In the Korean pork grading system, the criterion for grading is the average backfat thickness between the last rib and the first lumbar vertebra, as well as between the 11th and 12th ribs. The correlation coefficients between backfat thickness, belly fat percentage, total fat yield, and auction prices were calculated to investigate the correlation between backfat thickness and auction prices in pigs. The correlation coefficient with the auction price was high in the order of backfat thickness measured according to Korean pork carcass grading, total fat yield, first thoracic vertebra backfat thickness, pork belly fat percentage, and multi-branched muscle middle backfat thickness (Table 5).

The correlation coefficient between backfat thickness and auction prices in gilts was 0.703, indicating a strong correlation, while the correlation coefficients for the other measurements were above 0.40, indicating a moderate correlation. Both the backfat thickness and fat content in gilts were lower than in barrows, and the correlation coefficient between pork fat content and auction prices was higher for gilts than for barrows (Table 5). As backfat thickness increases, the fat yield of pork increases, and the meat yield decreases [24]. Higher backfat thickness results in lower pork carcass grades [31]. Thus, the correlation between backfat thickness and auction prices was found to be higher than that of other factors.

Analysis of production of forequarter, middle and hindquarter of gilt and barrow

The production quantity of the forequarter, middle, and hindquarter was measured for gilts and barrows using the VCS2000, and the production quantity of each part was compared between the two groups. No significant difference in forequarters was observed between gilts and barrows (Table 6).

The forequarter consists of the shoulder blade, spare ribs, and shoulder picnic. The shoulder blade was found to be higher in barrows compared to gilts ($p< 0$ .05, Table 1). The lack of difference in forequarter production quantities can be attributed to the larger production quantity of spare ribs or shoulder picnic in gilts. In terms of the middle and hindquarter, gilts showed a lower production quantity of the middle and a higher production quantity of the hindquarter compared to barrows ($p < 0.005$, Table 6). The middle consists of the loin, belly, and tenderloin, with the tenderloin occupying a very small proportion in the middle compared to the belly and loin [32]. Since barrows had higher production quantities of loin and belly compared to gilts, it was observed that barrows had a higher production quantity in the middle ($p < 0.05$, Tables 1 and 6). As gilts had a higher production quantity of ham compared to barrows, it was evident that gilts had a higher production quantity in the hindquarter ($p< 0.05$, Tables 1 and 6).

Correlation analysis between forequarter, middle, and hindquarter of gilt and barrow and auction price

To examine the influence of the production quantities of the Forequarter, middle, and hindquarter on auction prices in pork, The correlation between the production quantity of each division and the auction prices for pork forequarter, middle, and hindquarter was investigated. Both gilts and barrows showed a moderate correlation with auction prices for all three divisions, with correlation coefficients of 0.61 or higher (Table 7). Among the three divisions, the forequarter had the lowest correlation coefficient, whereas the middle had the highest correlation coefficient (Table 7). The middle division showed the highest correlation coefficient, primarily due to the inclusion of the belly, which forms the most expensive cut and has the highest meat production quantity among all the cuts (Table 6) [6]. The higher correlation coefficient for the hindquarter compared to the forequarter is likely due to the important role of the hindquarter in assessing the body condition score (BCS). The body condition score (BCS) evaluation of pigs is based on visual and tactile assessments of the hindquarter area [33, 34]. It assesses the pig's body condition by categorizing it into five levels: Emaciate, Thin, Ideal, Fat, and Overfat [33, 34]. It is used to evaluate the nutritional status and degree of fat deposition in pigs [33, 34]. It is presumed that the correlation with auction prices is higher for the hindquarter than the forequarter because the BCS is evaluated using the hindquarter. As the amount of fat deposition and overall health of pigs can be inferred through the hindquarter, it is presumed that the correlation with auction prices is higher compared to the forequarter.

Multiple regression analysis of gilt and barrow's carcass trait and auction price

To investigate the extent to which auction prices can be predicted through various factors of pig carcass, a multiple regression analysis was conducted between the auction price and several carcass traits that exhibited a relatively high correlation with the auction price.

