ETF2100 Introductory Econometrics

MONASH UNIVERSITY · SEMESTER 2, 2026

Full guide + ask Sia about ETF2100

SIDE 1/2 DEFINITIONS · FORMULAS · DECISION RULES · COMPARISONS

EXAM REVISION SHEET

Final examination 50% · current assessment summary

1. Exam map

COURSE.JSON

W 10 | Mid 15 | A2 25 | Final examination 50%

COMPONENT	WEIGHT	EVIDENCE
Workshop activities	10%	Current schedule
Mid-semester examination	15%	Week 8 teaching sequence
Assignment 2	25%	Later-semester schedule
Final examination	**50%**	Current assessment summary

Permitted materials: not confirmed for this offering in the course materials we hold — check the exam instructions on the LMS.

2. Frame the question

CH 1

population → sample → correlation

target → evidence → diagnostic

Fix the population, inspect the sample, then let correlation challenge—not prove—the story.

FIX FIRST	QUESTION TO ANSWER
Population	Which workers/firms, labour market and period?
Unit	What does one observation represent?
Outcome	Which response is explained?
Regressors	Which observed comparisons enter?
Error	Which unobserved influences remain?

CORRELATION BOUNDARY

```
-1 ≤ correlation ≤ 1
Zero linear correlation can hide a
nonlinear relation; a strong
correlation can be produced by a common
cause.
```

Description is not identification. Experimental data may support a cleaner intervention contrast; non-experimental data require care about selection and omitted causes.

EXAM USE *Before reading any coefficient, write the population, outcome, comparison and unobserved influences. Keep the conclusion inside that boundary.*

Data audit before algebra

CH 1

AUDIT LENS	QUESTION	REVISION SIGNAL
Missingness	Which units or fields are absent?	Observed sample may no longer represent the stated population.
Units	Are wage, education and experience measured at the intended scale?	Coefficient units and comparisons change.
Range	What x-values are supported?	Intercept or prediction may be extrapolative.

3. Simple regression

CH 2

MODEL AND CHANGE

```
y = β₀ + β₁x
Δy = β₁Δx
fitted value: ŷ; residual: e = y - ŷ
```

intercept → slope → residual

level at x=0 → fitted change → discrepancy

Read the line through its level, per-unit change and residual pattern.

OBJECT	CORRECT READING	CHECK
β_0	Fitted outcome at x=0	Is zero observed or meaningful?
β_1	Fitted y-change for one x-unit	Name both units and supported range.
$\hat{y}$	Value represented by fitted line	Use the stated x.
e	Observed y minus fitted $\hat{y}$	Discrepancy, not proof of cause.

INTERPRETATION SEQUENCE

1. State the direction and size of β_1.
2. Carry the response-per-predictor unit.
3. Keep the statement within the observed predictor range.
4. Call it a fitted conditional association unless design assumptions justify more.

IF THE PROMPT CHANGES...	THEN REVISE...
x from years to a degree indicator	β_1 becomes a group contrast, not an extra year.
x=0 lies outside 10–18	β_0 may have little substantive meaning.
Residual pattern curves	The straight-line mean may be misspecified.
New x lies outside the range	Flag extrapolation.

EXAM USE *A neat line is not evidence that omitted determinants are unrelated to x. Separate fit, interpretation and causal claim.*

4. Residual ≠ disturbance

CH 2–3

RESIDUAL	ERROR TERM
Sample discrepancy $y-\hat{y}$ for one observation.	Unobserved response determinants omitted from the population equation.
Observed after fitting.	Conceptual part of the data-generating relationship.

FULL-MARK READING CHECK

CHECK	REQUIRED CONTENT
Object	Is this β_0, β_1, $\hat{y}$ or e?
Scale	State outcome units per predictor unit.
Comparison	Name the one-unit change and what is held fixed.
Support	Keep the interpretation within the observed x range.

5. OLS credibility

CH 3

error term → ceteris paribus → omitted-var. bias

unobserved factors test the conditional claim

A partial coefficient holds included regressors fixed; omitted causes can still move with x.

CLAIM	WHAT IT EARNS	WHAT IT DOES NOT EARN
"β_1 is partial"	Other represented regressors are fixed.	Unmeasured factors are fixed.
"Model is linear"	A stated conditional-mean form.	Separation of x from the error.
"More controls"	A different conditional comparison.	Automatic reduction of bias.
"Random allocation"	Weakens the selection path described.	Automatic cure for attrition/non-compliance.

