Supplemental File S3. Model assumptions in segmentation analysis

The results of the assumptions of the linear models assessing the relationship between barn temperature (BT) and the bunching metrics: core range (CR), full range (FR), intercow distance (ICD) and nearest neighbor distance (NND), which were analysed in the Results in the main paper, are provided here.

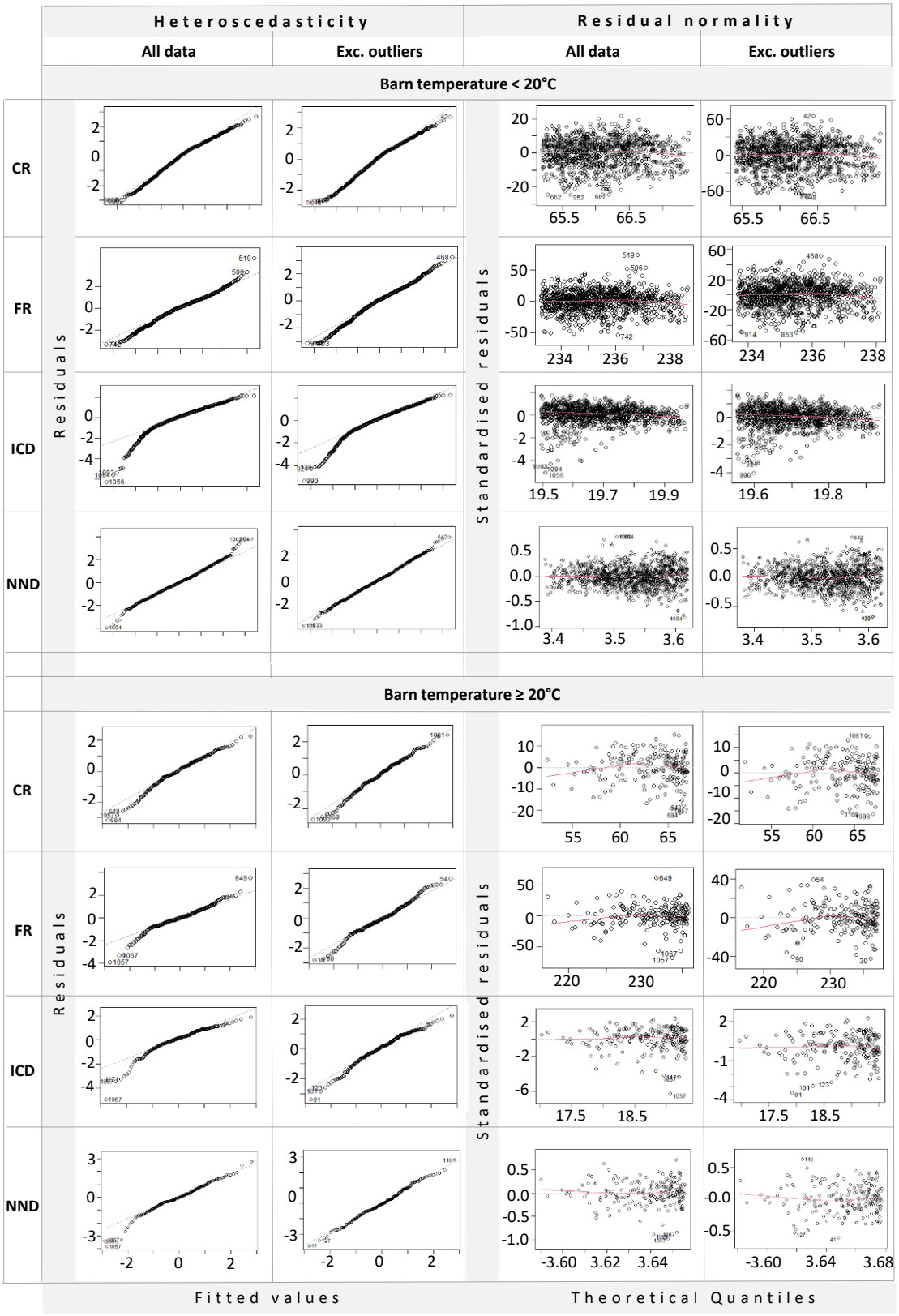
Heteroscedasticity, and residual normality were tested where barn temperature is below and equal to or above the breakpoint of 20°C, and the results show that assumptions are met for all the bunching metrics ≥ 20°C when excluding outliers (n = 5 data points), apart from for residual normality for ICD (Supplemental Table S3.1; Supplemental File S3.1). Both model assumptions are not met for < 20°C for ICD or for heteroscedasticity for NND (Supplemental Table S3.1; Supplemental File S3.1). However, given the large sample size, particularly below the breakpoint (< 20°C: n = 1067 data points, ≥ 20°C: n = 170 data points), extreme values skewing the data from residual normality and homoscedasticity are not unexpected, so linear regression was used.

