Borrowing information with random weights

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Information borrowing

Information external to the data.

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Authorities' restriction: Type I error.
Restriction makes a lot of sense.

What this talk is

Discuss:

- Discuss an approach to estimate borrow weight.
- Talk about context.
- Wonder a bit about what we're trying to achieve.

What this talk is not

Let us not talk about:

Whether or not we should be borrowing.

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Kopp-Schneider et al. (2019) teach us we can't get Type I error and power. We come back to this.

Basic model

$$Y_i \mid \mu \sim \mathcal{N}\left(\mu, \sigma^2\right), i = 1, \ldots, n$$

$$\pi(\mu) = w\pi_{inf}(\mu) + (1 - w)\pi_{rob}(\mu)$$

Leads to...

$$\pi(\mu \mid y) = \tilde{w}\pi_{inf}(\mu \mid y) + (1 - \tilde{w})\pi_{rob}(\mu \mid y)$$

Common problems

$\pi_{rob}(\mu)$ is not unrestricted.

Selecting w is complex.

Proposal

Estimate w! With Bayesian Inference, we set a prior:

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Reparameterize: $a = e\varphi$ and $b = (1 - e)\varphi$.
That way:

$$E[w] = e,$$

$$Var[w] = \frac{e(1 - e)}{2\varphi}$$

A bit about context

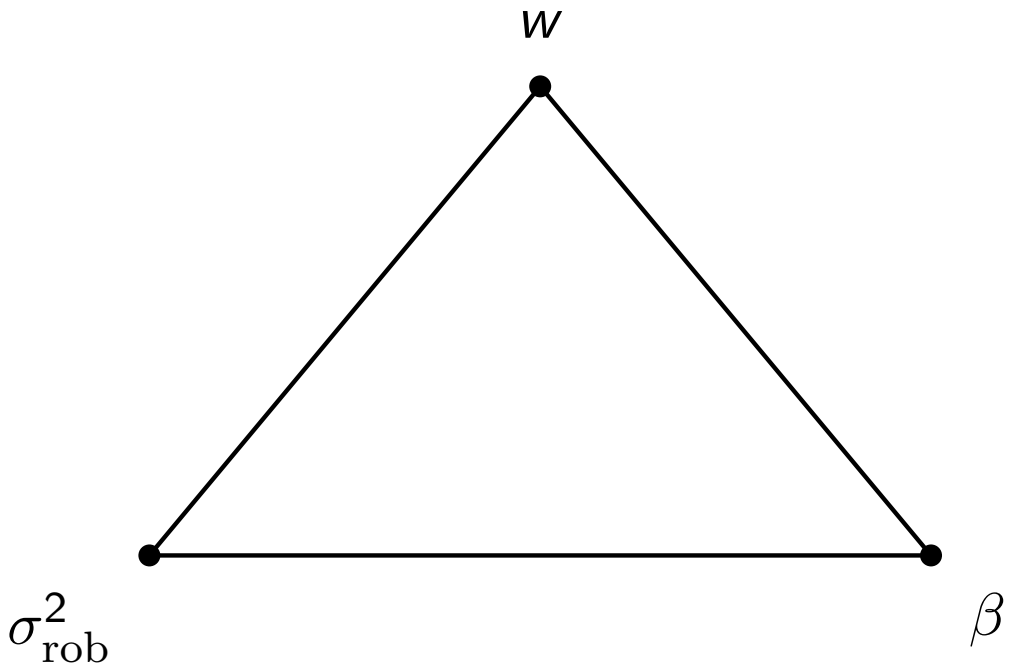
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Variance of $\pi_{rob}(\mu)$ cannot be too large (!!!!).

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Big driver about whether borrowing prior works:

Variance of $\pi_{rob}(\mu)$ cannot be too large (!!!!).
The work of Ratta et al. (2026) addresses this well.



Let's simulate!

Set true $\mu = 5$, $\sigma^2 = 1$ is known.

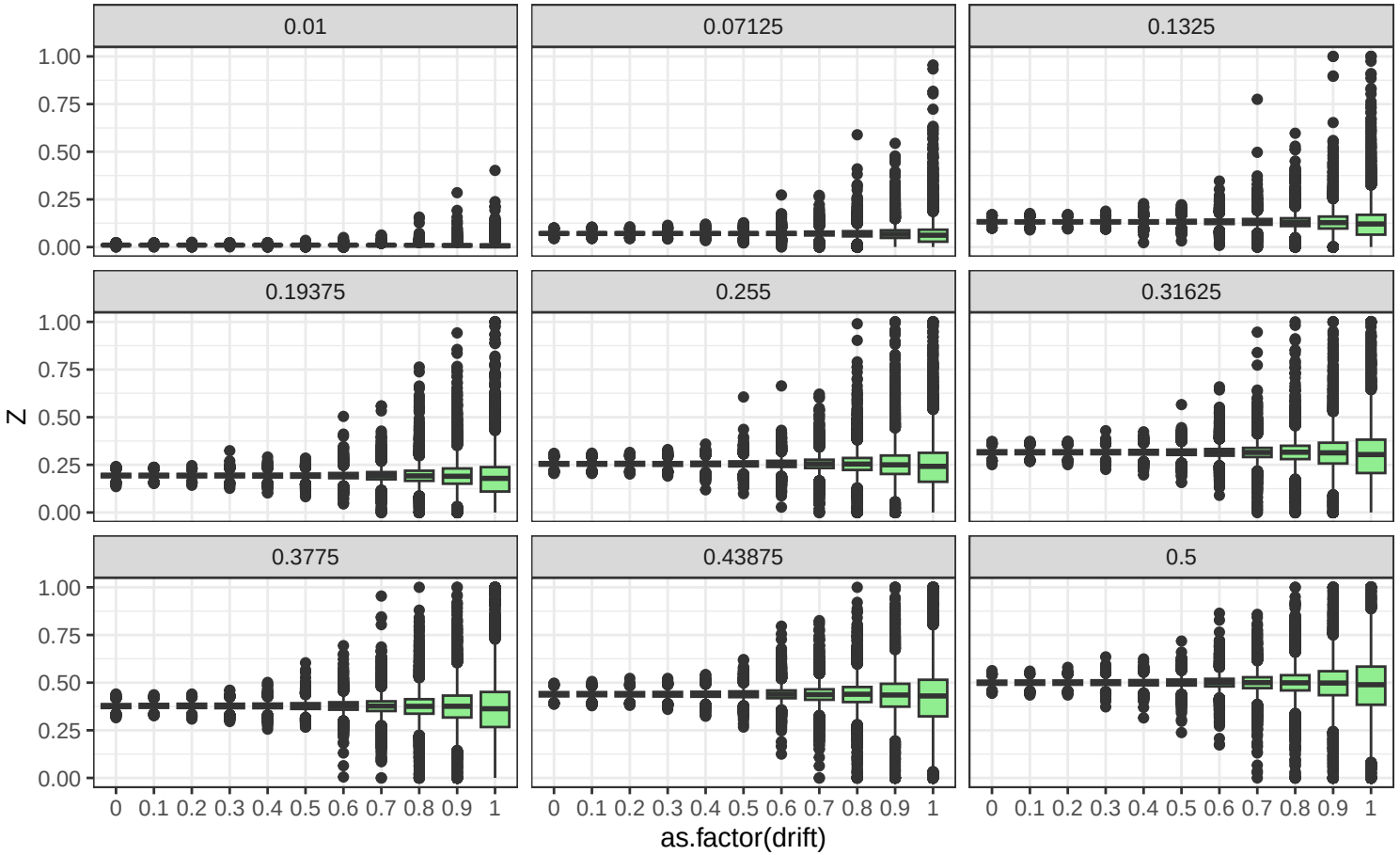
Set $\sigma^2_{inf} = 0.01$ and $\mu_{rob} = 0$.