OMITTED-VARIABLE BIAS DIAGNOSIS

QUESTION	WHY IT MATTERS
Which excluded factor affects y?	Place it in the error term if unmeasured.
Why does it covary with x?	Show the selection/common-cause path.
What sign is plausible?	Explain how the fitted x coefficient mixes relationships.
What evidence would weaken it?	Assignment rules, timing, comparable groups or a credible design.

TRAINING EXAMPLE PATH

```
motivation → wages
motivation → voluntary training
⇒ training coefficient may combine
program relationship + selection
```

Calling a coefficient partial does not make it causal. It only states which included variables are held fixed in the equation.

EXAM USE *Name the omitted factor, connect it to outcome and regressor, then name the design evidence that could revise the diagnosis.*

6. Claim ladder

CH 1–3

EVIDENCE	SAFE WORDING
Correlation only	Linear co-movement in the stated sample.
Regression coefficient	Fitted association/conditional contrast.
Credible design + assumptions	Causal language only to the supported population.

CHANGED ALLOCATION CASE

CONDITION	INFERENCE
Voluntary training	Motivation may affect both participation and wages; positive coefficient can mix program association with selection.

7. Sampling uncertainty

CH 4

sampling distribution → standard error → hypothesis test

samples → spread → decision

One estimate is read against its repeated-sampling uncertainty and the stated reference claim.

TERM	DEFINITION
Sampling distribution	Distribution an estimator would have across comparable repeated samples.
Standard error	Estimated repeated-sampling spread of the estimator.
Hypothesis test	Rule comparing evidence with a reference claim under assumptions.
Confidence interval	Procedure reporting parameter values compatible with data and model at a chosen level.

ZERO-RESTRICTION RATIO

```
estimate ÷ estimated standard error
Then use the specified reference
distribution, degrees of freedom and
assumptions.
```

TEST-WRITING ORDER

1. Write the coefficient or restriction encoding the economic claim.
2. State the null precisely (for example, $\beta_3=0$).
3. Report the estimate and its uncertainty.
4. Calibrate to the stated reference distribution.
5. Conclude about compatibility with the null, not certainty or causation.

DO SAY	DO NOT SAY
Evidence is difficult to reconcile with the stated null/reference model.	The p-value is the probability that the null is true.
The estimate is 48 with SE 20.	Every worker gains 48.
Precision is conditional on model and sample process.	Precision certifies the economic story.

A precise misspecified or selectively collected model can be confidently misleading.

EXAM USE *Make n count independent sampling units; a small tail probability is neither a large effect nor a causal result.*

8. Individual vs joint

CH 6

QUESTION	USE
One coefficient?	Single restriction and its uncertainty.
Several coefficients together?	One joint null; restricted vs unrestricted specifications; course-appropriate joint procedure.
Joint rejection?	Evidence against the restrictions together—not proof every coefficient differs from zero.

STRENGTH OF CONCLUSION

RESULT	STILL REPORT
Individual restriction rejected	Coefficient size, sign, SE and conditional meaning.

9. Multiple regression

CH 5

MODEL AND CHANGE

```
y = β₀ + β₁x₁ + β₂x₂
Δy = β₁Δx₁ + β₂Δx₂
If Δx₂=0, β₁ is the fitted partial
effect of x₁.
```

multiple regression → partial effect → control variable

model → fixed-regressor contrast → audit

Adding a variable changes the represented comparison; decide whether that is the question wanted.

MOVE	INTERPRETATION
$\Delta x_1=1$; $\Delta x_2=0$	β_1: fitted change holding represented x_2 fixed.
$\Delta x_1=1$; $\Delta x_2=2$	$\beta_1+2\beta_2$: both represented predictors move.
Add a control	Comparison becomes conditional on that variable; coefficient may change.
Add a consequence of exposure	May answer a different question or introduce distortion.

CONTROL-VARIABLE DECISION

BEFORE ADDING Z	ASK	RISK
Confounder?	Common cause of x and y?	Leaving it out can mix relationships.
Mediator/consequence?	Does x affect z?	Holding z fixed changes the target.
Outcome of selection?	How was z generated?	More controls need not be safer.

Partial is model-relative. It holds named included variables fixed, not unmeasured ability or labour-market access.

EXAM USE *State which regressor moves, which stay fixed, which units apply and what unobserved determinants remain.*

10. Conditional inference

CH 6

conditional coefficient → joint restriction → confidence interval

preserve model + comparison + uncertainty

Inference answers the claim encoded by this specification; it does not certify the story.