Gilt: $y = 40.55x_1 + 84.40x_2 + 63.065$, $R^2 = 0.556$

Barrow: $y = 33.65x_1 + 36.87x_2 + 1872.37$, $R^2 = 0.408$

The first multiple regression equations of gilt and barrow were set with the auction price (y) as the dependent variable and body weight (x1) and backfat thickness used for grading (x2) as independent variables, which are used to evaluate the carcass quality of pigs.

Gilt: $y = 48.70x1 + 98.32x2 + 18.53x3 + 28.52x4 + 78.09x5 + 80.58x6 + 848.32$, $R^2 = 0.560$

Barrow: $y = 97.86x1 + 51.35x2 + 12.72x3 + 3.58x4 + 77.31x5 + 35.14x6 + 2025.39$, $R^2 = 0.411$

The second multiple regression equations of gilt and barrow were set with the auction price(y) as the dependent variable and five primal cuts (shoulder blade = x1, loin = x2, belly = x3, shoulder picnic = x4, ham = x5) and backfat thickness used for grading (x6) as independent variables.

Based on the R^2 values of the first and second multiple regression equations, it can be observed that the R^2 value for Gilt is higher than that for Barrow. This suggests that the correlation between the independent variables used in each equation and the auction price is generally stronger for Gilt compared to Barrow, as indicated in Table 3 and Table 5. Additionally, it can be observed that both Gilt and Barrow show slightly higher R^2 values in the second multiple regression equation compared to the first one. This suggests that the analysis using the five primal cuts measured by VCS2000 provides a better understanding of the auction price than carcass weight alone. However, the R^2 values for Gilt and Barrow in both equations are not high. The reason for this can be found in the current structure of pig auctions in Korea. As mentioned in the introduction, pig auctions are conducted through a bidding system targeting wholesalers and trading participant [14]. The participants in the bidding may have different preferences for pig carcasses, and furthermore, they may have varying requirements for specific primal cuts or the degree of fat. Due to these reasons, the R^2 values for Gilt and Barrow in the first and second equations did not show a high correlation. However, despite this, it can be sufficiently confirmed through this regression equation the tendency in which auction prices are formed. Therefore, it is deemed usable as a reference material for auction prices.

Conclusion

In this study, we compared the production quantity of primal cuts between LYD gilts and barrows using data measured by the VCS2000 equipment, analyzed the relationship between carcass weight and primal cuts, and investigated their correlation with auction prices. Regression analysis was conducted to derive formulas that predicted the production quantity of primal cuts based on the carcass weight of LYD pigs in Korea. The obtained formulas showed high reliability with determination coefficients ranging from 0.77 to 0.98. The correlation analysis between primal cuts and auction prices found that primal cuts and fat content had a moderate or strong correlation with auction prices. Therefore, this study provides a means to predict the production quantity of primal cuts based on carcass weight and establishes a correlation with auction prices, making it a useful indicator for determining pig specifications in the swine industry.

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Tables

Table 1. Carcass weights and production of primal cut measured by the VCS2000 in gilts and barrows

	Gilts	Barrows
Carcass weight	83.22±7.59	83.18±7.67
Shoulder blade	5.48±0.55$^{\mathbf{bE}}$	5.53±0.56$^{\mathbf{aE}}$
Loin	9.54±1.04$^{\mathbf{bD}}$	9.6±1.08$^{\mathbf{aD}}$
Belly	16.01±1.97$^{\mathbf{bB}}$	16.1±2.03$^{\mathbf{aB}}$
Shoulder picnic	10.77±1.13$^{\mathbf{aC}}$	10.75±1.14$^{\mathbf{bC}}$
Ham	18.30±1.89$^{\mathbf{aA}}$	18.21±1.86$^{\mathbf{bA}}$

Unit: kg, gilts: 17,602 pigs, barrows: 16,579 pigs. Each value is presented as the mean ± standard deviation. $^{A\text{-}E}$ Different superscripts in the same column are significantly different from each other ($p < 0.0001$). $^{a\text{-}b}$ Different superscripts in the same row are significantly different from each other ($p < 0.05$).