Set burnin $= 1000$, sampling $= 5000$, thin $= 5$.

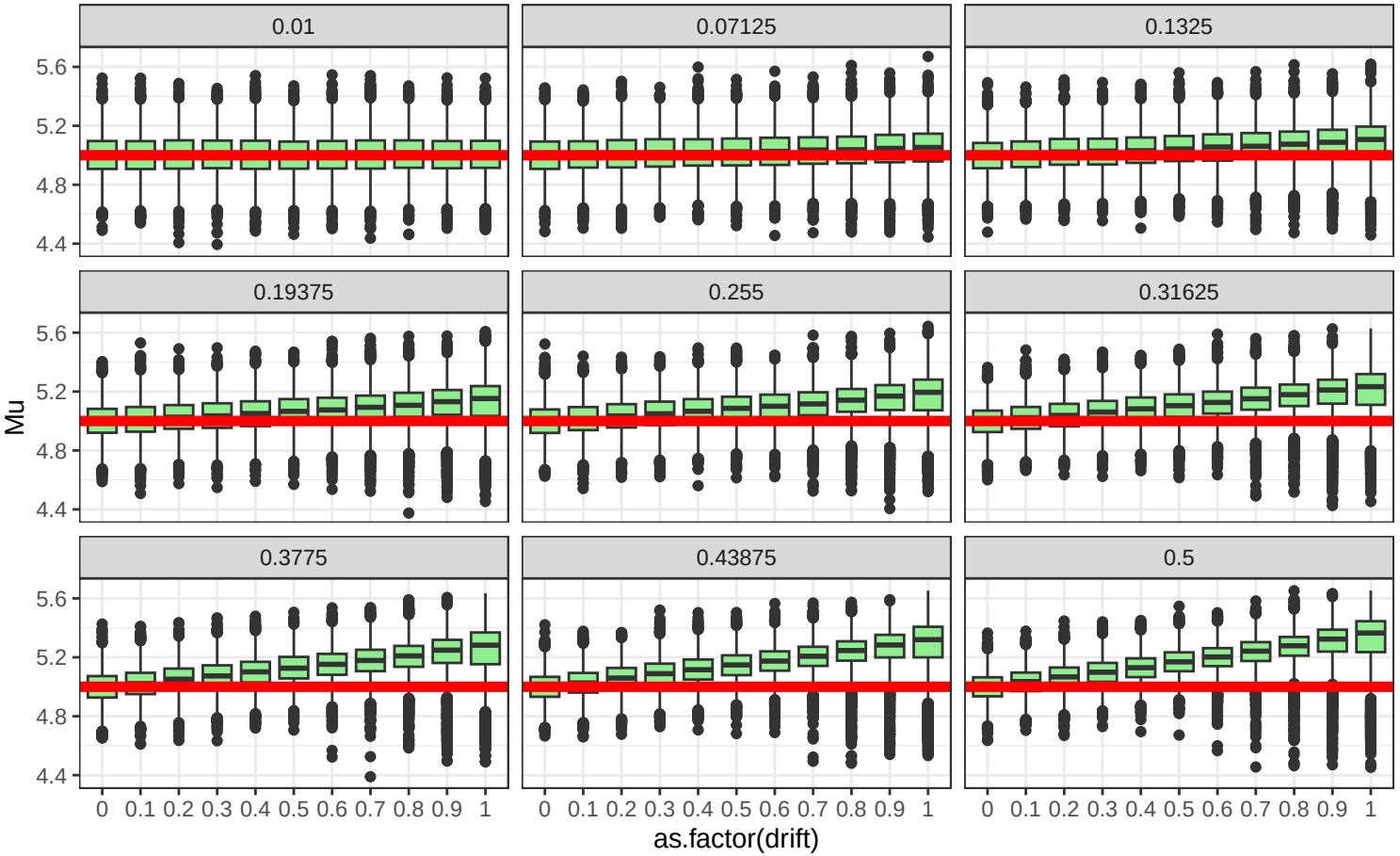
Vary: e, φ, drift $= 5 - \mu_{inf}$

Each scenario: 5000 times. Results: Draw a boxplot of the respective posterior means.

