

Malaria Molecular Surveillance Study Design Workshop

Module 4: Power

Remember ...

		Conclusion about H_0	
		Fail to reject	Reject
Truth about H_0	True	True negative $1 - \alpha$	False positive α
	False		

α sets the **false positive rate** of a test. Using α we can control how often we incorrectly conclude that there is a real effect when there is none.

In power analysis, we also specify an **alternative hypothesis**

H_0 : The population prevalence equals p_0

H_1 : The population prevalence equals p , which is different from p_0

In power analysis, we also specify an **alternative hypothesis**

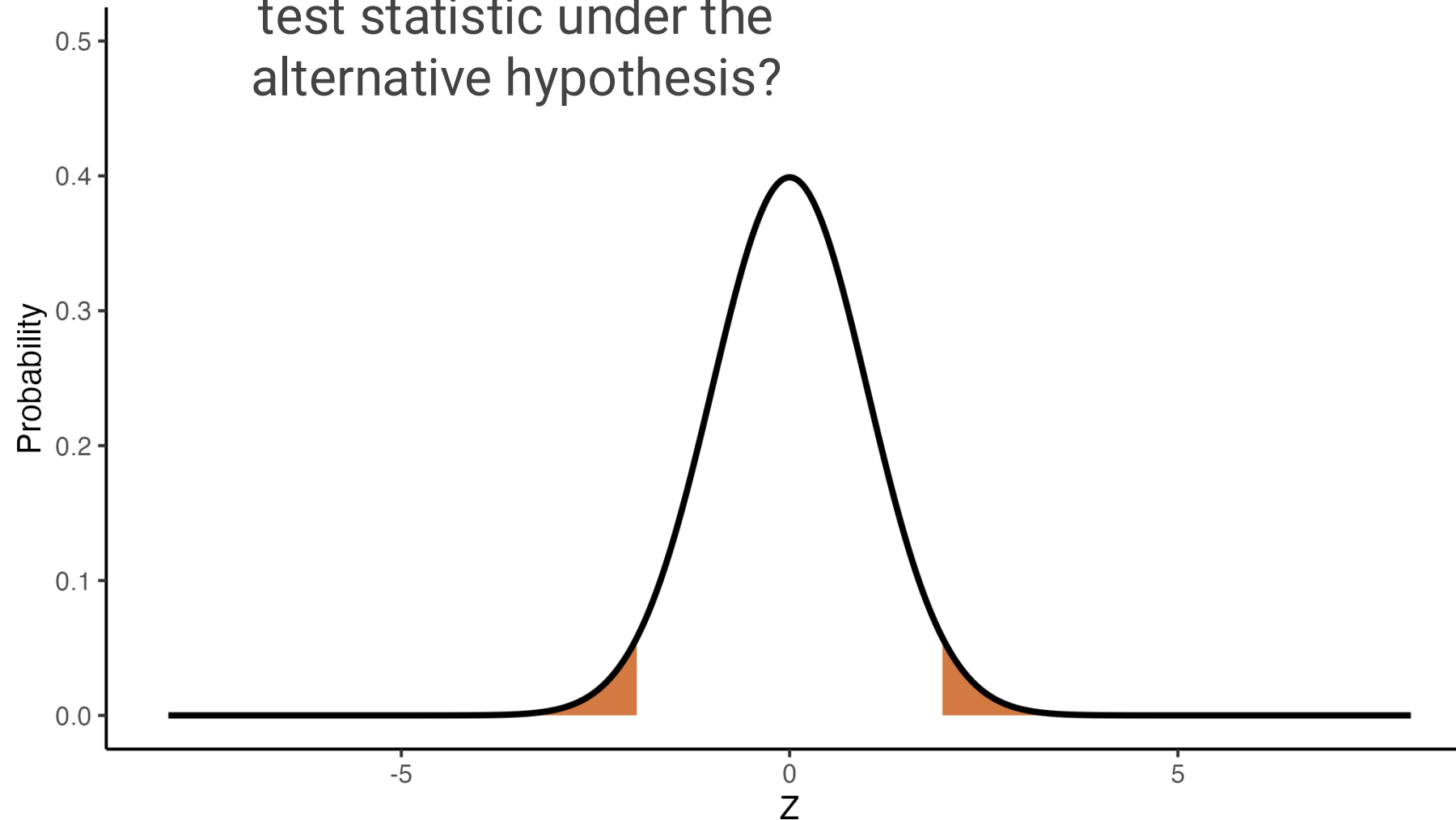
H_0 : The population prevalence equals p_0

H_1 : The population prevalence equals p , which is different from p_0

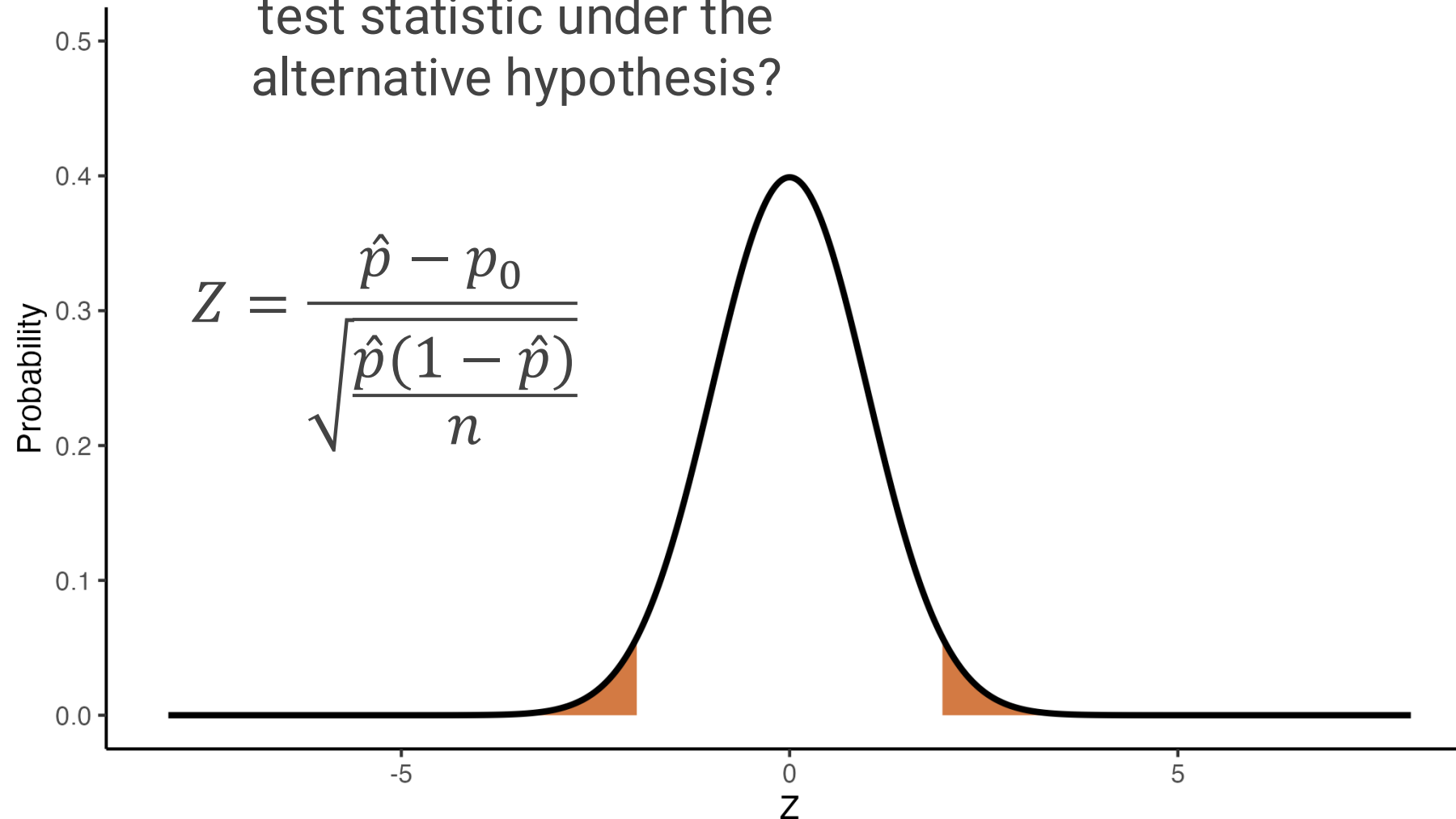
For example...