421 Table 2. Simple regression analysis of carcass weights and production of each primal cut measured by the

422 VCS2000 in gilts and barrows

	Linear regression slope		Intercept		Coefficient of determination (R^2)	
	Gilts	Barrows	Gilts	Barrows	Gilts	Barrows
Shoulder blade	12.86	12.78	12.74	12.46	0.8551	0.8609
Loin	6.85	6.64	17.82	19.38	0.8820	0.8815
Belly	3.35	3.47	26.34	27.18	0.8496	0.8487
Shoulder picnic	6.43	6.42	13.84	17.10	0.9137	0.9089
Ham	3.53	3.66	18.57	16.37	0.7699	0.7901

423 Gilts: 17,602 pigs, barrows: 16,579 pigs.

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425 Table 3. Correlation coefficient between the carcass weight, production of primal cuts measured by the

426 VCS2000, and auction price in gilts and barrows

	Gilts	Barrows
Carcass weight	0.700**	0.706**
Shoulder blade	0.665**	0.665**
Loin	0.711**	0.683**
Belly	0.693**	0.660**
Shoulder picnic	0.653**	0.653**
Ham	0.653**	0.664**

427 Gilts: 17,602 pigs, barrows: 16,579 pigs. $^{**}p < 0.01$.

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433 Table 4. Pork backfat thickness, belly fat content, and total fat percentage measured by the VCS2000 in gilts and
434 barrows

	Gilts	Barrows
First thoracic vertebra backfat thickness (mm)	36.73 ± 4.56^{bA}	38.83 ± 4.40^{aA}
Backfat thickness used for grading (mm)[1]	20.87 ± 4.48^{bB}	22.77 ± 4.65^{aB}
Multi-branched muscle middle backfat thickness (mm)	16.28 ± 4.52^{bC}	18.15 ± 4.71^{aC}
Pork belly fat percentage (%)	32.34 ± 6.05^{b}	33.83 ± 6.07^{a}
Total fat yield (%)	26.29 ± 3.52^{b}	27.50 ± 3.58^{a}

435 Gilts: 17,602 pigs, barrows: 16,579 pigs. [1]Average of two backfat thickness (the backfat thickness between the
436 last rib and the first lumbar vertebra, and the backfat thickness between the 11th and 12th ribs). Each value is
437 presented as the mean ± standard deviation. [A-E]Different superscripts in the same column are significantly
438 different from each other ($p < 0.0001$). [a-b]Different superscripts in the same row are significantly different from
439 each other ($p < 0.05$).

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443 Table 5. Correlation between pork backfat thickness, belly fat content, and total fat percentage measured by the

444 VCS2000 and auction price in gilts and barrows

	Gilt	**Barrow**
First thoracic vertebra backfat thickness	0.596**	0.535**
Backfat thickness used for grading[1]	0.703**	0.607**
Multi-branched muscle middle backfat thickness	0.537**	0.476**
Pork belly fat percentage	0.556**	0.519**
Total fat yield	0.680**	0.618**

445 Gilts: 17,602 pigs, barrows: 16,579 pigs. [1]Average of two backfat thickness (the backfat thickness between

446 the last rib and the first lumbar vertebra, and the backfat thickness between the 11th and 12th ribs). $^{**}p < 0.01$

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454 Table 6. Forequarter, middle, and hindquarter production measured by the VCS 2000 in gilts and barrows

Items	Gilts	Barrows
Forequarter[1)]	19.81±1.95	19.83±1.98
Middle[2)]	27.11±3.03[b]	27.23±3.14[a]
Hindquarter[3)]	18.29 ±1.88[a]	18.20±1.85[b]

455 Unit: kg, gilts: 17,602 pigs, barrows: 16,579 pigs. [1)] Forequarter: spare ribs, shoulder blade, and shoulder picnic;
456 [2)] middle: loin, belly, and tenderloin; and [3)] Hindquarter: ham. Each value is presented as the mean ± standard
457 deviation. [a-b] Different superscripts in the same row are significantly different from each other ($p < 0.05$).

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464 Table 7. Correlation coefficient between forequarter, middle, and hindquarter production measured by the VCS

465 2000 and auction price in gilts and barrows

	Gilts	**Barrows**
Forequarter[1)]	0.615**	0.619**
Middle[2)]	0.697**	0.654**
hindquarter[3)]	0.640**	0.641**

466 Gilts: 17,602 pigs, barrows: 16,579 pigs. [1)] Forequarter: spare ribs, shoulder blade, and shoulder picnic; [2)]

467 middle: loin, belly, and tenderloin; and [3)] hindquarter: ham. $^{**}p < 0.01$.