

## Supplementary Material

Supplementary Tables S1–S6 (R = 200 replications).

### Supplementary Tables (R = 200 Monte Carlo replications)

**Table S1.** *Sensitivity to event prevalence (Scenario S3): Out-of-sample performance by method.*

| Condition (setting)            | Method | AUC              | Brier              | LogLoss            | Cal int           | Cal slope        | Prev (train)     | Prev (test)      |
|--------------------------------|--------|------------------|--------------------|--------------------|-------------------|------------------|------------------|------------------|
| Prev $\beta_0$ = -4.6 (cond 5) | ENT    | 0.791<br>(0.108) | 0.0155<br>(0.0066) | 0.0795<br>(0.0240) | 0.598<br>(4.043)  | 1.506<br>(1.692) | 0.021<br>(0.006) | 0.021<br>(0.008) |
| Prev $\beta_0$ = -4.6 (cond 5) | LOG    | 0.783<br>(0.109) | 0.0156<br>(0.0068) | 0.0804<br>(0.0320) | -0.562<br>(2.002) | 0.888<br>(0.757) | 0.021<br>(0.006) | 0.021<br>(0.008) |
| Prev $\beta_0$ = -3.5 (cond 6) | ENT    | 0.746<br>(0.074) | 0.0376<br>(0.0092) | 0.1598<br>(0.0300) | -0.035<br>(1.043) | 1.118<br>(0.390) | 0.048<br>(0.008) | 0.047<br>(0.012) |
| Prev $\beta_0$ = -3.5 (cond 6) | LOG    | 0.744<br>(0.074) | 0.0377<br>(0.0095) | 0.1610<br>(0.0347) | -0.486<br>(0.871) | 0.842<br>(0.300) | 0.048<br>(0.008) | 0.047<br>(0.012) |
| Prev $\beta_0$ = -2.2 (cond 7) | ENT    | 0.719<br>(0.045) | 0.1020<br>(0.0132) | 0.3473<br>(0.0359) | -0.084<br>(0.501) | 0.998<br>(0.266) | 0.132<br>(0.012) | 0.133<br>(0.021) |
| Prev $\beta_0$ = -2.2 (cond 7) | LOG    | 0.718<br>(0.045) | 0.1022<br>(0.0135) | 0.3481<br>(0.0381) | -0.181<br>(0.477) | 0.897<br>(0.244) | 0.132<br>(0.012) | 0.133<br>(0.021) |

*Note.* Values are mean (SD) across R = 200 replications. ENT = PROC ENTROPY (GMED); LOG = PROC LOGISTIC. AUC: higher is better. Brier and LogLoss: lower is better. Calibration is summarized by intercept (ideal 0) and slope (ideal 1) from logistic recalibration on test-set predictions. Prev (train/test) is the empirical event rate in the training/test split.

**Table S2.** *Sensitivity to ESUPPORTS width in PROC ENTROPY (Scenario S3): Out-of-sample performance by method.*

| <b>Condition<br/>(setting)</b> | <b>Method</b> | <b>AUC</b>       | <b>Brier</b>       | <b>LogLoss</b>     | <b>Cal int</b>    | <b>Cal<br/>slope</b> | <b>Prev<br/>(train)</b> | <b>Prev<br/>(test)</b> |
|--------------------------------|---------------|------------------|--------------------|--------------------|-------------------|----------------------|-------------------------|------------------------|
| ESUPP<br>narrow<br>(cond 8)    | ENT           | 0.745<br>(0.079) | 0.0373<br>(0.0097) | 0.1591<br>(0.0348) | -0.154<br>(1.055) | 0.993<br>(0.395)     | 0.047<br>(0.009)        | 0.048<br>(0.012)       |
| ESUPP<br>narrow<br>(cond 8)    | LOG           | 0.744<br>(0.079) | 0.0374<br>(0.0098) | 0.1606<br>(0.0369) | -0.307<br>(1.004) | 0.905<br>(0.370)     | 0.047<br>(0.009)        | 0.048<br>(0.012)       |
| ESUPP<br>base<br>(cond 9)      | ENT           | 0.748<br>(0.072) | 0.0396<br>(0.0100) | 0.1661<br>(0.0323) | 0.104<br>(0.937)  | 1.151<br>(0.337)     | 0.048<br>(0.008)        | 0.050<br>(0.013)       |
| ESUPP<br>base<br>(cond 9)      | LOG           | 0.746<br>(0.072) | 0.0397<br>(0.0103) | 0.1673<br>(0.0374) | -0.366<br>(0.790) | 0.869<br>(0.265)     | 0.048<br>(0.008)        | 0.050<br>(0.013)       |
| ESUPP<br>wide<br>(cond 10)     | ENT           | 0.744<br>(0.073) | 0.0407<br>(0.0089) | 0.1770<br>(0.0260) | 0.524<br>(1.140)  | 1.559<br>(0.491)     | 0.048<br>(0.008)        | 0.049<br>(0.013)       |
| ESUPP<br>wide<br>(cond 10)     | LOG           | 0.743<br>(0.073) | 0.0396<br>(0.0097) | 0.1676<br>(0.0364) | -0.497<br>(0.744) | 0.818<br>(0.252)     | 0.048<br>(0.008)        | 0.049<br>(0.013)       |