I want to test if the prevalence of *pfprt* K76T mutations is significantly different from 10%. When powering this test, I assume the true prevalence of K76T mutations is 15%.

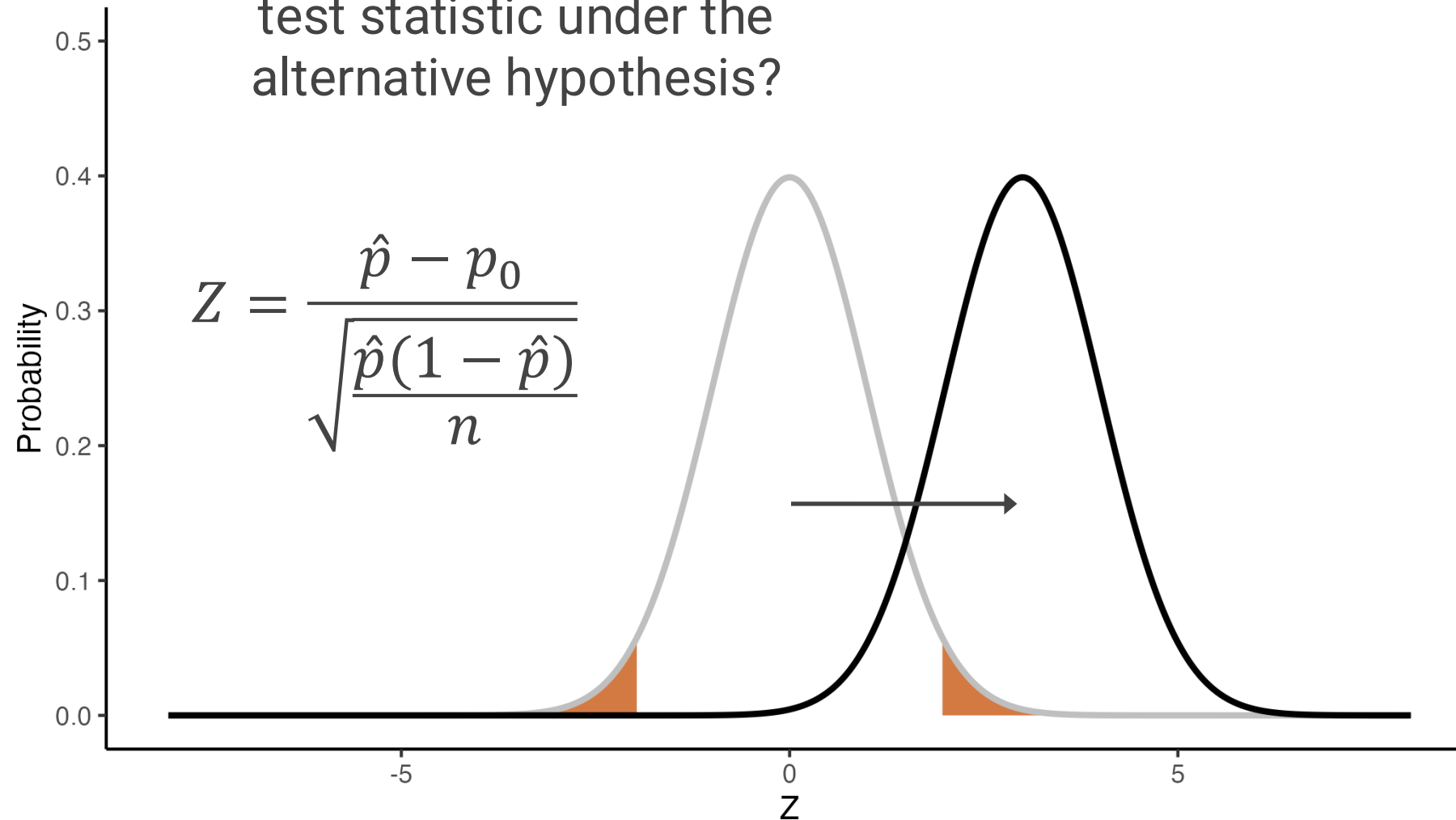
What is the distribution of my
test statistic under the
alternative hypothesis?



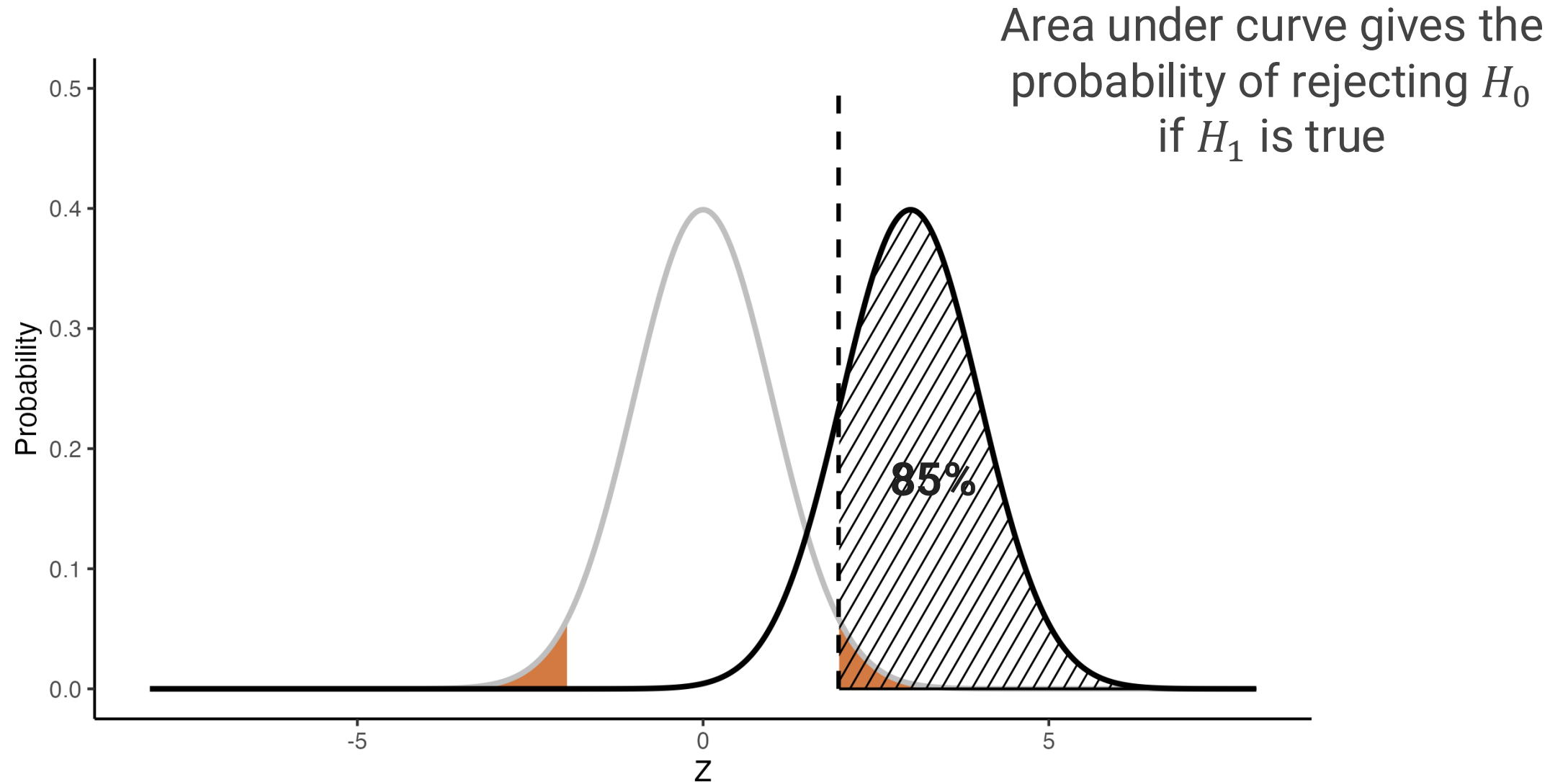
What is the distribution of my
test statistic under the
alternative hypothesis?