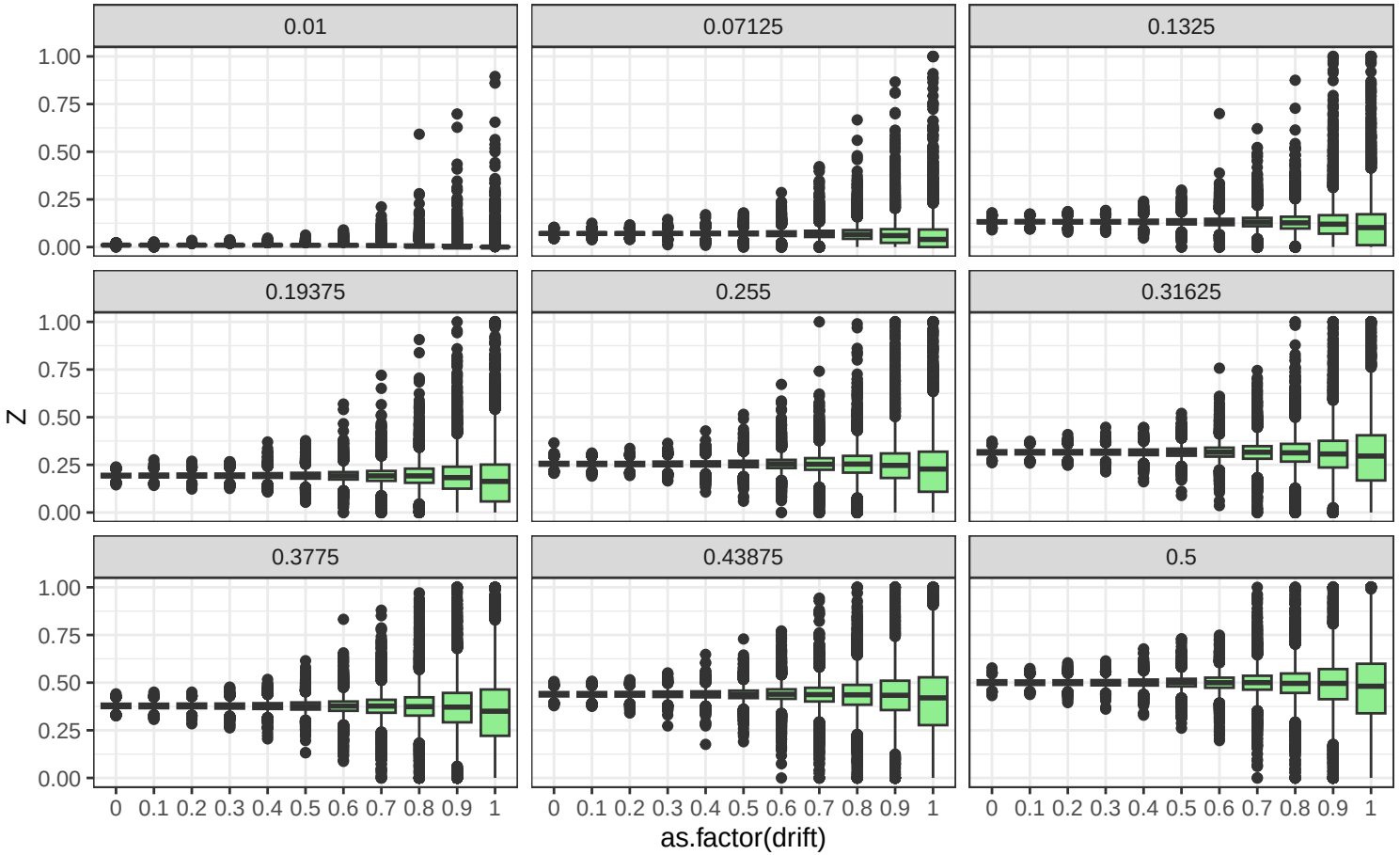
$\sigma^2_{rob} = 1000$, $\varphi = 5e6$