*Note.* Values are mean (SD) across R = 200 replications. ESUPPORTS refers to the error-support grid used in PROC ENTROPY (GMED). Other notes as in Table S1.

**Table S3.** *Sensitivity to sample size in the collinearity setting (Scenario S2): Out-of-sample performance by method.*

| <b>Condition<br/>(setting)</b> | <b>Method</b> | <b>AUC</b>       | <b>Brier</b>       | <b>LogLoss</b>     | <b>Cal int</b>    | <b>Cal<br/>slope</b> | <b>Prev<br/>(train)</b> | <b>Prev<br/>(test)</b> |
|--------------------------------|---------------|------------------|--------------------|--------------------|-------------------|----------------------|-------------------------|------------------------|
| n=50<br>(cond 11)              | ENT           | 0.549<br>(0.171) | 0.3106<br>(0.0889) | 0.9634<br>(0.3680) | -0.043<br>(2.398) | 0.342<br>(2.329)     | 0.452<br>(0.081)        | 0.452<br>(0.127)       |
| n=50<br>(cond 11)              | LOG           | 0.547<br>(0.172) | 0.3165<br>(0.0948) | 1.1564<br>(1.3474) | -0.037<br>(2.432) | 0.327<br>(2.261)     | 0.452<br>(0.081)        | 0.452<br>(0.127)       |
| n=100<br>(cond 12)             | ENT           | 0.588<br>(0.112) | 0.2654<br>(0.0422) | 0.7498<br>(0.1146) | -0.119<br>(0.504) | 0.386<br>(0.529)     | 0.457<br>(0.057)        | 0.455<br>(0.098)       |
| n=100<br>(cond 12)             | LOG           | 0.587<br>(0.112) | 0.2668<br>(0.0432) | 0.7560<br>(0.1206) | -0.119<br>(0.504) | 0.375<br>(0.516)     | 0.457<br>(0.057)        | 0.455<br>(0.098)       |
| n=250<br>(cond 13)             | ENT           | 0.628<br>(0.069) | 0.2396<br>(0.0192) | 0.6746<br>(0.0442) | -0.051<br>(0.274) | 0.721<br>(0.477)     | 0.454<br>(0.034)        | 0.455<br>(0.056)       |
| n=250<br>(cond 13)             | LOG           | 0.628<br>(0.069) | 0.2399<br>(0.0196) | 0.6757<br>(0.0454) | -0.051<br>(0.274) | 0.705<br>(0.468)     | 0.454<br>(0.034)        | 0.455<br>(0.056)       |

*Note.* Values are mean (SD) across R = 200 replications. Other notes as in Table S1.

**Table S4.** Sensitivity to event prevalence (Scenario S3): Paired differences ( $\Delta = \text{ENTROPY} - \text{LOGISTIC}$ ).

| Condition (setting)       | $\Delta\text{AUC}$ mean (SD) [95% CI]          | $\Delta\text{Brier}$ mean (SD) [95% CI]        | $\Delta\text{LogLoss}$ mean (SD) [95% CI]      | $\Delta\text{Cal intercept}$ mean (SD) [95% CI] | $\Delta\text{Cal slope}$ mean (SD) [95% CI]    |
|---------------------------|------------------------------------------------|------------------------------------------------|------------------------------------------------|-------------------------------------------------|------------------------------------------------|
| $\beta_0 = -4.6$ (cond 5) | 0.008112<br>(0.029663)<br>[0.003976, 0.012249] | -0.000123<br>(0.000892) [-0.000247, 0.000002]  | -0.000884<br>(0.011220) [-0.002449, 0.000680]  | 1.159507<br>(3.169931)<br>[0.717497, 1.601517]  | 0.617858<br>(1.360333)<br>[0.428176, 0.807541] |
| $\beta_0 = -3.5$ (cond 6) | 0.001766<br>(0.006042)<br>[0.000923, 0.002608] | -0.000116<br>(0.000604) [-0.000200, -0.000032] | -0.001159<br>(0.006165) [-0.002018, -0.000299] | 0.451016<br>(0.240426)<br>[0.417491, 0.484541]  | 0.275557<br>(0.114548)<br>[0.259585, 0.291529] |
| $\beta_0 = -2.2$ (cond 7) | 0.000194<br>(0.000723)<br>[0.000093, 0.000295] | -0.000115<br>(0.000493) [-0.000184, -0.000046] | -0.000874<br>(0.002882) [-0.001276, -0.000473] | 0.097398<br>(0.032060)<br>[0.092928, 0.101869]  | 0.101302<br>(0.027080)<br>[0.097526, 0.105078] |