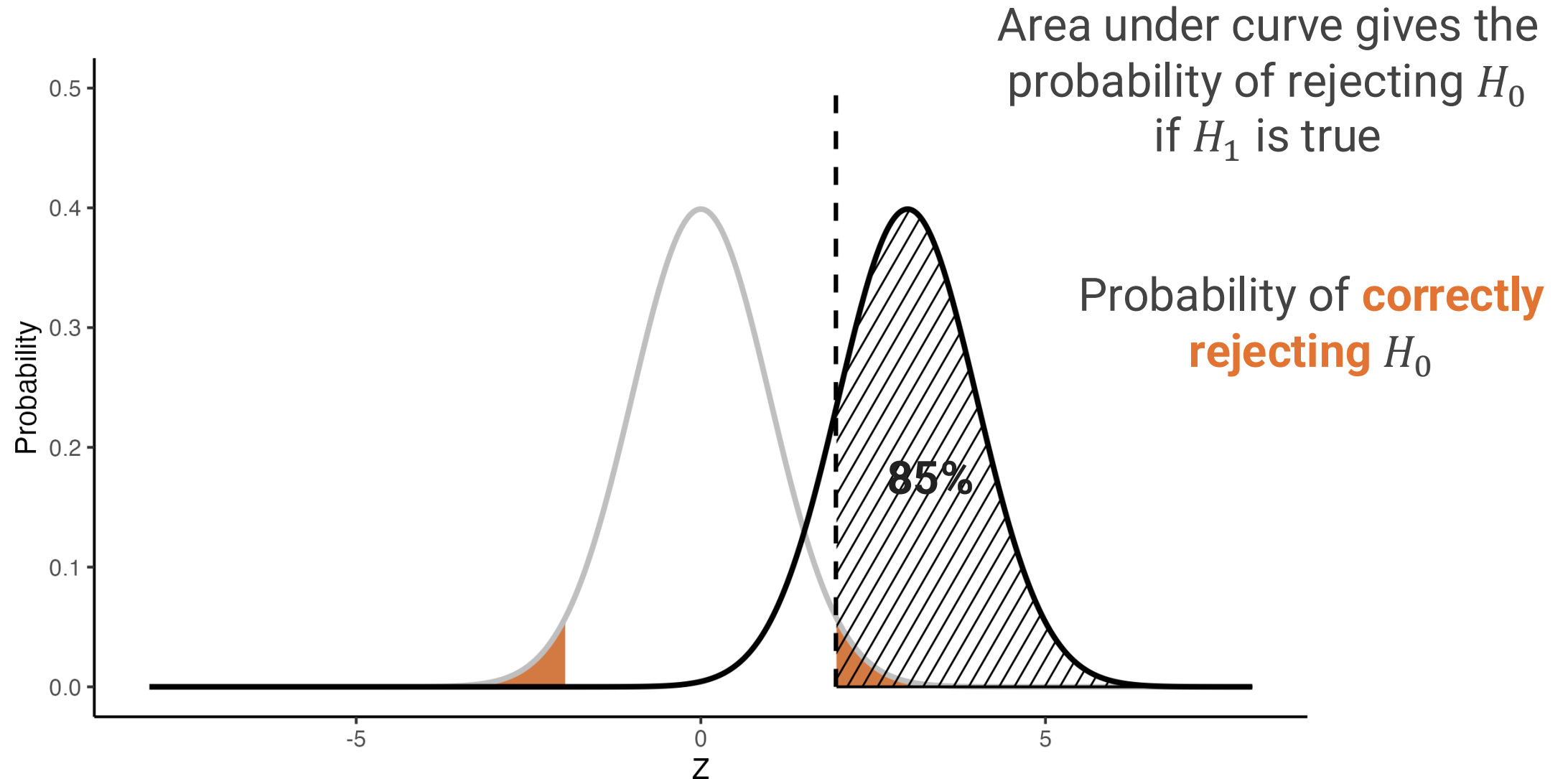
What is the distribution of my
test statistic under the
alternative hypothesis?