AUDIT	WRITE
Coefficient	Name its conditional comparison.
Joint claim	Write all restrictions together.
Interval	Read compatible values under the fitted assumptions.
Conclusion	Return to size, uncertainty and economic meaning.

11. Indicators + interactions

CH 7

indicator variable → reference category → interaction

code group → set baseline → allow change

Reconstruct fitted cases: coefficients change with coding, but the fitted observations do not.

TERM	READ IT AS...
Indicator D	Membership in a category, commonly coded 0/1.
Reference D=0	Baseline for intercept and non-interacted slope; not inherently normal.
D coefficient	Fitted group contrast when the interacted variable equals zero.
x×D	How the x slope differs when D changes.

SAFE RECONSTRUCTION

```
D=0: read the reference-category fitted
line.
D=1: combine the baseline, indicator and
interaction terms.
Compare fitted values at observed x
values.
```

CHANGE	WHAT CHANGES?	INVARIANT
Reverse 0/1 coding	Signs/meanings of intercept and indicator terms.	Fitted observations.
Centre education at 12	Zero-point group contrast becomes meaningful at 12 years.	Fitted observations.
Add interaction	Main terms become conditional on the other variable's zero.	Need case-by-case fitted comparisons.

An interaction describes heterogeneity; it does not explain why groups differ.

12. Robust inference

CH 8

hetero-skedasticity → robust standard error → model diagnostic

spread problem → uncertainty repair → recheck

Robust uncertainty addresses specified changing variance, not every model or design failure.

RESIDUAL EVIDENCE	DIAGNOSIS	RESPONSE
Fan-shaped spread	Variance changes with predictor/fitted value.	Compare conventional and course-approved robust uncertainty.
Curved centre	Mean relation may be misspecified.	Robust SE alone is insufficient.
One high-leverage point	Influence problem, not necessarily heteroskedasticity.	Investigate observation and fit.
Dependence/selection	Sample/design problem.	Robust SE cannot create independence or identification.

ETF2100 Introductory Econometrics

WORKED MINI-EXAMPLES · JUDGEMENT CARDS · CLASSIC TRAPS

Full guide + ask Sia about ETF2100

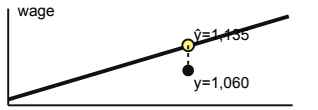
SIDE 2/2 CALCULATE · INTERPRET · DIAGNOSE · SELF-TEST

EXAM REVISION SHEET

Original practice aligned to the guide's concepts

13. Drill 1 · fitted line WORKED 2.1

Given: wage = 420 + 55×education; observed education range 10–18; education=13; observed wage=1,060.



The residual is the vertical observed-minus-fitted discrepancy: 1,060−1,135=−75.

STEP	WORKING	MEANING
1. Fit	ŷ=420+55×13	420+715=1,135
2. Residual	e=y−ŷ	1,060−1,135=−75
3. Slope	Δwage=55×1	12→13 gives fitted +55 units
4. Intercept	education=0	Outside 10–18; little substantive meaning
5. Boundary	Keep within range	Association, not proof of underpayment/cause

ANSWER PATH

```
model → substitute x → compute ŷ → compute y-ŷ → interpret units → state range/causal boundary
```

SELF-TEST CHANGE	CORRECT RESPONSE
12→13 years	One x-unit; fitted wage changes by 55.
Years replaced by 0/1 degree	One-unit coefficient becomes a group contrast.
Observed wage below line	Negative residual; not direct evidence of underpayment.

TRAP *Do not call −75 the population disturbance. It is this fitted observation's residual.*

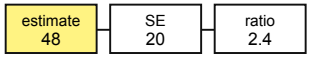
Exam-morning loop GUIDE

1. **Retrieve:** population → intercept/slope/residual → error/ceteris paribus/omitted-variable bias → sampling distribution/SE/test → multiple/partial/control → conditional/joint/interval → indicator/reference/interaction → heteroskedasticity/robust/diagnostic.
2. **Explain:** one mechanism in plain language without notes.
3. **Change:** alter one condition; predict what moves and what remains invariant.
4. **Audit:** scale, units, sample process, model form, evidence and causal boundary.
5. **Correct:** name the first failed relationship instead of copying a whole answer.

CAN YOU DO THIS COLD?	PASS CONDITION
Compute 1,135 and −75	Show substitution, residual sign and boundary.
Explain 48/20 and doubled SE	Separate estimate from uncertainty.

