |

producer areas. Higher CV in the producer areas would cause more fluctuations in the beef retail price. In the producer area, since the consumption of beef was low and many retailers dictate the retail price, therefore, the retail price in the producer area is more volatile than that in the central market.

**Pearson price correlation**

Pearson price correlation was used to examine the beef retail price series relationships between the central market and regional market and between and among regional markets (Dang, 2009). The beef retail price is strongly correlated (0.9). As shown in Table 2, all of the retail price series have very strong correlation (>0.9). The positive correlation showed that the increase in the retail price in one market would follow the price increase in other markets in Central Java. There is a very close distance among markets; only about 20-30 km, making it easy and convenient for the retailers to communicate with each other. During the conduct of the study, it was found out that all the retailers owned mobile phones.

Table 2. Results of Pearson correlation between beef price series at the retail level, Central Java, Indonesia,1990-2008.

| Market | Cen | Blo | Gro | Rem | Pa | Sem | Kla | Boy | Sra | Mag | Won |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cen | 1.00 | | | | | | | | | | |
| Blo | 0.99 | 1.00 | | | | | | | | | |
| Gro | 0.98 | 0.99 | 1.00 | | | | | | | | |
| Rem | 0.95 | 0.98 | 0.98 | 1.00 | | | | | | | |
| Pa | 0.97 | 0.99 | 0.99 | 0.99 | 1.00 | | | | | | |
| Sem | 0.99 | 0.99 | 0.99 | 0.97 | 0.99 | 1.00 | | | | | |
| Kla | 0.97 | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 | 1.00 | | | | |
| Boy | 0.98 | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 | 1.00 | | | |
| Sra | 0.98 | 0.99 | 0.99 | 0.98 | 0.98 | 0.99 | 0.99 | 0.99 | 1.00 | | |
| Mag | 0.98 | 0.99 | 0.99 | 0.98 | 0.98 | 0.99 | 0.99 | 0.99 | 0.99 | 1.00 | |
| Won | 0.99 | 0.99 | 0.99 | 0.97 | 0.97 | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 | 1.00 |

**Econometric analysis of spatial market integration**

Price series for the ten (10) regional markets and the central market price series were also used to analyze the beef markets at the retail level covering the period 1990-2008. To examine the relationship of the price series in different market locations and stages of marketing channels, the Augmented Dickey Fuller (ADF) test was used to test for stationary of the presence of a unit root.

Results of the ADF test showed that in the price level, the t-statistic failed to reject the null hypothesis of non-stationary beef retail market series for all markets (Table 3), when the price series were first differences, ADF test with a drift and trends, the null hypothesis of non-stationary beef retail price series for all markets was rejected. In this situation, the beef price series at the retail level were integrated of order one (I(1)). Dang (2009) supports these findings since it is a sufficient condition for the price series to be tested using VAR frameworks. As shown in Table 3, all of the markets were stationary in first differences; this means that the data could be analyzed using Johansen cointegration to test the market integration.

Table 3.Unit root test for beef markets at the retail level, Central Java, Indonesia, 1990-2008.

| Price series | Level | First difference |
|---|---|---|
| | With drift and trends | |
| Blora | -1.706 | -3.97** |
| Grobogan | -3.094 | -3.48* |
| Rembang | -2.94 | -3.56* |
| Pati | -2.157 | -3.97** |
| Kab. Semarang | -2.24 | -3.79** |
| Klaten | -2.512 | -3.95** |
| Boyolali | -2.200 | -3.79** |
| Sragen | -2.607 | -4.27** |
| Magelang | -2.68 | -3.93** |
| Wonogiri | -2.22 | -3.62* |
| Central | -2.73 | -3.89** |

***, **, * Significant at 1%, 5% and 10% probability levels.

**Degree of spatial market integration**

Spatial integration of the beef retail markets was investigated by examining the integration of the beef retail price in market pairs. Among the 11 market locations, 16 market pairs were examined.

Similarly, the Johansen testing framework was used to examine market integration for each retail price market pair and subject to two different null hypotheses: (1) there is no cointegrating vector between them, and (2) there is one cointegrating vector between them. Both Trace test and Max test statistics were also used to justify the rejection of the null hypothesis.

Among the 16 markets pairs at the retail level, 16 market pairs were found to have one cointegrating vector. As shown in Table 4, test results indicated that the beef retail markets were highly integrated with one another which support the results of Pearson correlation analysis. Similar values were obtained which conform with the findings of Goodwin and Schoeder (1991) that if one market was integrated with other market, transportation cost is the only variable that makes the difference. Since the distance of beef market retailers was just 20-30 km, the markets were integrated. Findings also revealed that beef retail prices in Central Java were highly correlated.