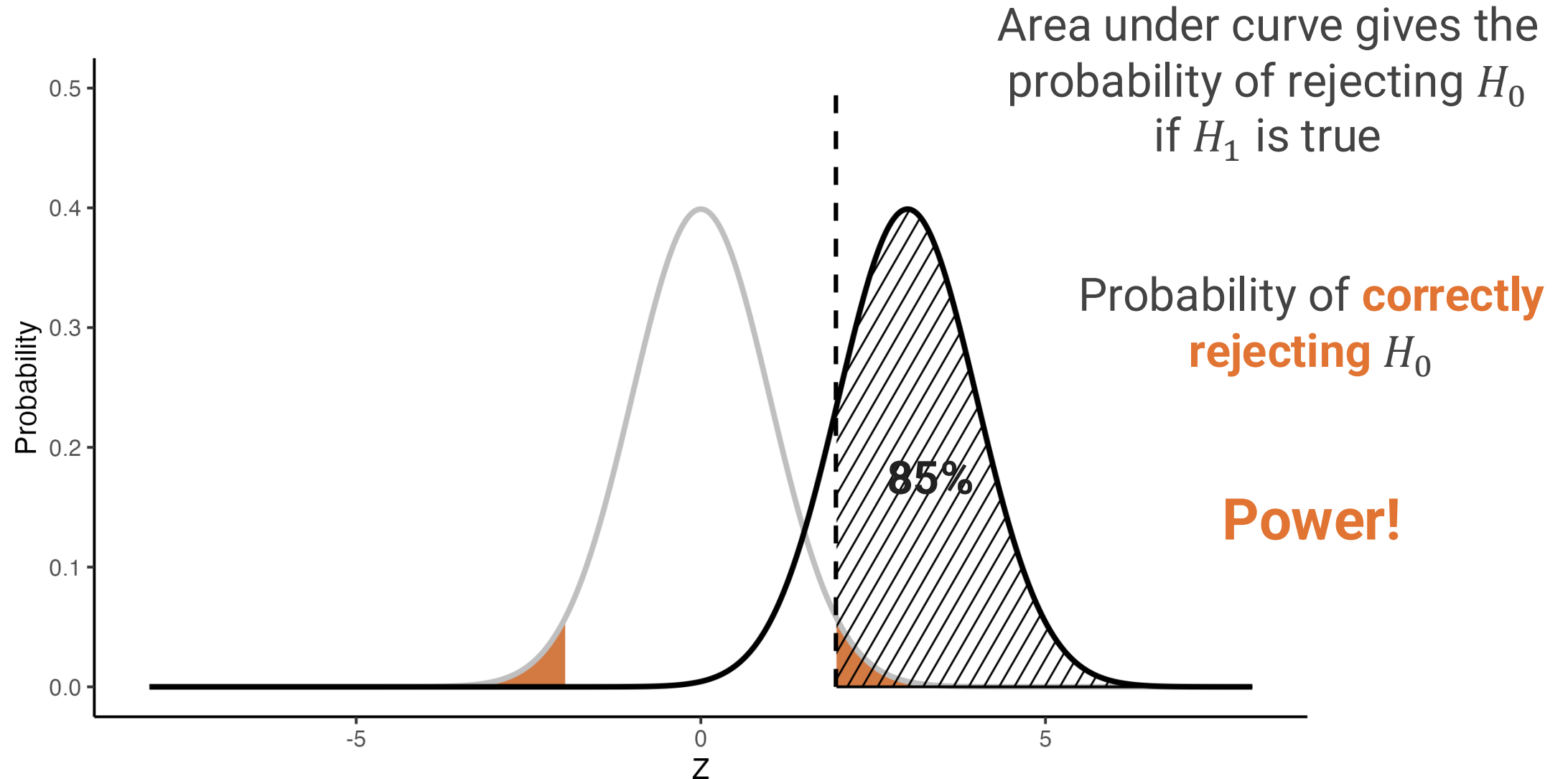
Power



Power



Power



		Conclusion about H_0	
		Fail to reject	Reject
Truth about H_0	True	True negative $1 - \alpha$	False positive α
	False		

		Conclusion about H_0	
		Fail to reject	Reject
Truth about H_0	True	True negative $1 - \alpha$	False positive α
	False	False negative	True positive

		Conclusion about H_0	
		Fail to reject	Reject
Truth about H_0	True	True negative $1 - \alpha$	False positive α
	False	False negative $1 - \text{Power}$	True positive Power

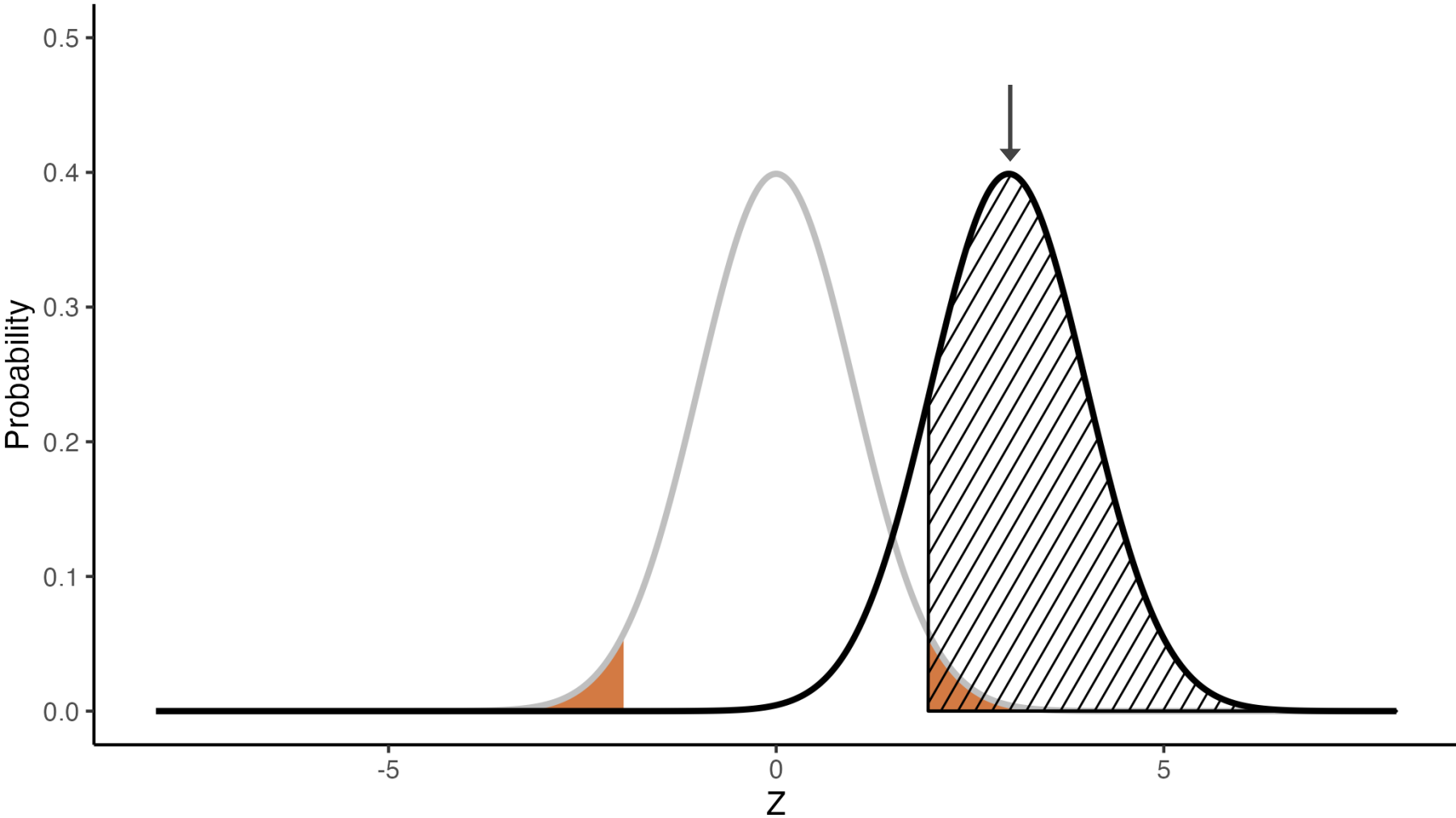
		Conclusion about H_0	
		Fail to reject	Reject
Truth about H_0	True	True negative $1 - \alpha$	False positive α
	False	False negative $1 - \text{Power}$	True positive Power

Power is the probability of **correctly rejecting** the null hypothesis. It is the chance that we find something interesting, given that it is there.