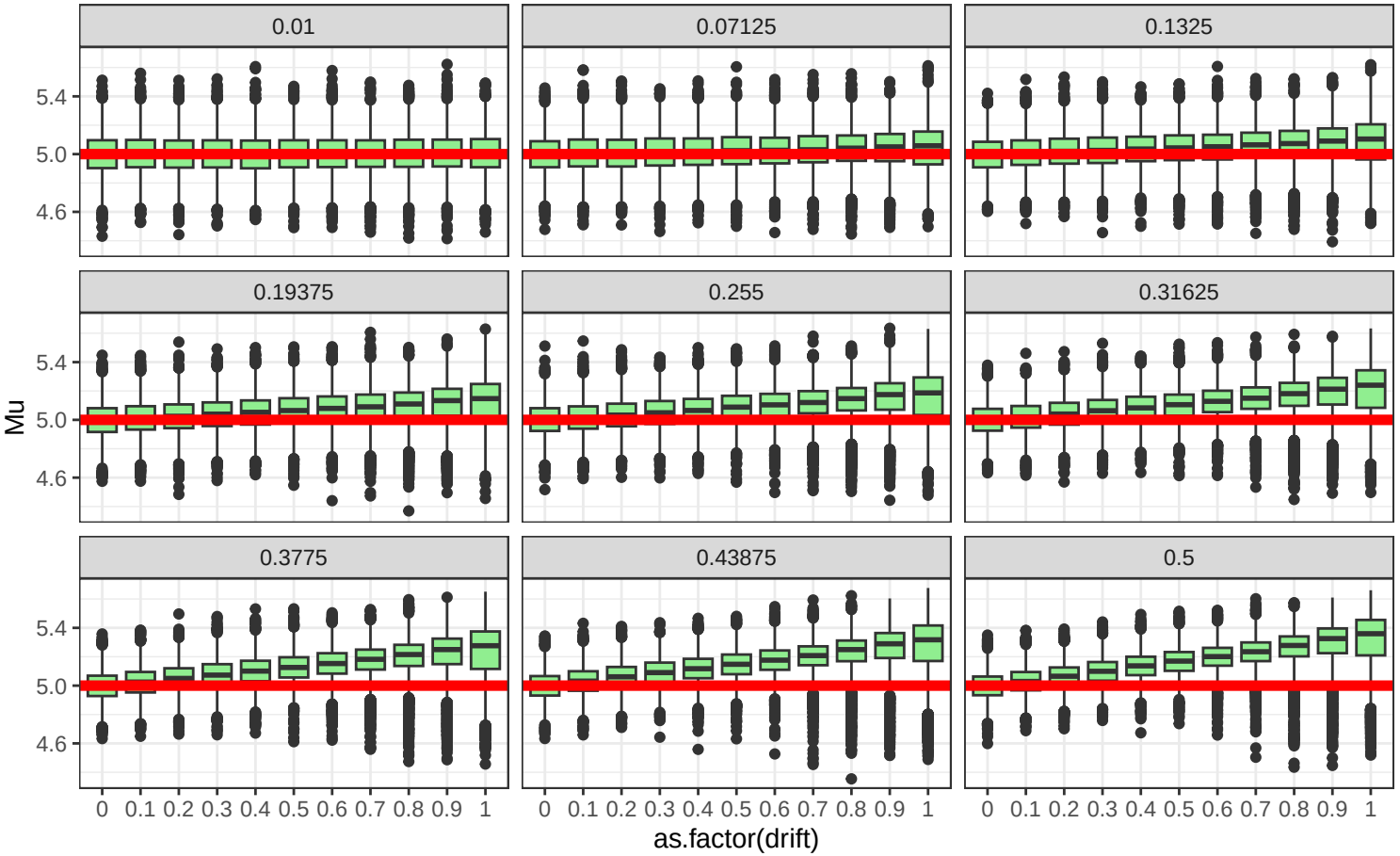
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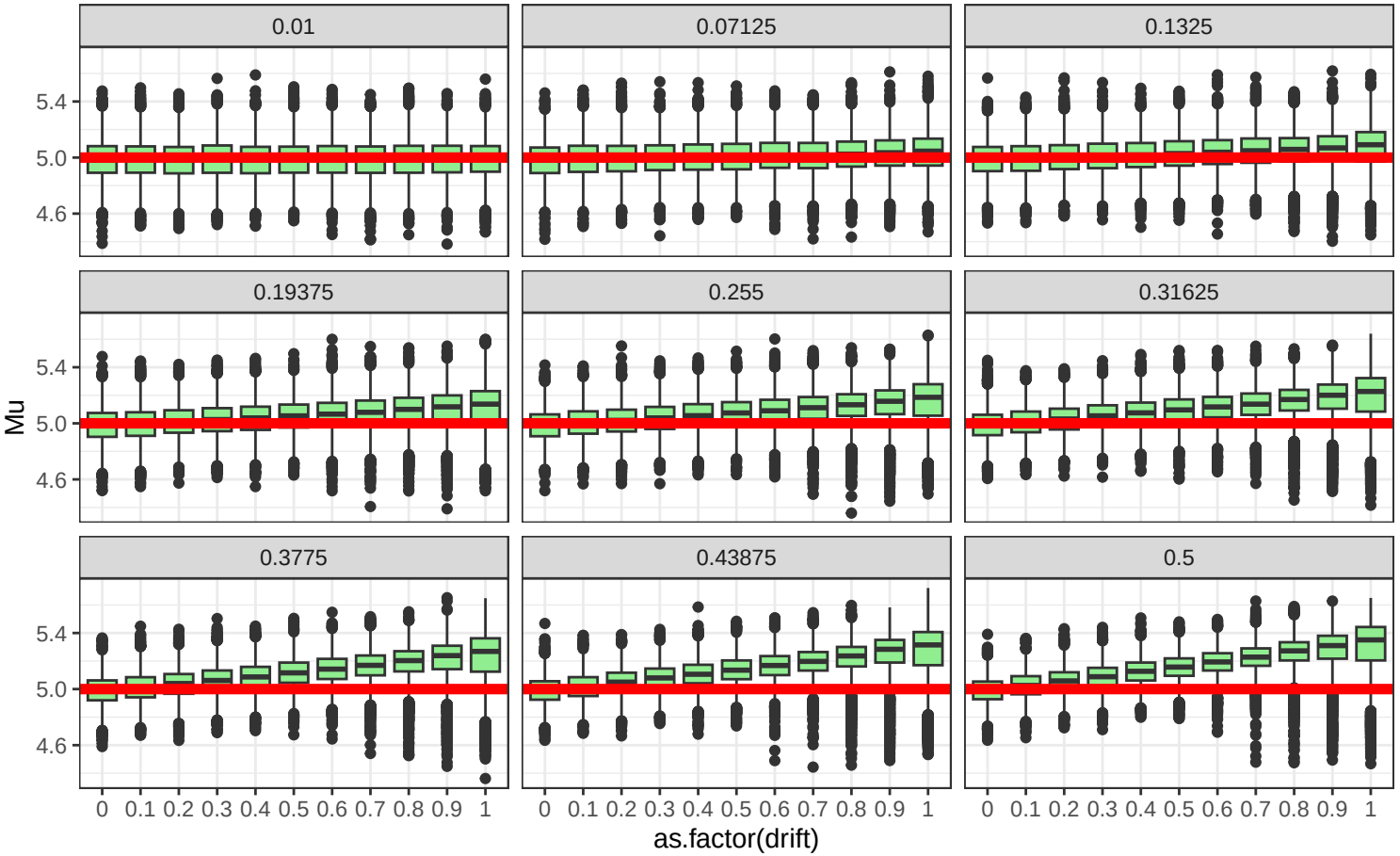
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