14. Drill 2 · uncertainty WORKED 4.1

Given: estimated training coefficient 48; estimated standard error 20; zero restriction under a specified test.



if SE doubles to 40

48 ÷ 40 = 1.2

Holding the estimate fixed while SE doubles halves the ratio and weakens evidence against zero.

STEP	WORKING / STATEMENT
1. Parameter	Training coefficient in the stated model.
2. Estimate	Fitted conditional contrast = 48 wage units.
3. Uncertainty	Estimated SE = 20.
4. Ratio	48÷20=2.4.
5. Calibrate	Use specified reference distribution, df and assumptions.
6. Conclude	Evidence may be difficult to reconcile with zero; do not assert certainty or causation.

CHANGE ONE CONDITION	WHAT MOVES?
SE 20→40	Point estimate stays 48; ratio 2.4→1.2; evidence weakens.
Same ratio, misspecified model	Numerical precision can still mislead.
Small tail probability	Not the probability the null is true; not effect size.

SAFE CONCLUSION STEM

```
"Under the stated model, sample process and reference distribution, the estimate of 48 with SE 20 yields a ratio of 2.4 against the zero restriction. Report the calibrated decision, then retain the model and causal boundaries."
```

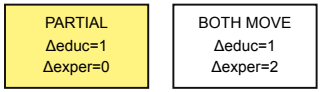
TRAP *A number can be statistically precise and economically small, misspecified or non-causal. Report estimate before decision.*

Inference audit card CH 4 + 6

BEFORE THE DECISION	WRITE
Target	Population parameter/coefficient or set of restrictions.
Comparison	Which regressors are fixed in this specification.
Estimate	Direction, size and outcome units.
Uncertainty	SE and the sampling process it presumes.
Calibration	Null, reference distribution and degrees of freedom.
Boundary	Model fit, selection and causal assumptions remain separate.

15. Drill 3 · partial change WORKED 5.1

Given: fitted wage equation includes education and experience with coefficients 52 and 18.



Δŷ=52 Δŷ=52+2×18=88

"Hold fixed" is an input to the comparison, not a decorative phrase.

COMPARISON	WORKING	ANSWER
One more education year; same represented experience	52×1 + 18×0	Fitted wage +52 units.
One more education year; two more experience years	52×1 + 18×2	52+36=**88 units**.
Unmeasured ability differs	Not held fixed by equation	Neither result is automatically causal.

ANSWER PATH

```
identify moving regressors → write each Δ → multiply by its coefficient → sum → interpret units → list included fixed variables → state unmeasured boundary
```

ADDING TRAINING

BEFORE ESTIMATION ASK...	WHY?
Is training a confounder?	Conditioning may better represent the intended comparison.
Is it a mediator/consequence of education?	Conditioning changes the target.
Is it selected by motivation?	Selection can remain in the error term.
Does sign/size change?	The represented comparison changed; preferred sign is not a selection rule.

JOINT QUESTION	CORRECT METHOD
Do exposure and intensity together add explanatory power?	State the two restrictions as one joint null; compare restricted and unrestricted specifications using the taught joint procedure.
One precise, one imprecise; joint null rejected	Not contradictory: the joint procedure evaluates restrictions together.

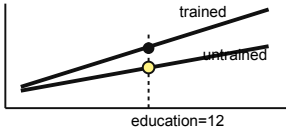
TRAP *Two separate single-coefficient decisions do not directly answer one joint claim.*

Comparison sentence builder CH 5

SLOT	FILL IT
Who/what?	Workers in the stated sample/population and period.
Move	One extra education year; optionally two extra experience years.

16. Drill 4 · interaction WORKED 7.1

Given: wage model contains education, training indicator and education×training.



With an interaction, the education slope and training contrast depend on the other variable's value.

TERM	INTERPRETATION PATH
Education coefficient	Education slope when training=0.
Training coefficient	Training contrast when education=0; possibly not meaningful.
Interaction	Difference in education slopes between training groups.
Centre education at 12	Training coefficient becomes contrast at 12 years.

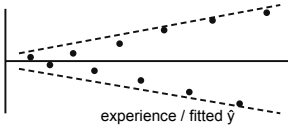
ANSWER PATH

```
write D=0 fitted line → write D=1 fitted line → combine all active terms → compare at observed education values → state what coding changes and what remains fitted
```

CHANGED CASE	PREDICTION
Reference changes from untrained to trained	Coefficient signs/meanings can change; fitted wages remain invariant.
No interaction	Model imposes the same education slope for both groups.
Interaction present	No single permanent training effect across education values.