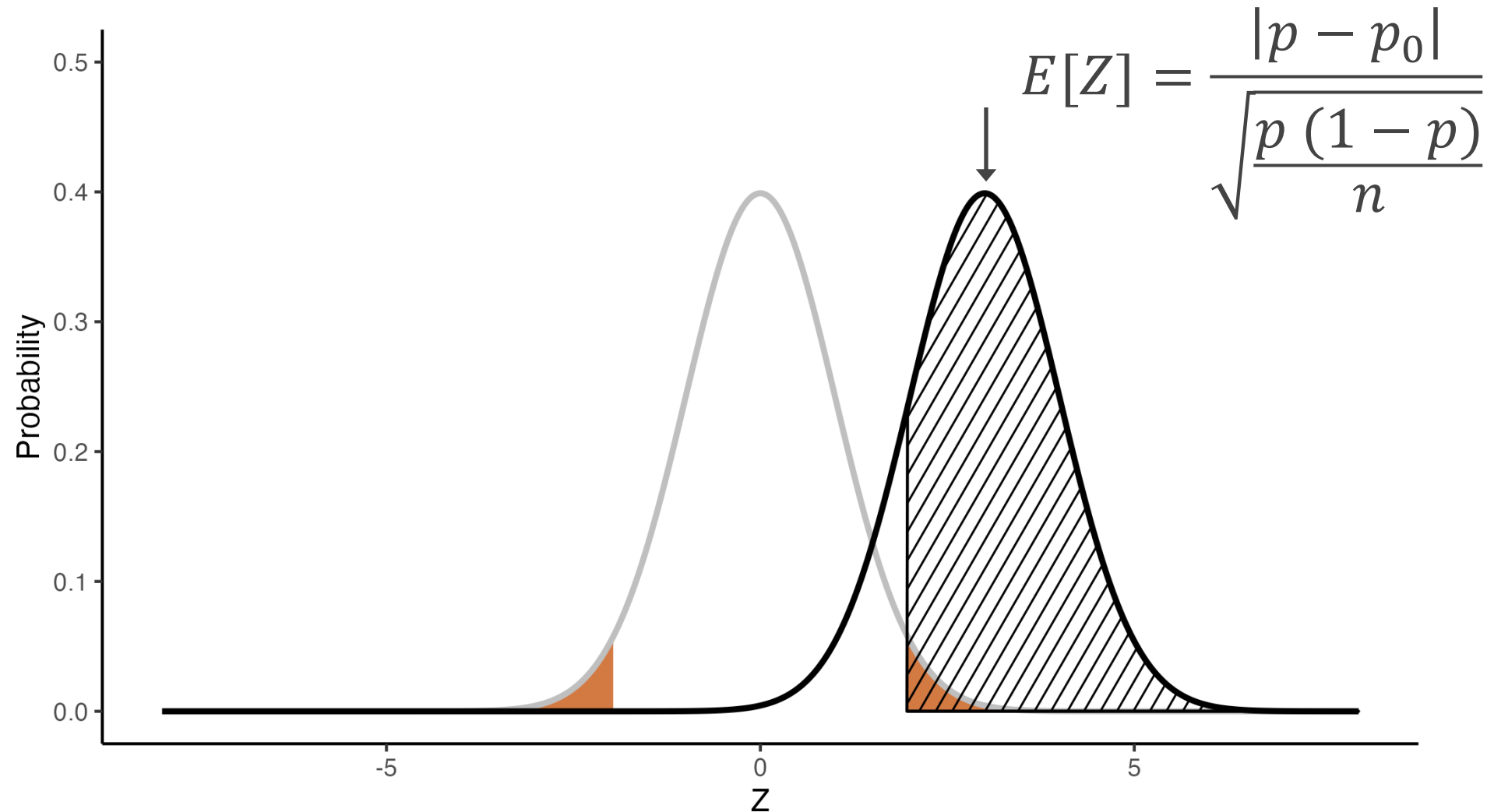
		Conclusion about H_0	
		Fail to reject	Reject
Truth about H_0	True	True negative $1 - \alpha$	False positive α
	False	False negative β	True positive $1 - \beta$

Power is the probability of **correctly rejecting** the null hypothesis. It is the chance that we find something interesting, given that it is there.

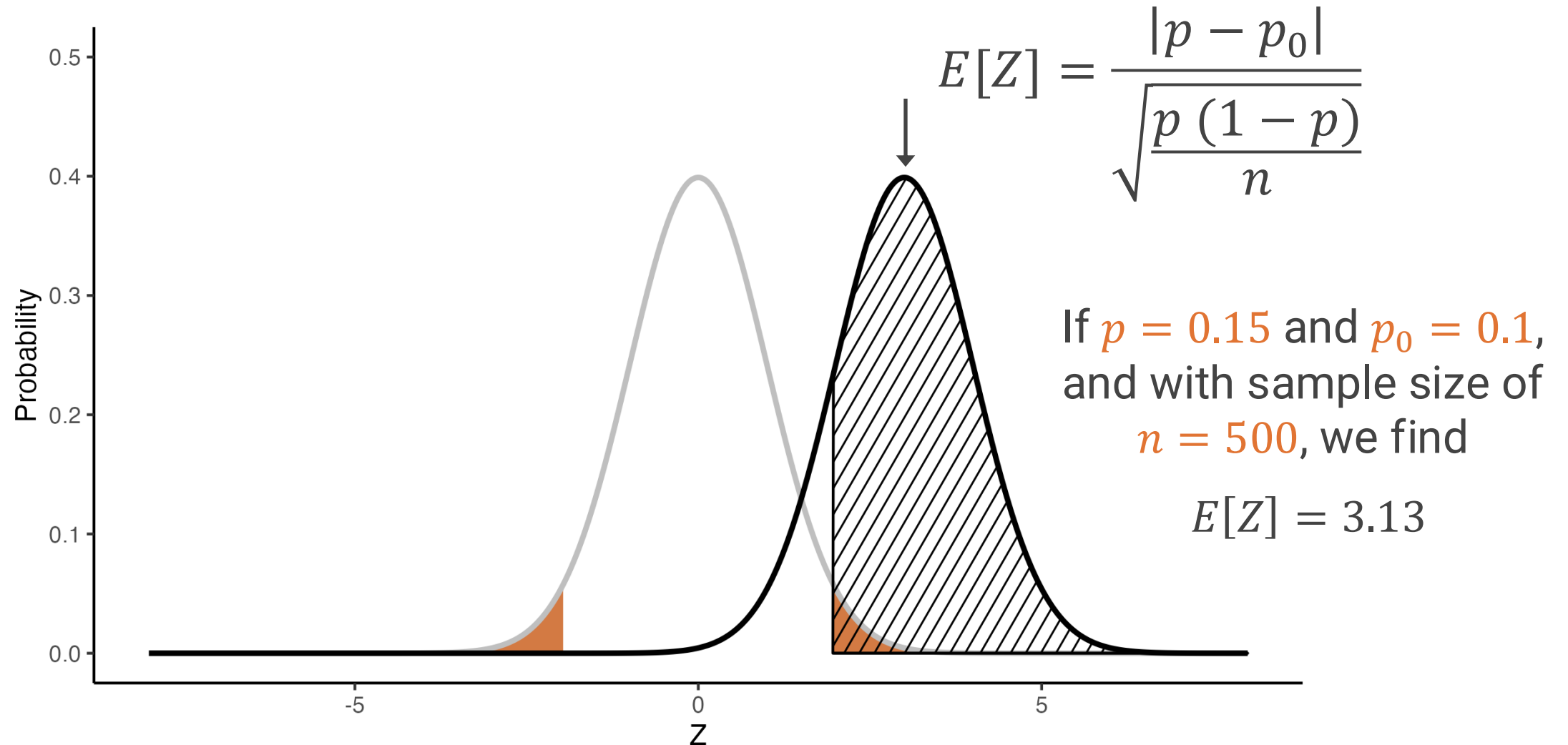
How do we calculate power?