**Law of one price (LOP) test**

Similarly, the AIC criterion was used to select the optimum lag length of the VAR system of the markets. Based on the above-identified integrated market pairs shown in Table 5, restriction of LOP was imposed and tested for each market pair using the formulated VAR framework. The tests of the null hypothesis of LOP held in each market pair was also based on the computed Chi-square statistics with the

Table 4. Results of bi-variate cointegration test at the retail level, Central Java,Indonesia,1990-2008.

| HO:Rank=P | | Eigen value | Trace test | Max test |
|---|---|---|---|---|
| 1. Blora and Central: | P=0 | 0.799 | 24.09*** | 24.09*** |
| | P≤1 | 0.034 | 1.765 | 1.765 |
| 2. Grobogan and Central: | P=0 | 0.728 | 19.55*** | 19.55*** |
| | P≤1 | 0.032 | 1.665 | 1.665 |
| 3. Rembang and Central: | P=0 | 0.41 | 7.926*** | 7.926*** |
| | P≤1 | 0.014 | 1.265 | 1.265 |
| 4. Pati and Central: | P=0 | 0.596 | 13.630*** | 13.630*** |
| | P≤1 | 0.044 | 1.465 | 1.465 |
| 5. Kab. Semarang and Central: | P=0 | 1.00 | 551.05*** | 551.05*** |
| | P≤1 | 0.034 | 1.875 | 1.875 |
| 6. Klaten and Central: | P=0 | 0.538 | 11.613*** | 11.613*** |
| | P≤1 | 0.034 | 1.765 | 1.765 |
| 7. Boyolali and Central: | P=0 | 0.665 | 16.424*** | 16.425*** |
| | P≤1 | 0.034 | 1.765 | 1.765 |
| 8. Sragen and Central: | P=0 | 0.799 | 22.091*** | 22.091*** |
| | P≤1 | 0.034 | 1.765 | 1.765 |
| 9. Magelang and Central: | P=0 | 0.799 | 15.559*** | 15.559*** |
| | P≤1 | 0.034 | 1.765 | 1.765 |
| 10. Wonogiri and Central: | P=0 | 0.799 | 30.489*** | 30.489*** |
| | P≤1 | 0.034 | 1.765 | 1.765 |
| 11. Blora and Grobogan: | P=0 | 0.773 | 14.520*** | 14.520*** |
| | P≤1 | 0.014 | 1.816 | 1.816 |
| 12. Blora and Sragen: | P=0 | 0.617 | 12.430*** | 12.430*** |
| | P≤1 | 0.031 | 1.856 | 1.856 |
| 13. Blora and Boyolali: | P=0 | 0.525 | 13.500*** | 13.500*** |
| | P≤1 | 0.021 | 1.721 | 1.721 |
| 14. Blora and Kab. Semarang: | P=0 | 0.75 | 16.540*** | 16.540*** |
| | P≤1 | 0.018 | 1.651 | 1.651 |
| 15. Blora and Wonogiri: | P=0 | 0.731 | 11.680*** | 11.680*** |
| | P≤1 | 0.030 | 1.850 | 1.850 |
| 16. Kab. Semarang and Klaten: | P=0 | 0.753 | 16.889*** | 16.889*** |
| | P≤1 | 0.029 | 1.751 | 1.751 |

*** Significant at 1% probability level.

degrees of freedom equal to the number of restrictions. The value of LOP revealed that the retail price in the central market was similar with the retail price in the regional markets, plus transportation cost.

**Pattern of interdependence**

To examine the pattern of interdependence at the retail level, Granger Causality test was also used. Selection of lag length for a pair of the price series was done using the VAR framework. The coefficients $c_1$ to $c_{16}$ represent constants in the cointegrating vectors from 1 to 16, respectively. According to Juselius as cited by Nga (2006), these constants were not determined exactly because the model

Table 5. Normalizing cointegrating vectors of the system of cointegrated price series at the retail level, Central Java, Indonesia,1990-2008.

| Cointegrating vector | LOP Imposition |
|---|---|
| 1 | Blora = Central +c1 |
| 2 | Grobogan = Central +c2 |
| 3 | Rembang = Central +c3 |
| 4 | Pati = Central +c4 |
| 5 | Kab. Semarang = Central +c5 |
| 6 | Klaten = Central +c6 |
| 7 | Boyolali = Central +c7 |
| 8 | Sragen = Central +c8 |
| 9 | Magelang = Central +c9 |
| 10 | Wonogiri = Central +c10 |
| 11 | Blora = Grobogan + c11 |
| 12 | Blora = Sragen + c12 |
| 13 | Blora = Boyolali + c13 |
| 14 | Blora = Kab. Semarang + c14 |
| 15 | Blora = Wonogiri +c15 |
| 16 | Kab. Semarang = Klaten +c16 |

used for the cointegration analysis was the model with unrestricted constant, where linear trends existed in both data (level) and cointegration relations. In this study, the constants were not restricted and represented by a constant in the VAR system.