Supplemental Table S3.1. Outputs from the linear model assessing the relationship between bunching and barn temperature (BT), below and above (or equal to) the breakpoint of 20°C (n = 195 data points). Assumptions of heteroscedasticity and residual normality were tested using NVC and Shapiro-Wilks, respectively. Each test result is shown for each bunching metric, including all the data (Y), and excluding outliers (N) (n = 5 data points)[1]

		Heteroscedasticity		**Residual normality**	
Bunching metric	**Outliers exc.** (*n* = 5)	**< 20°C**	**≥ 20°C**	**< 20°C**	**≥ 20°C**
CR	N	Chi-sq = 0.01, *P* = 0.91	Chi-sq = 2.31, *P* = 0.13	W = 0.98, *P* = 0.004*	W = 0.99, *P* = 0.22
	Y	Chi-sq = 0.39, *P* = 0.53	Chi-sq = 0.22, *P* = 0.64	W = 0.99, *P* = 1.41e-8*	W = 0.99, *P* = 0.21
FR	N	Chi-sq = 0.85, *P* = 0.36	Chi-sq = 0.38, *P* = 0.54	W = 0.99, P = 2.69e-8*	W = 0.96, *P* = 5.67e-5*
	Y	Chi-sq = 0.19, *P* = 0.66	Chi-sq = 5.04, *P* = 0.02*	W = 0.99, *P* = 6.09e-7*	W = 0.99, *P* = 0.10
ICD	N	Chi-sq = 141.36, *P* < 2.2e-16*	Chi-sq = 0.89, *P* = 0.35	W = 0.91, *P* < 2.2e-16*	W = 0.91, *P* = 1.14e-9*
	Y	Chi-sq = 93.97, *P* < 2.2e-16*	Chi-sq = 0.84, *P* = 0.36	W = 0.94, *P* < 2.2e-16*	W = 0.97, *P* = 0.002*
NND	N	Chi-sq = 38.57, *P* = 5.27e-10*	Chi-sq = 0.15, *P* = 0.70	W = 0.99, *P* = 0.0007*	W = 0.97, *P* = 0.0008*
	Y	Chi-sq = 36.78, *P* = 1.32e-9*	Chi-sq = 2.47, *P* = 0.12	W = 1.00, *P* = 0.40	W = 1.00, *P* = 0.82

[1]Bunching metrics: CR = core range, FR = full range, ICD = intercow distance, NND = nearest-neighbor distance.

*Significant *P*-values.



Supplemental Figure S3.1. Plots viewing assumptions of a linear model assessing the relationship between bunching and barn temperature (BT), below and above (or equal to) 20°C: heteroscedasticity, and residual normality. Plots are shown for each bunching metric (CR = core range, FR = full range, ICD = intercow distance, NND = nearest neighbor distance).

Furthermore, comparing Supplemental Table S3.2 to Table 1 in the main paper, the conclusions drawn from the linear model outputs do not change drastically before excluding these outliers (n = 5 data points).

Supplemental Table S3.2. Outputs from the linear model assessing the relationship between barn temperature and bunching, on the commercial farm in Essex, below and above (or equal to) the breakpoint of barn temperature (BT) = 20°C (n = 195 data points), including outliers (n = 5 data points). Chow test outputs testing the significance of the breakpoint are also shown. Each test result is shown for each bunching metric[1]

Bunching metric	**Chow-test**	**< 20°C**	**≥ 20°C**
CR	F = 3.63, *P* = 0.03*	e = -0.17, SE = 0.08, t-value = -2.12, *P* = 0.03*	e = -1.89, SE = 0.28, t-value = -6.64, *P* = 3.09e-10*
FR	F = 1.50, *P* = 0.22	e = -0.42, SE = 0.16, t-value = -2.57, *P* = 0.01*	e = -2.39, SE = 0.73, t-value = -3.27, *P* = 0.001*
ICD	F = 2.03, *P* = 0.13	e = -0.04, SE = 0.01, t-value = -4.63, *P* = 4.1e-6*	e = -0.30, SE = 0.05, t-value = -5.66, *P* = 5.52e-8*
NND	F = 8.21, *P* = 0.0003*	e = 0.02, SE = 0.002, t-value = 8.60, *P* < 2e-16*	e = -0.01, SE = 0.01, t-value = -0.78, *P* = 0.44

[1]Bunching metrics: CR = core range, FR = full range, ICD = intercow distance, NND = nearest-neighbor distance. Periods during which cows were in the milking parlor or collecting yard (0500–0759h, 1200–1459 h, and 2000–2259 h) or times when the sensor reset (2300–0059 h) were removed.
*Significant *P*-values.