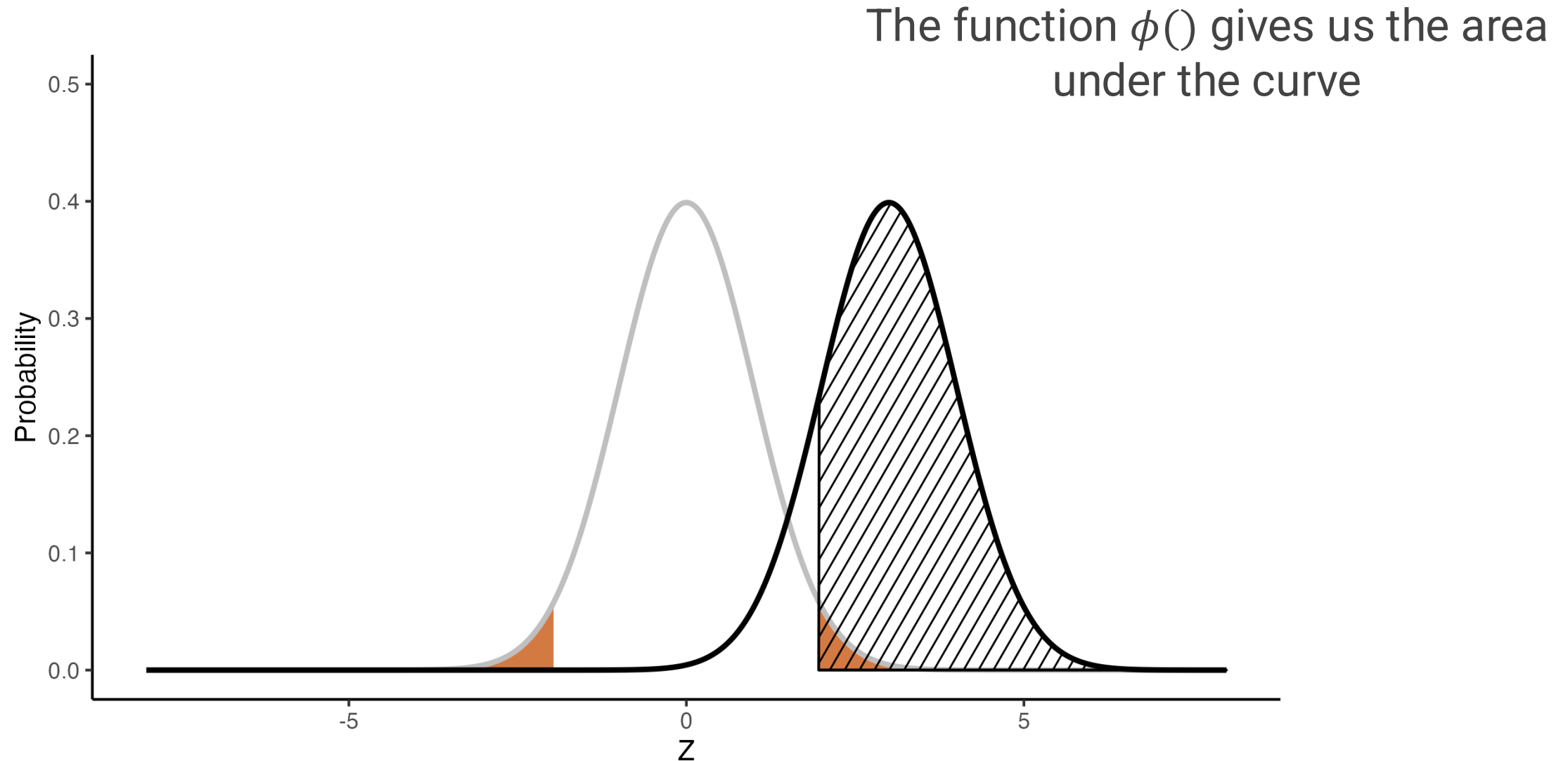
How do we calculate power?



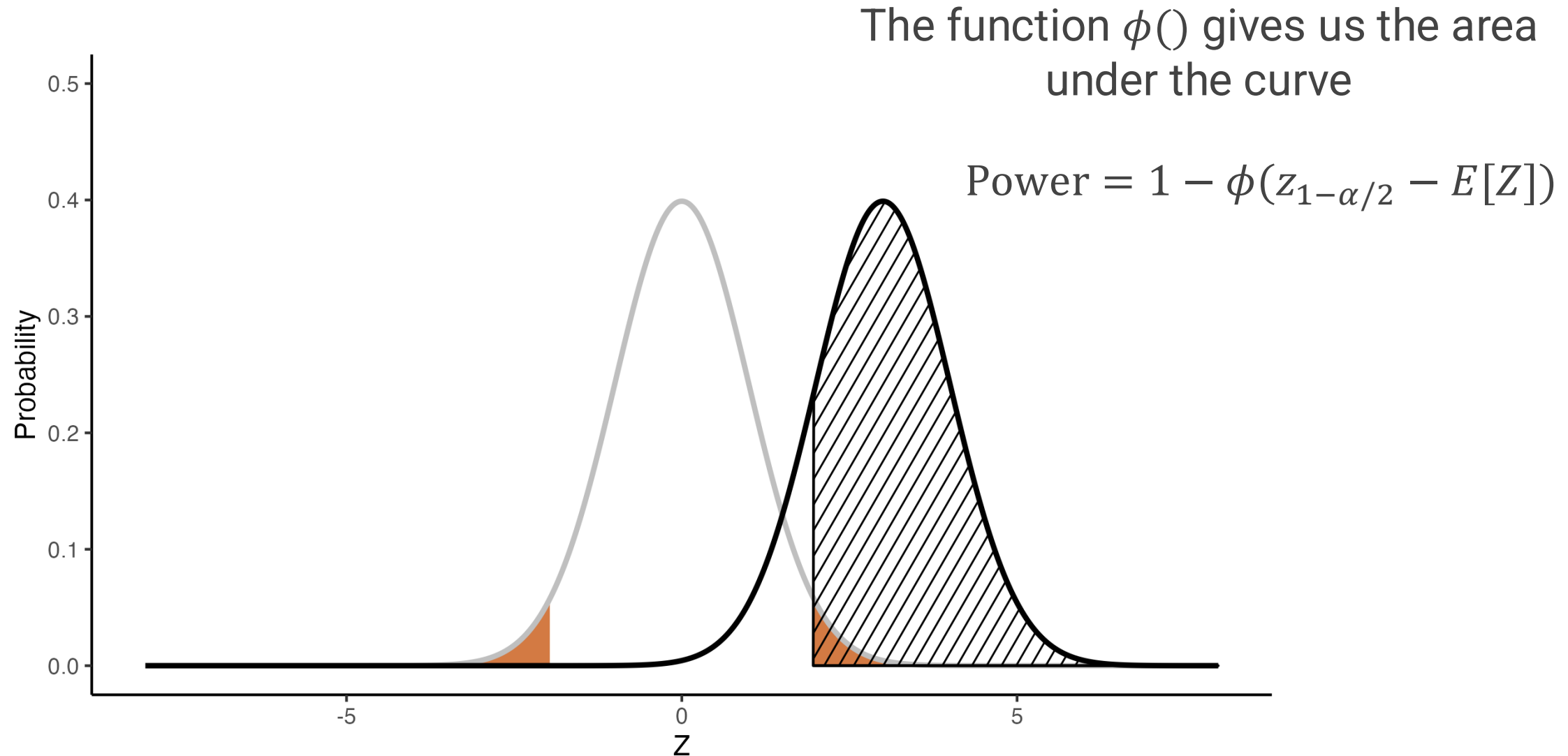
How do we calculate power?