Among the 16 cattle market pairs, there were 10 market pairs which had unidirectional relations (Table 6). This means that a price change in one market was caused by the price change in the other markets and vice versa. Bi-directional relations were found in six (6) market pairs. The unidirectional relation was caused by the central market since it is a cattle importing region, aside from the fact that it also experienced an increase in beef prices. Retail price in the central market affected the regional markets which implies that the high beef demand in the Central market (consumer area) influenced the retail price in the regional markets (producer area).

**Market price asymmetry**

The interdependent pattern of the market price series at the retail level was also examined through the pattern of price transmission, which can be either symmetric or asymmetric (Dang, 2009). Testing the null hypothesis in this study showed that the price transmission between market locations is symmetric. Rejecting the null hypothesis means that the price transmission process is asymmetric. All the market pairs at the retail level in Central Java were cointegrated (Table 7). Meanwhile, Granger and Lee as cited by Dang (2009) used Granger-Causality to test the null hypothesis of $\beta^{+} = \beta^{-}$, where betas are the estimated coefficients corresponding to positive and negative values of the error correction

Table 6. Result of Granger-Causality test for beef price series at the retail level, Central Java, Indonesia,1990-2008.

| Relation | Type | Relation | Type |
|---|---|---|---|
| Central – Blora | Unidirectional | Blora – Grobogan | Bi-directional |
| Central – Grobogan | Unidirectional | Blora – Sragen | Bi-directional |
| Central – Rembang | Unidirectional | Blora – Boyolali | Bi-directional |
| Central – Pati | Unidirectional | Blora - Kab. Semarang | Bi-directional |
| Central – Kab. Semarang | Unidirectional | Blora and Wonogiri | Bi-directional |
| Central – Klaten | Unidirectional | Kab. Semarang and Klaten | Bi-directional |
| Central – Boyolali | Unidirectional | | |
| Central – Sragen | Unidirectional | | |
| Central – Magelang | Unidirectional | | |
| Central – Wonogiri | Unidirectional | | |

terms, respectively.

The symmetric test results at the retail level showed that price transmission in 16 market pairs was symmetric. In totality, beef markets at the retail level in Central Java showed that the price transmission from one market to the other was

Table 7. Asymmetric test results at the retail level, Central Java, Indonesia, 1990-2008.

| Market pair | Lag | Chi Statistics |
|---|---|---|
| Blora and Central | 2 | 0.678 $^{ns}$ |
| Grobogan and Central | 2 | 0.532 $^{ns}$ |
| Rembang and Central | 2 | 0.431 $^{ns}$ |
| Pati and Central | 2 | 0.356 $^{ns}$ |
| Kab. Semarang and Central | 2 | 0.890 $^{ns}$ |
| Klaten and Central | 2 | 0.038 $^{ns}$ |
| Boyolali and Central | 2 | 0.064 $^{ns}$ |
| Sragen and Central | 2 | 0.264 $^{ns}$ |
| Magelang and Central | 2 | 0.242 $^{ns}$ |
| Wonogiri and Central | 2 | 0.237 $^{ns}$ |
| Blora and Grobogan | 1 | 0.726 $^{ns}$ |
| Blora and Sragen | 3 | 0.156 $^{ns}$ |
| Blora and Boyolali | 3 | 0.567 $^{ns}$ |
| Blora and Kab. Semarang | 2 | 0.221 $^{ns}$ |
| Blora and Wonogiri | 3 | 0.340 $^{ns}$ |
| Kab. Semarang and Klaten | 2 | 0.320 $^{ns}$ |

$^{ns}$: Not significant at 5% probability level.

symmetric. Results also showed that price increases in one market were transmitted more efficiently to the other market than the price decreases. The easy transmission of the price from one market to the other market shortened the distance between market by less than 30 km.

Based on the results of the study, two policy directions are proposed. First is proper maintenance of good market infrastructure and communication facilities. Central Java is equipped with good market infrastructure and telecommunication facilities, which the government should properly maintain to ensure market integration of beef in the province. Second is production of better quality beef. The government should help improve the quality of beef through the provision of better equipped slaughterhouses. The quality of beef and the health and safety of the consumers will greatly depend on the availability of good quality slaughterhouses.

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