*Note.* Cells show mean (SD) [95% CI] across  $R = 200$  paired replications. For Brier and LogLoss, negative  $\Delta$  indicates better performance for ENTROPY. Confidence intervals use a  $t$  distribution with  $df = 199$ .

**Table S5.** Sensitivity to ESUPPORTS width (Scenario S3): Paired differences ( $\Delta = \text{ENTROPY} - \text{LOGISTIC}$ ).

| Condition (setting) | $\Delta\text{AUC}$ mean (SD) [95% CI]     | $\Delta\text{Brier}$ mean (SD) [95% CI]     | $\Delta\text{LogLoss}$ mean (SD) [95% CI]   | $\Delta\text{Cal}$ intercept mean (SD) [95% CI] | $\Delta\text{Cal}$ slope mean (SD) [95% CI] |
|---------------------|-------------------------------------------|---------------------------------------------|---------------------------------------------|-------------------------------------------------|---------------------------------------------|
| narrow (cond 8)     | 0.000432 (0.001989) [0.000155, 0.000710]  | -0.000104 (0.000274) [-0.000142, -0.000066] | -0.001509 (0.003182) [-0.001953, -0.001066] | 0.152982 (0.081269) [0.141650, 0.164314]        | 0.087601 (0.037298) [0.082401, 0.092802]    |
| base (cond 9)       | 0.001666 (0.006728) [0.000727, 0.002604]  | -0.000087 (0.000568) [-0.000166, -0.000008] | -0.001200 (0.006387) [-0.002091, -0.000310] | 0.470158 (0.219195) [0.439593, 0.500722]        | 0.282551 (0.100766) [0.268500, 0.296601]    |
| wide (cond 10)      | 0.001117 (0.014838) [-0.000953, 0.003186] | 0.001131 (0.001307) [0.000949, 0.001313]    | 0.009382 (0.012712) [0.007610, 0.011155]    | 1.021109 (0.580868) [0.940114, 1.102104]        | 0.741576 (0.302895) [0.699341, 0.783811]    |

*Note.* Cells show mean (SD) [95% CI] across R = 200 paired replications. Confidence intervals use a t distribution with df = 199. Other notes as in Table S4.

**Table S6.** Sensitivity to sample size (Scenario S2): Paired differences ( $\Delta$  = ENTROPY – LOGISTIC).

| Condition (setting) | $\Delta$ AUC mean (SD) [95% CI]            | $\Delta$ Brier mean (SD) [95% CI]           | $\Delta$ LogLoss mean (SD) [95% CI]         | $\Delta$ Cal intercept mean (SD) [95% CI]  | $\Delta$ Cal slope mean (SD) [95% CI]    |
|---------------------|--------------------------------------------|---------------------------------------------|---------------------------------------------|--------------------------------------------|------------------------------------------|
| n=50 (cond 11)      | 0.001209 (0.018453) [-0.001364, 0.003782]  | -0.005838 (0.012733) [-0.007613, -0.004062] | -0.193046 (1.172266) [-0.356505, -0.029587] | -0.005724 (0.079614) [-0.016825, 0.005377] | 0.015173 (0.074057) [0.004847, 0.025500] |
| n=100 (cond 12)     | 0.000223 (0.002212) [-0.000085, 0.000532]  | -0.001383 (0.001233) [-0.001555, -0.001212] | -0.006169 (0.007978) [-0.007281, -0.005056] | 0.000148 (0.001154) [-0.000013, 0.000309]  | 0.010837 (0.013454) [0.008961, 0.012713] |
| n=250 (cond 13)     | -0.000025 (0.000528) [-0.000099, 0.000048] | -0.000359 (0.000432) [-0.000419, -0.000298] | -0.001115 (0.001391) [-0.001309, -0.000921] | 0.000122 (0.000348) [0.000074, 0.000171]   | 0.015724 (0.009777) [0.014360, 0.017087] |

*Note.* Cells show mean (SD) [95% CI] across R = 200 paired replications. Confidence intervals use a t distribution with df = 199. Other notes as in Table S4.