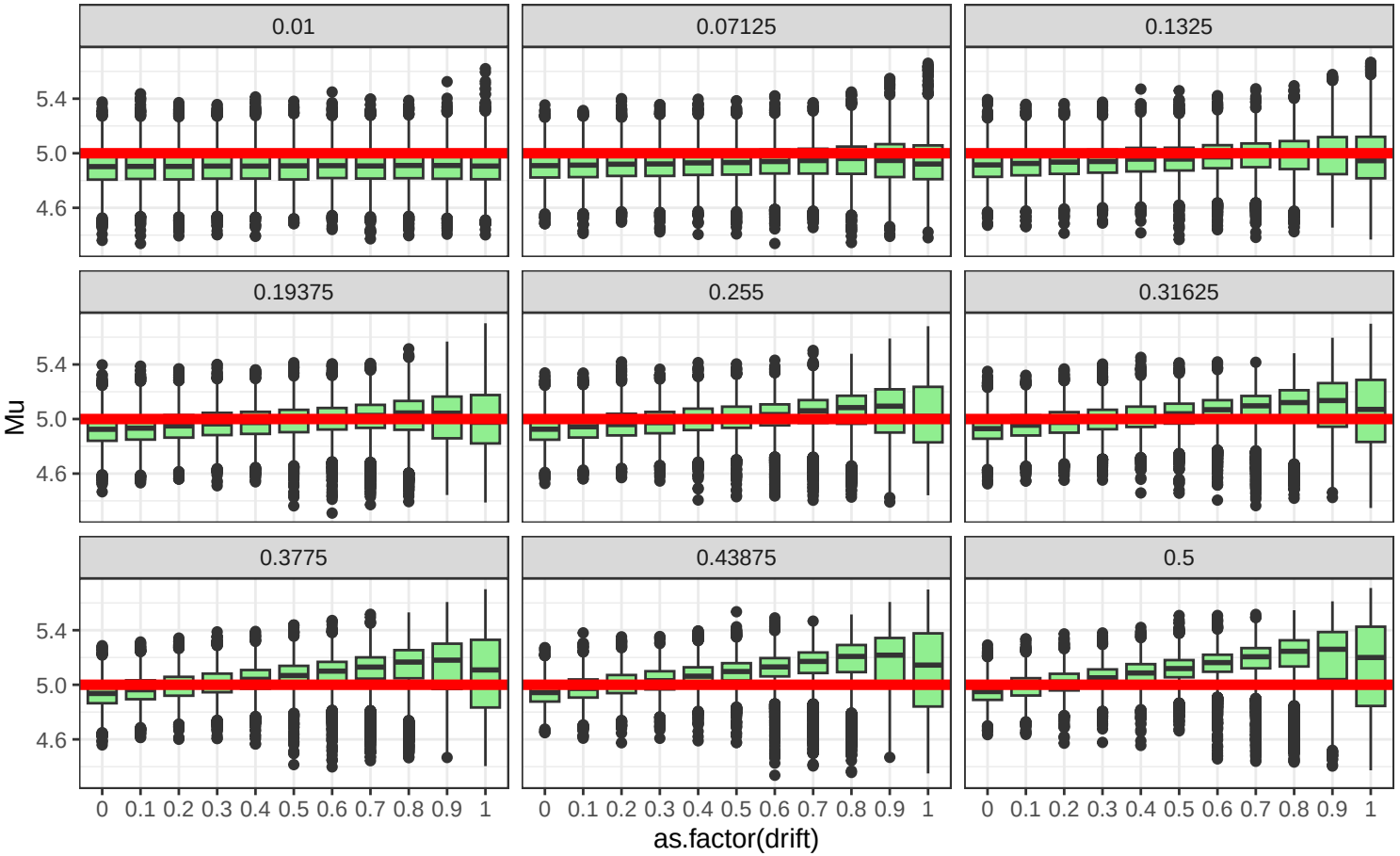
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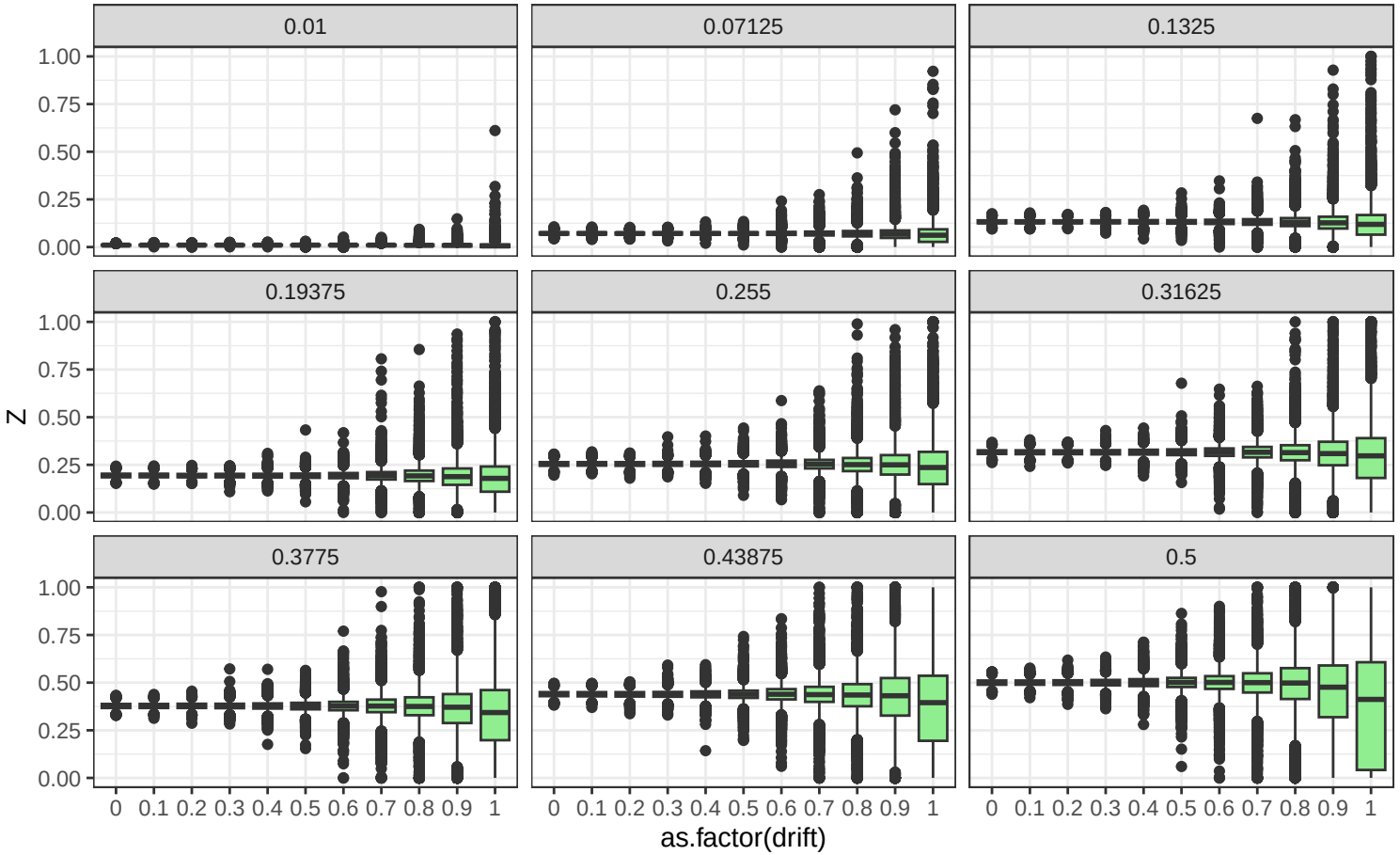
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