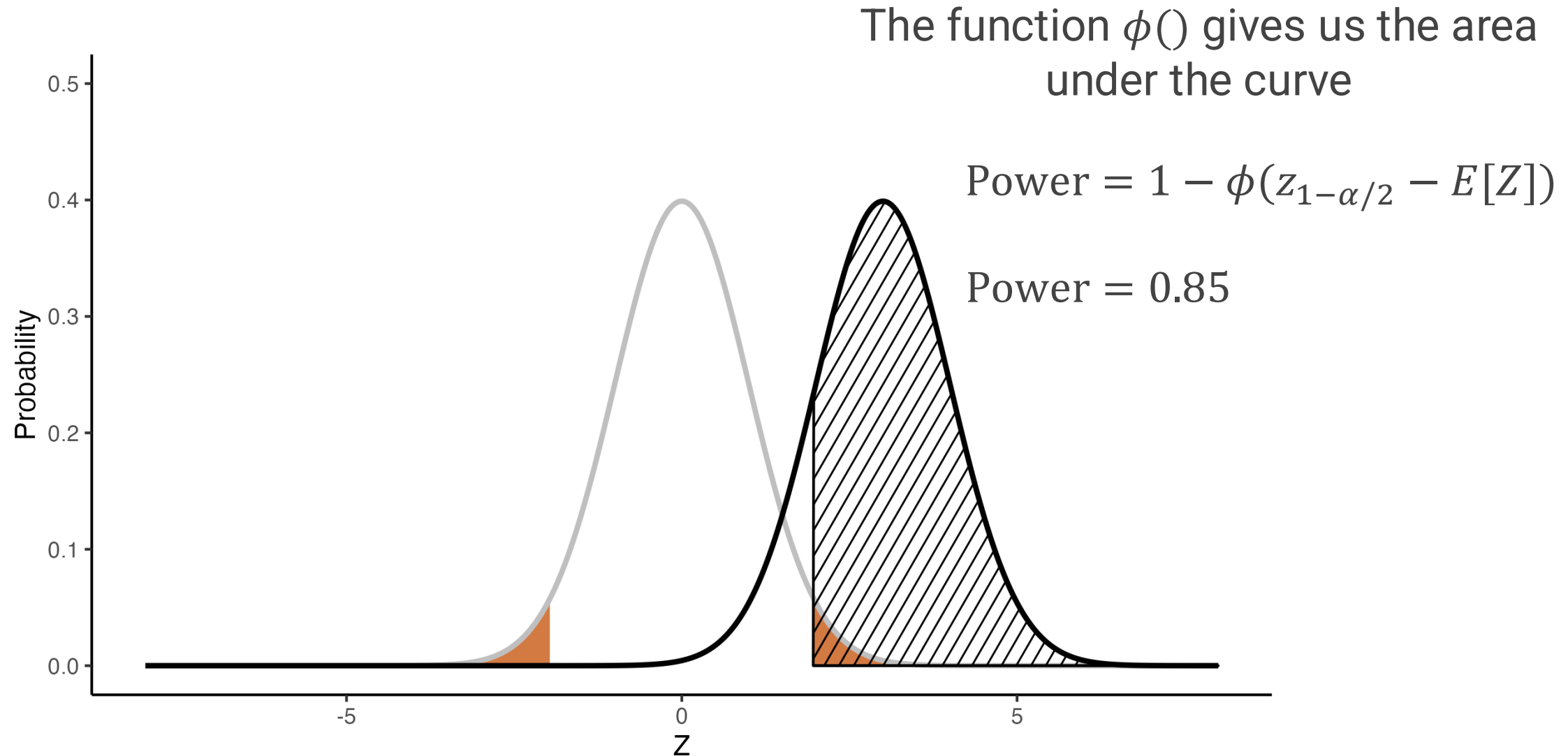
How do we calculate power?



How do we calculate power?



How do we calculate power?



Power as a function of sample size



$$\text{Power} = 1 - \Phi(z_{1-\alpha/2} - E[Z])$$

Power as a function of sample size

$$\text{Power} = 1 - \phi \left(z_{1-\alpha/2} - \frac{|p - p_0|}{\sqrt{\frac{p(1-p)}{n}}} \right)$$

Power as a function of sample size

$$\text{Power} = 1 - \phi \left(z_{1-\alpha/2} - \frac{|p - p_0|}{\sqrt{\frac{p(1-p)}{n}}} \right)$$

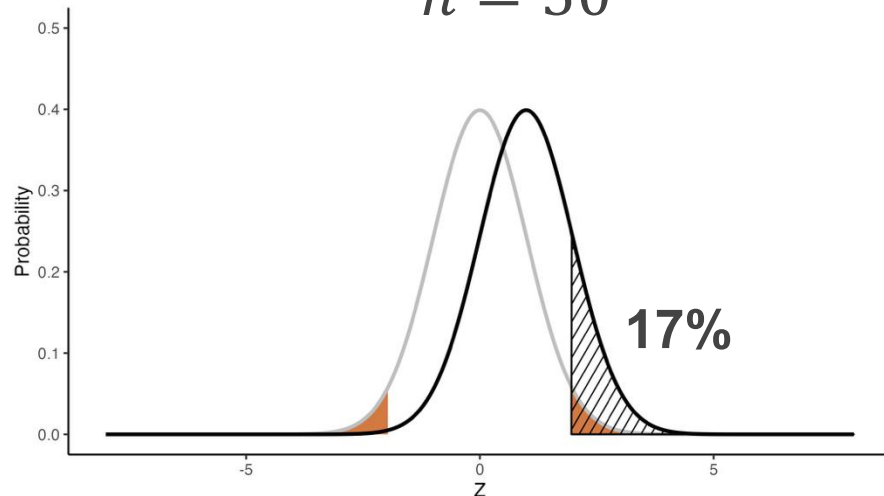
Power varies as a function
of sample size

Power as a function of sample size

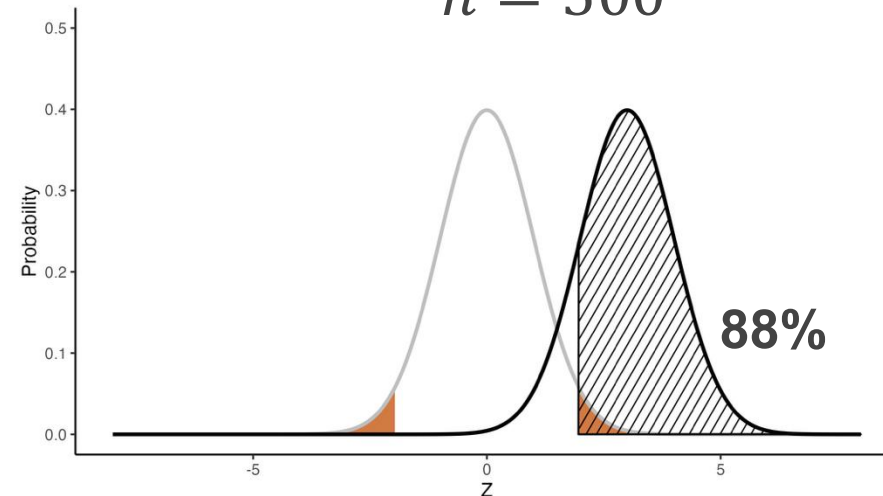
$$\text{Power} = 1 - \phi \left(z_{1-\alpha/2} - \frac{|p - p_0|}{\sqrt{\frac{p(1-p)}{n}}} \right)$$

