

Greek Letters

The alphabet

The 24 letters of the Greek alphabet, in alphabetical order. Uppercase and lowercase letters can represent different quantities in mathematical notation.

In Quarto, put inline mathematics between dollar signs. For example, type `$\beta$` to display β . The commands below also work in LaTeX math mode.

For uppercase Greek letters that share the shape of a Latin letter, standard LaTeX uses that Latin letter, such as `$\alpha$` for alpha. Lowercase omicron uses `$\omicron$` .

Name	Uppercase	LaTeX/Quarto	Lowercase	LaTeX/Quarto
Alpha	A	<code>α</code>	α	<code>α</code>
Beta	B	<code>β</code>	β	<code>β</code>
Gamma	Γ	<code>γ</code>	γ	<code>γ</code>
Delta	Δ	<code>δ</code>	δ	<code>δ</code>
Epsilon	E	<code>ϵ</code>	ϵ	<code>ϵ</code>
Zeta	Z	<code>ζ</code>	ζ	<code>ζ</code>
Eta	H	<code>η</code>	η	<code>η</code>
Theta	Θ	<code>θ</code>	θ	<code>θ</code>
Iota	I	<code>ι</code>	ι	<code>ι</code>
Kappa	K	<code>κ</code>	κ	<code>κ</code>
Lambda	Λ	<code>λ</code>	λ	<code>λ</code>
Mu	M	<code>μ</code>	μ	<code>μ</code>
Nu	N	<code>ν</code>	ν	<code>ν</code>
Xi	Ξ	<code>ξ</code>	ξ	<code>ξ</code>
Omicron	O	<code>$\omicron$</code>	$\omicron$	<code>$\omicron$</code>
Pi	Π	<code>π</code>	π	<code>π</code>
Rho	P	<code>ρ</code>	ρ	<code>ρ</code>
Sigma	Σ	<code>σ</code>	σ	<code>σ</code>
Tau	T	<code>τ</code>	τ	<code>τ</code>
Upsilon	Υ	<code>υ</code>	υ	<code>υ</code>
Phi	Φ	<code>ϕ</code>	ϕ	<code>ϕ</code>
Chi	X	<code>χ</code>	χ	<code>χ</code>
Psi	Ψ	<code>ψ</code>	ψ	<code>ψ</code>
Omega	Ω	<code>ω</code>	ω	<code>ω</code>

Alternative forms

Some lowercase letters have alternative forms that you may encounter in mathematical notation.

Name	Usual form	LaTeX/Quarto	Alternative	LaTeX/Quarto
Epsilon	ϵ	<code>\epsilon</code>	ε	<code>\varepsilon</code>
Theta	θ	<code>\theta</code>	ϑ	<code>\vartheta</code>
Kappa	κ	<code>\kappa</code>	$\varkappa$	<code>\varkappa</code>
Pi	π	<code>\pi</code>	ϖ	<code>\varpi</code>
Rho	ρ	<code>\rho</code>	ϱ	<code>\varrho</code>
Phi	ϕ	<code>\phi</code>	φ	<code>\varphi</code>

The form ς (`\varsigma`) is used for sigma at the end of a Greek word. In our mathematical notation, we generally use σ (`\sigma`).

How we use these symbols

These are common conventions. Always check how a symbol is defined in the model or paper you are reading. The examples below follow our notes. See [Formulae](#) for the main results together with the conditions under which they apply.

Symbol	Use	Example from the module
$\beta_0, \beta_1, \dots$	Population regression coefficients	β_1 is the coefficient on treatment or schooling in Weeks 1–4. Week 5 writes the schooling coefficient as β , following BJB.
$\hat{\beta}_1$	Estimated regression coefficient	The hat indicates an estimate calculated from a sample.
$\gamma_0, \gamma_1, \dots$	Coefficients in another relationship	Ability regressed on university attendance in Week 1, the logit model in Week 2, and slope differences in RDD.
$\pi_0, \pi_1, \dots$	First-stage coefficients	π_1 measures how the instrument changes the endogenous explanatory variable.
$\delta_0, \delta_1, \dots$	Reduced-form coefficients	In Weeks 3–4, δ_1 measures how the instrument changes the outcome. Elsewhere, δ can label other regression coefficients.
τ	Treatment effect	τ_{ATT} in matching and τ_{LATE} in IV.
ρ	Correlation, or a treatment-effect coefficient	$\rho_{x,z}$ is a correlation in Week 5. In Week 7, ρ is the RD effect at the cutoff.
$\varepsilon, \epsilon, \nu, \eta, \xi$	Disturbances or unobserved components	Week 1 uses ε_i in the earnings relationship and $\eta_i = Y_i^0 - E[Y_i^0]$. Week 5 uses ν_i for the first-stage disturbance.
μ	A mean, or an unobserved group component	$\mu_0 = E[Y_i^0]$ in Week 1. In the class-size application, μ_s is an unobserved school effect.

Symbol	Use	Example from the module
σ	Population standard deviation	The outcome standard deviation in the power calculation.
σ^2	Population variance	The common outcome variance assumed in that calculation.
$\sigma_{x,y}$	Population covariance	Week 5 uses $\sigma_{x,\epsilon}$ for the covariance between schooling and the outcome disturbance.
α	Significance level, or a regression coefficient	$\alpha = 0.05$ in a five-percent test. The class-size application also uses α for a coefficient.
β in power calculations	Probability of a Type II error at a specified alternative	Power is $1 - \beta$. This use is separate from the regression coefficients.
Δ	A difference or specified effect size	The effect a study is designed to detect in Week 1.
θ, λ	Additional regression coefficients	Coefficients on controls or interactions.
Σ	Summation	$\sum_{i=1}^n Y_i$ adds the outcomes of all n observations. The summation symbol is based on uppercase sigma, Σ .

We also use the Latin letters u , v and e for disturbances. In particular, Latin v and Greek ν can look similar. A hat on a disturbance, such as $\hat{v}_i$, denotes an estimated residual.