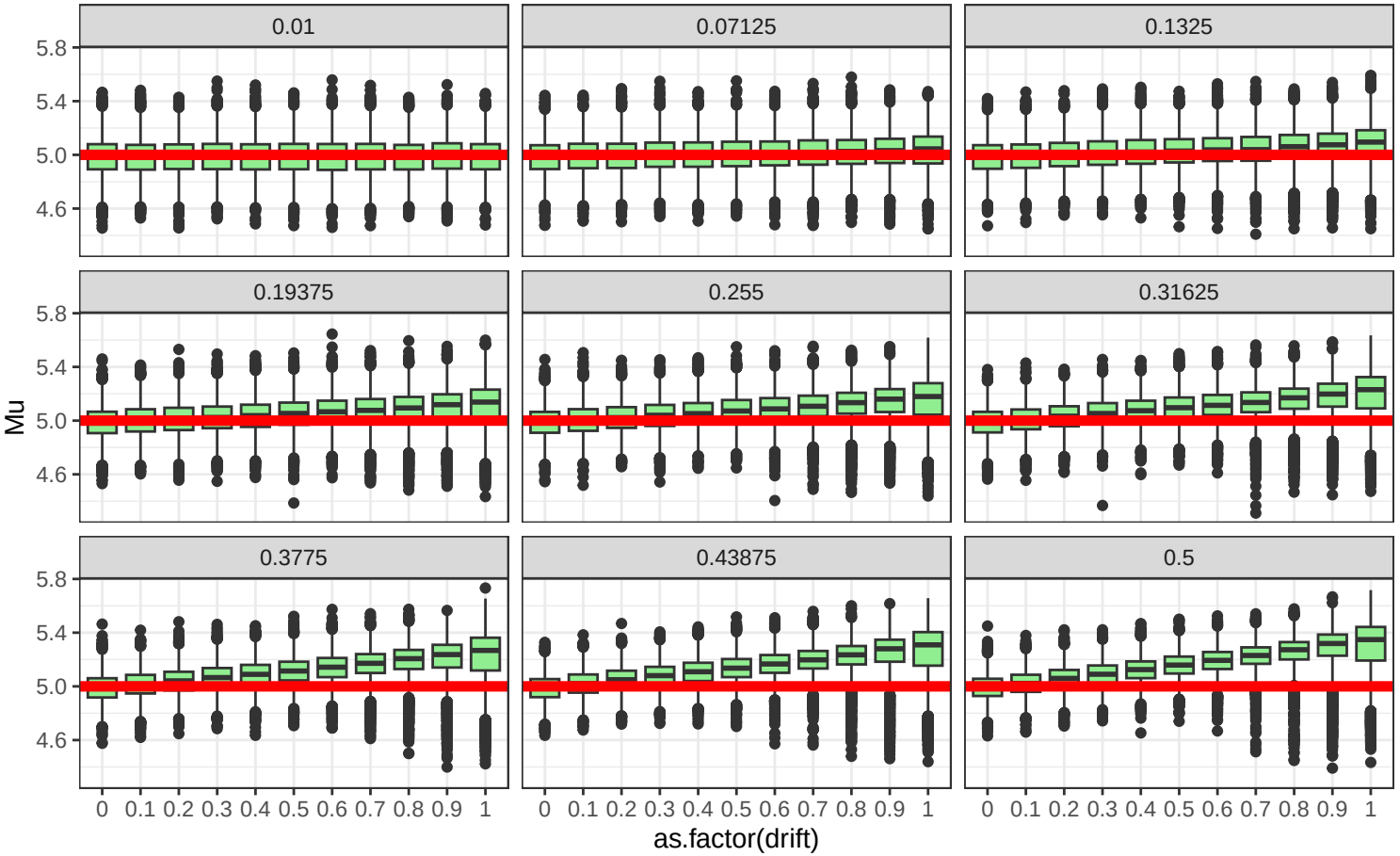
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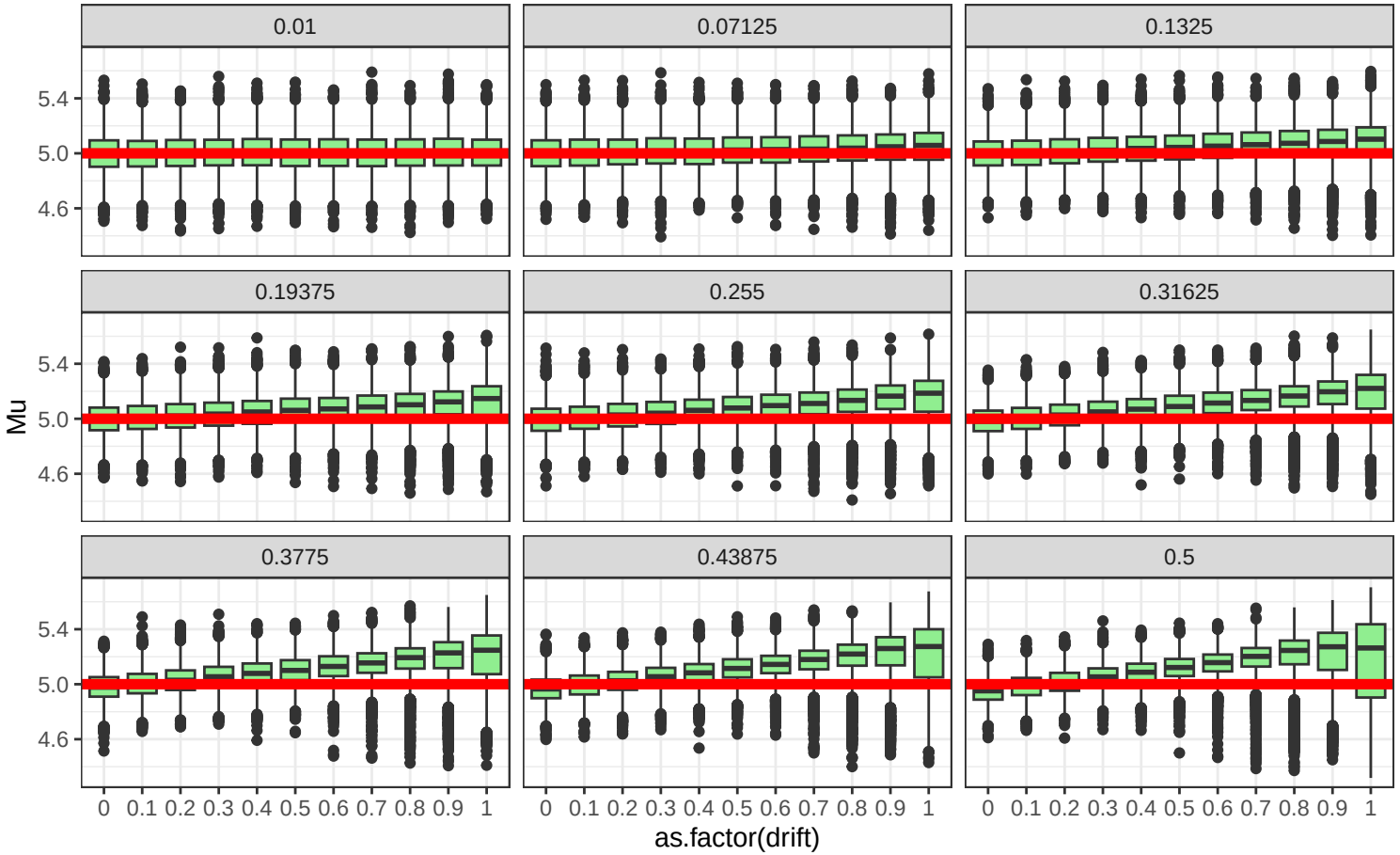
$\beta = 5.83$, $\varphi =$ 5e6