TRAP *Do not interpret either main term as unconditional once its variable appears in an interaction.*

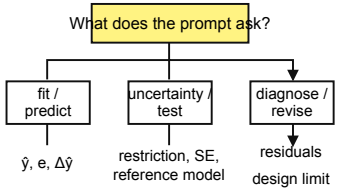
17. Drill 5 · residual spread WORKED 8.1



Small spread at low experience, larger spread at high experience: verify coding and mean form first.

OBSERVE	SAY
Fan, mean roughly linear	Non-constant variance; robust uncertainty may be appropriate.
Only SE changes	Fitted coefficient/conditional mean unchanged.
Fan plus curvature	Robust SE leaves mean misspecification unresolved.
Constant spread + one extreme leverage point	Heteroskedasticity is not the best diagnosis.

18. Method chooser CH 1–8



Choose the operation from the instruction verb, then preserve comparison, uncertainty and boundary.

IF YOU SEE...	DO THIS
"Interpret β_1"	Name y/x units, direction, size, fixed included regressors and range.
"Predict/fitted value"	Substitute stated x values; include every active indicator/interaction term.
"Residual"	Compute observed y−fitted ŷ; interpret as discrepancy.
"Causal effect"	Audit selection, omitted causes, assignment, timing and population boundary.
"Test β=0"	State restriction, estimate, SE, reference distribution/df, calibrated conclusion.
"Test terms jointly"	Write one joint null and compare restricted/unrestricted specifications.
"Indicator/reference"	Write fitted cases for D=0 and D=1; identify baseline.
"Interaction"	Compute slopes/contrasts at values of the other variable.
"Fan-shaped residuals"	Check coding/mean form; then robust uncertainty if variance is the issue.

JUDGEMENT CARDS

IF X...	→ THEN Y
Coefficient changes after adding z	The conditional comparison changed; diagnose z's role before choosing a model.
Correlation=0	Do not conclude "no relation"; inspect nonlinear structure.
Strong correlation	Do not conclude cause; ask about common causes/design.
Intercept is outside support	Keep it algebraic; avoid substantive story.
Joint null rejected	Do not claim every restricted coefficient is important.
Robust and conventional SE differ	Coefficient is unchanged; inference changes.

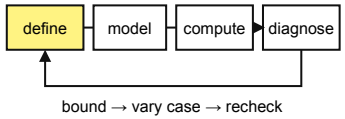
DIAGNOSTIC BOUNDARIES

TOOL	CAN SHOW	CANNOT ESTABLISH ALONE
Correlation	Linear co-movement.	Causal effect or absence of nonlinear relation.
Residual plot	Pattern contradicting spread/mean assumptions.	Which omitted cause generated the pattern.

19. Classic traps FAQ + WORKED

TRAP	REPAIR
"Correlation proves training raises wages."	Correlation describes linear co-movement; name motivation/employer selection/prior skill and required design assumptions.
"β_0 always has economic meaning."	Check whether x=0 is meaningful and within support.
"Residual = unobserved population error."	Residual is observed y−ŷ after fitting; error term collects omitted determinants.
"Partial = causal."	Partial only holds included controls fixed.
"More controls always reduce bias."	A consequence/mediator can change the target or distort.
"p is Pr(null true)."	It is a tail calculation under the reference model.
"Small p means large effect."	Report coefficient size and uncertainty separately.
"Two single tests answer a joint claim."	Use the joint restriction procedure.
"Indicator zero is normal."	Zero is the chosen reference category.
"Training effect is constant with x×D."	Compute contrast at observed x values.
"Robust SE fixes the model."	It does not repair curvature, omitted variables, dependence, influence or selection.

20. Answer architecture STUDY STRATEGY



End with the first condition that would narrow or reverse the result.

LINE	MARKER-FACING CONTENT
1. Define	Population, unit, outcome, regressor/reference category.
2. Represent	Equation, restriction or fitted cases.
3. Work	Inputs, units, transformations and arithmetic.
4. Interpret	Direction, size, conditional comparison and support.
5. Audit	Residual pattern, omitted path, reference model or design.
6. Bound	State what the evidence does not establish and what would change the conclusion.

21. Final self-audit GUIDE

QUESTION	REQUIRED ANSWER
Is the population stable?	Same units, period and operating state from claim to conclusion.