Power varies as a function of sample size

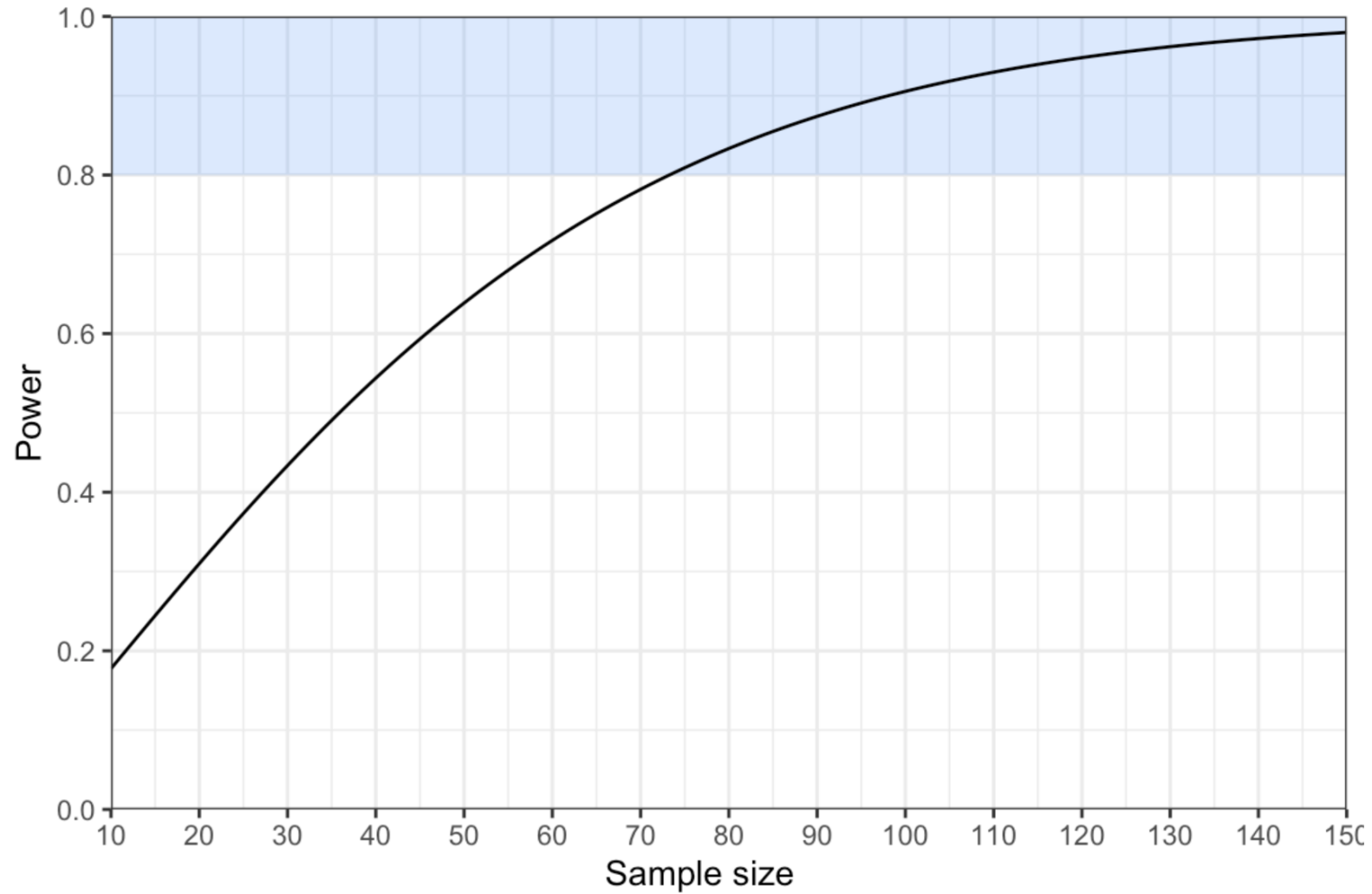
Small sample
 $n = 50$



Large sample
 $n = 500$

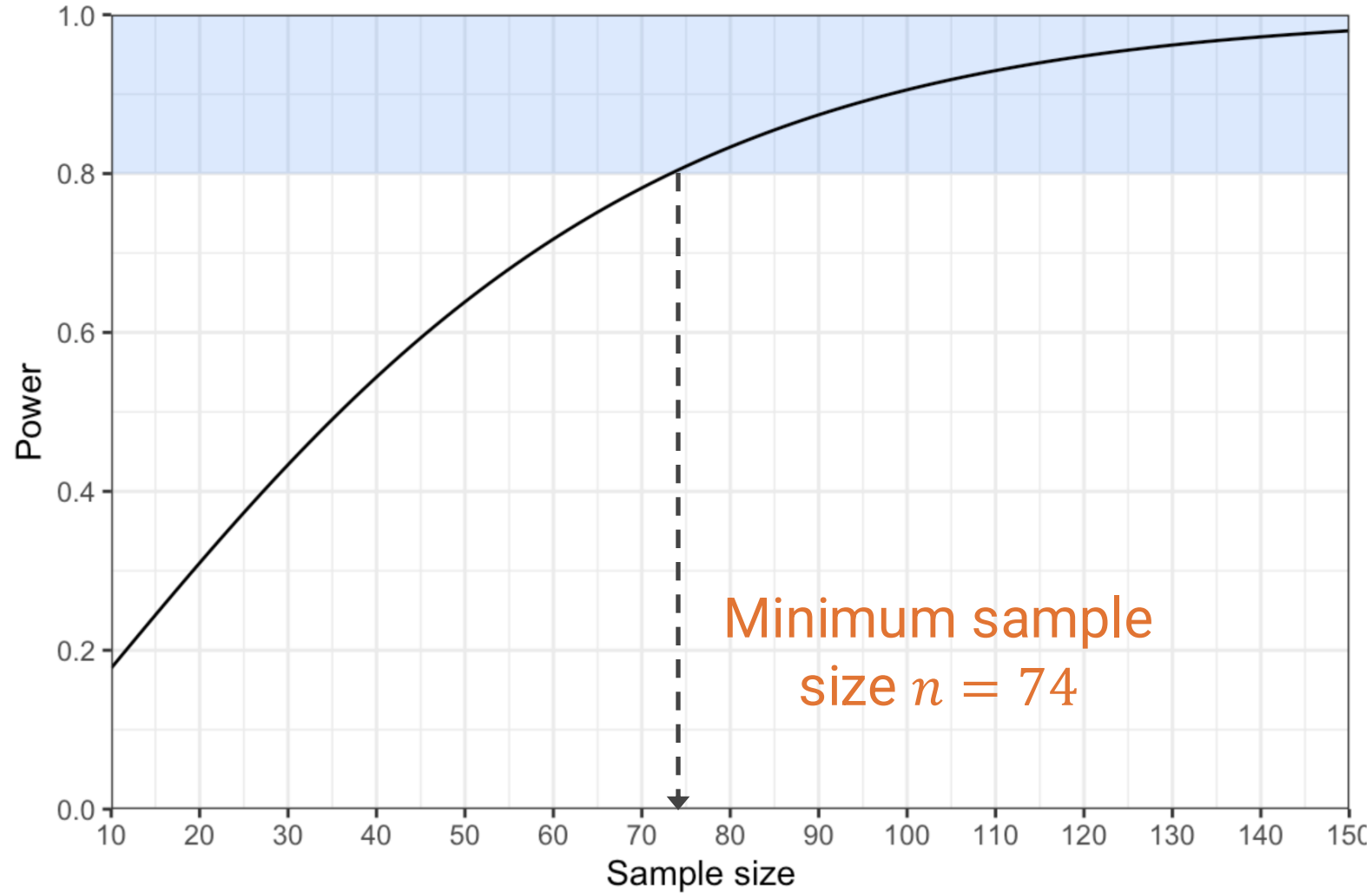


Power curves



80% power

Power curves



80% power

Minimum sample
size $n = 74$

$$\text{Power} = 1 - \phi \left(z_{1-\alpha/2} - \frac{|p - p_0|}{\sqrt{\frac{p(1-p)}{n}}} \right)$$

Can we reverse-engineer this to find the value of n that achieves a target power?

$$\text{Power} = 1 - \phi \left(z_{1-\alpha/2} - \frac{|p - p_0|}{\sqrt{\frac{p(1-p)}{n}}} \right)$$

Can we reverse-engineer this to find the value of n that achieves a target power?

$$n = \left(z_{1-\beta} + z_{1-\frac{\alpha}{2}} \right)^2 \frac{p(1-p)}{(p - p_0)^2}$$

For 80% power, we find $z_{1-\beta} = 0.84$

- **Power** is the true positive rate. It is the chance of **correctly rejecting the null hypothesis**.
- Power increases with **sample size**. We can use power curves or sample size formulae to choose a value of n

Format: Interactive R code, accessed through the web

- Test for change in prevalence
- Using power curves and sample size tables
- Test for detection of rare *pfk13* variant



Workshop materials

https://mrc-ide.github.io/MMS-SD_workshop/