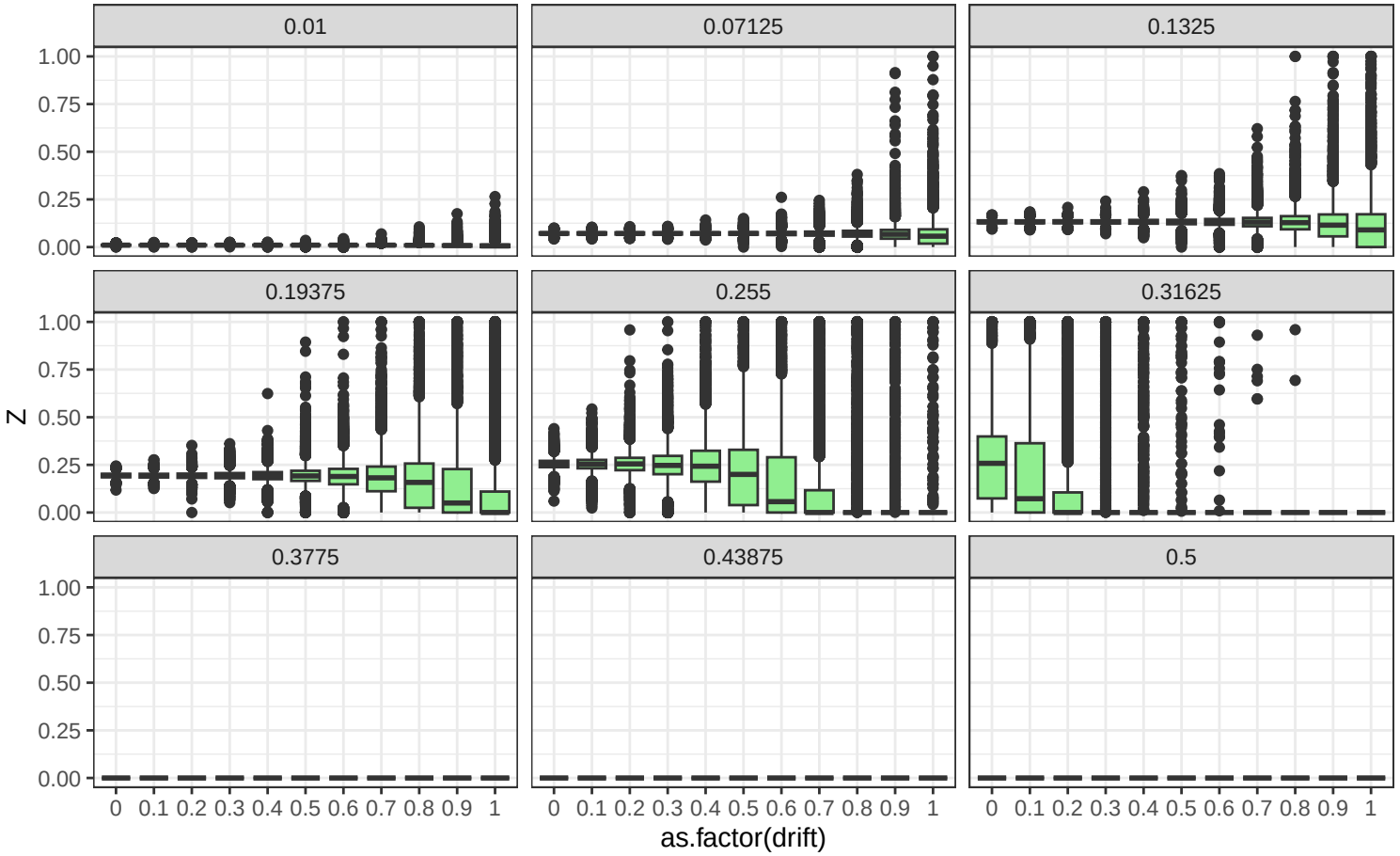
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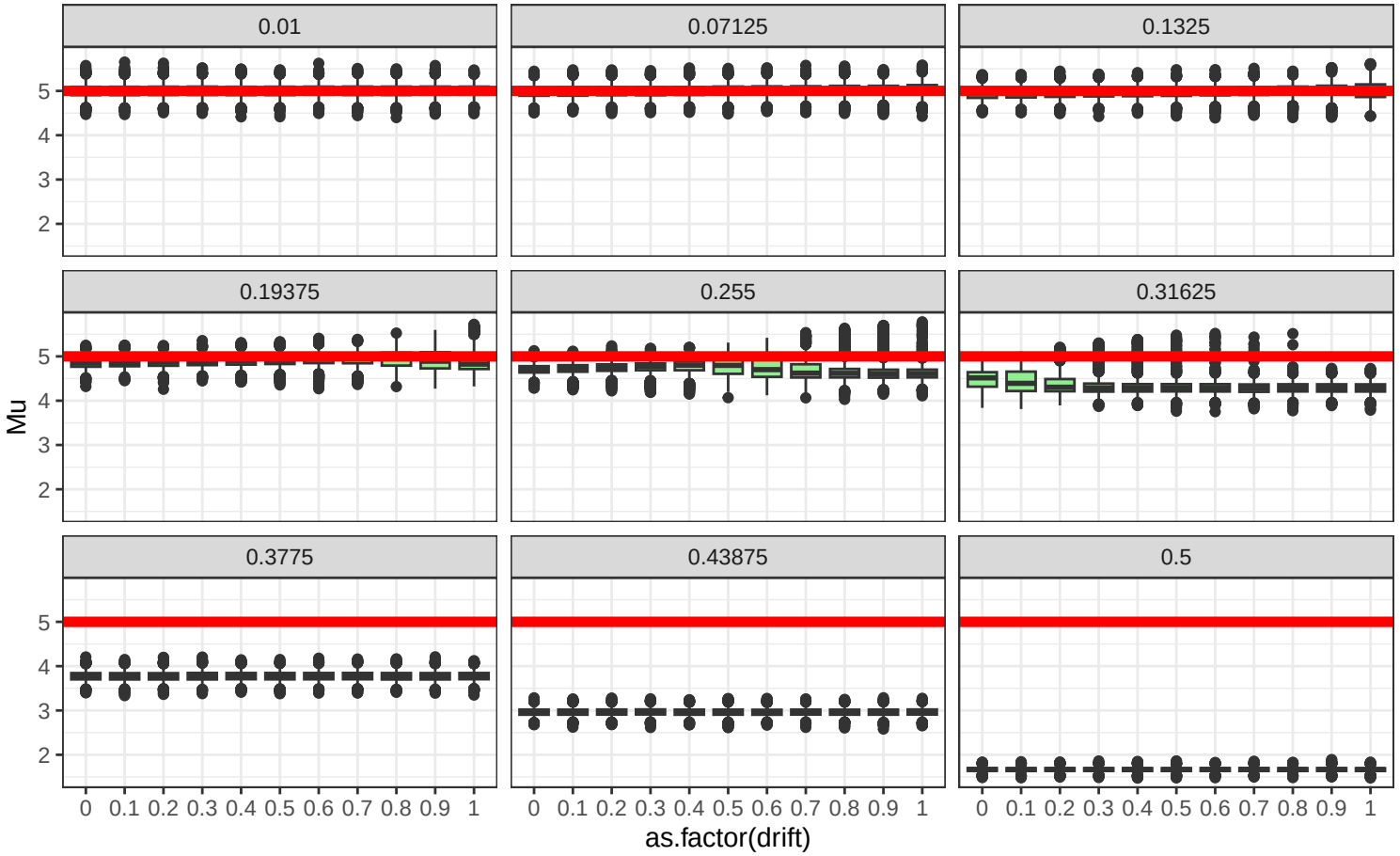
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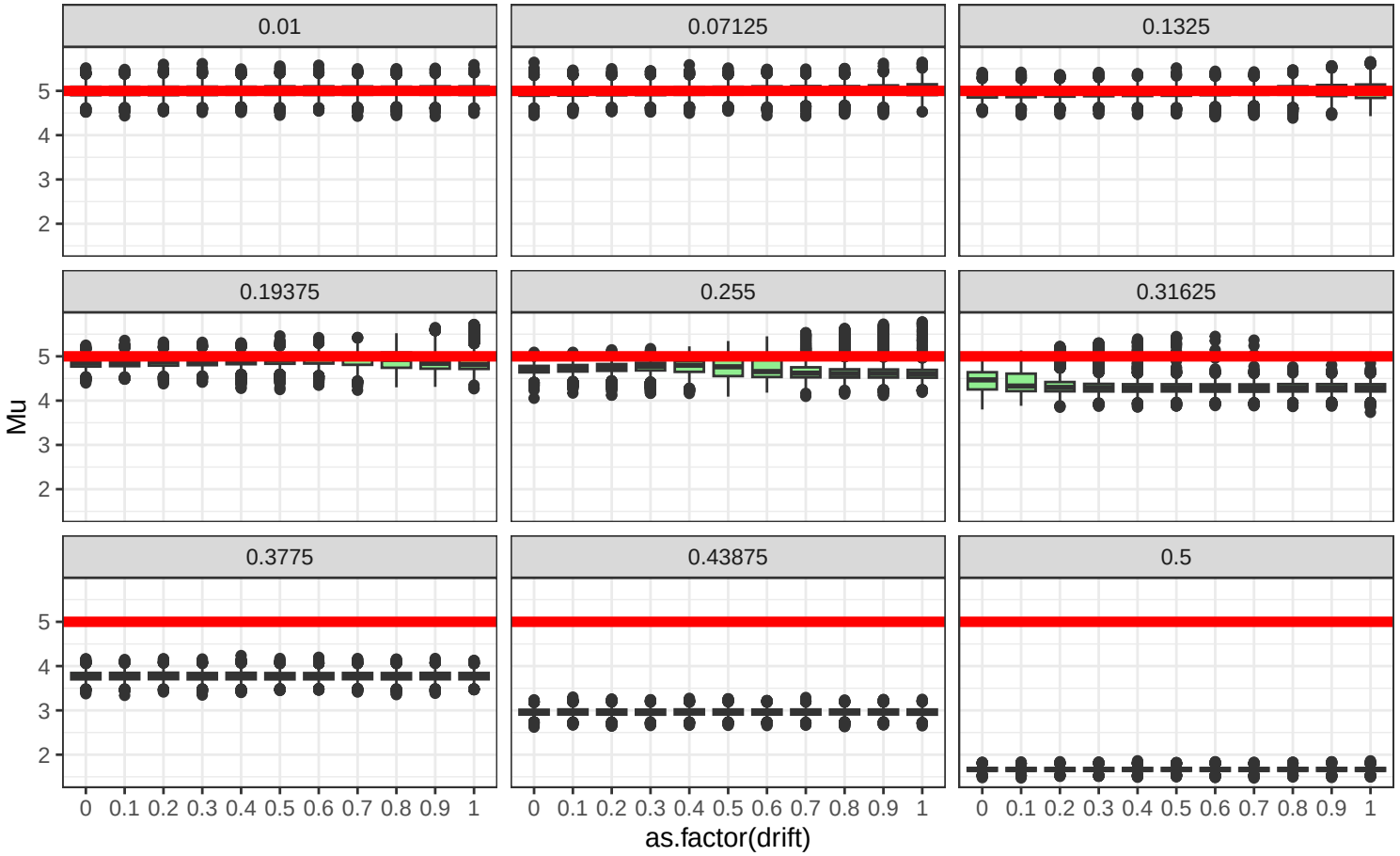
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  - good borrowing in low drift?
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- Estimating w doesn't seem to work.
- There are many objectives to target when borrowing. Do we want...
  - good borrowing in low drift?
  - control over borrow decay over drift?
  - frequentist operating characteristics?
- Rely on Ratta et al. (2026) for decay control, but try different βs.
- Simulate your way to ~~victory~~ desired decay.

Thank you!

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Wait for the eventual paper (it'll come, I promise)!

References

Kopp-Schneider, A., Calderazzo, S., and Wiesenfarth, M. (2019). Power gains by using external information in clinical trials are typically not possible when requiring strict type i error control. *Biometrical Journal*, 62(2):361–374.

Ratta, M., Saint-Hilary, G., Gasparini, M., and Mozgunov, P. (2026). On the interplay between prior weight and variance of the robustification component in robust mixture prior bayesian dynamic borrowing approach. *Statistics in Medicine*, 45(13-14).