ECON 1123 Section 6

Slides at github.com/cjleggett/1123-section

Outline

- Name Circle
- Pset Feedback
- Lecture Recap / Questions
- Midterm Prep

Name Circle

Name Circle

- Name
- Favorite Song of the Moment

If it Can, it Will
Bug Wife

Problem Set Feedback

Problem Set Feedback

- Make sure everything is included in your non-code submission
- You don’t need a stargazer/outreg2 table, but you do need some table when asked

Lecture Recap

Internal vs. External Validity

- **Internal Validity:** Have we estimated valid causal effects for those within our sample, and are our standard errors correct?
- **External Validity:** Can we generalize our results to other populations / settings?

Threats to Internal Validity

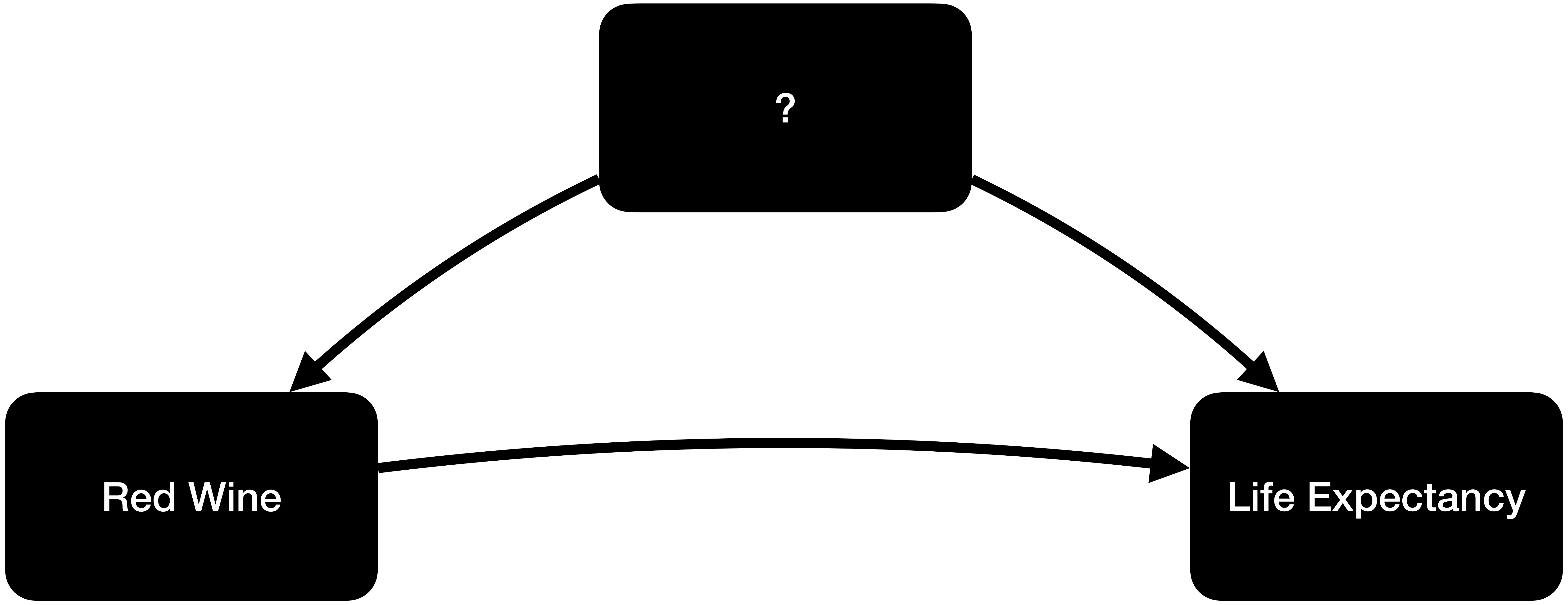
- Omitted Variable Bias
- Functional Form Bias
- Measurement Error
- Bad Controls
- Sample Selection Bias
- Simultaneous Causality Bias
- Wrong Standard Errors

OVB Practice

- We run a regression of an indicator for a person drinking a glass of red wine with dinner five days per week and life expectancy:
$$life\_exp = 70.234 + .0345 red\_wine$$

- What are we missing?

OVB Practice

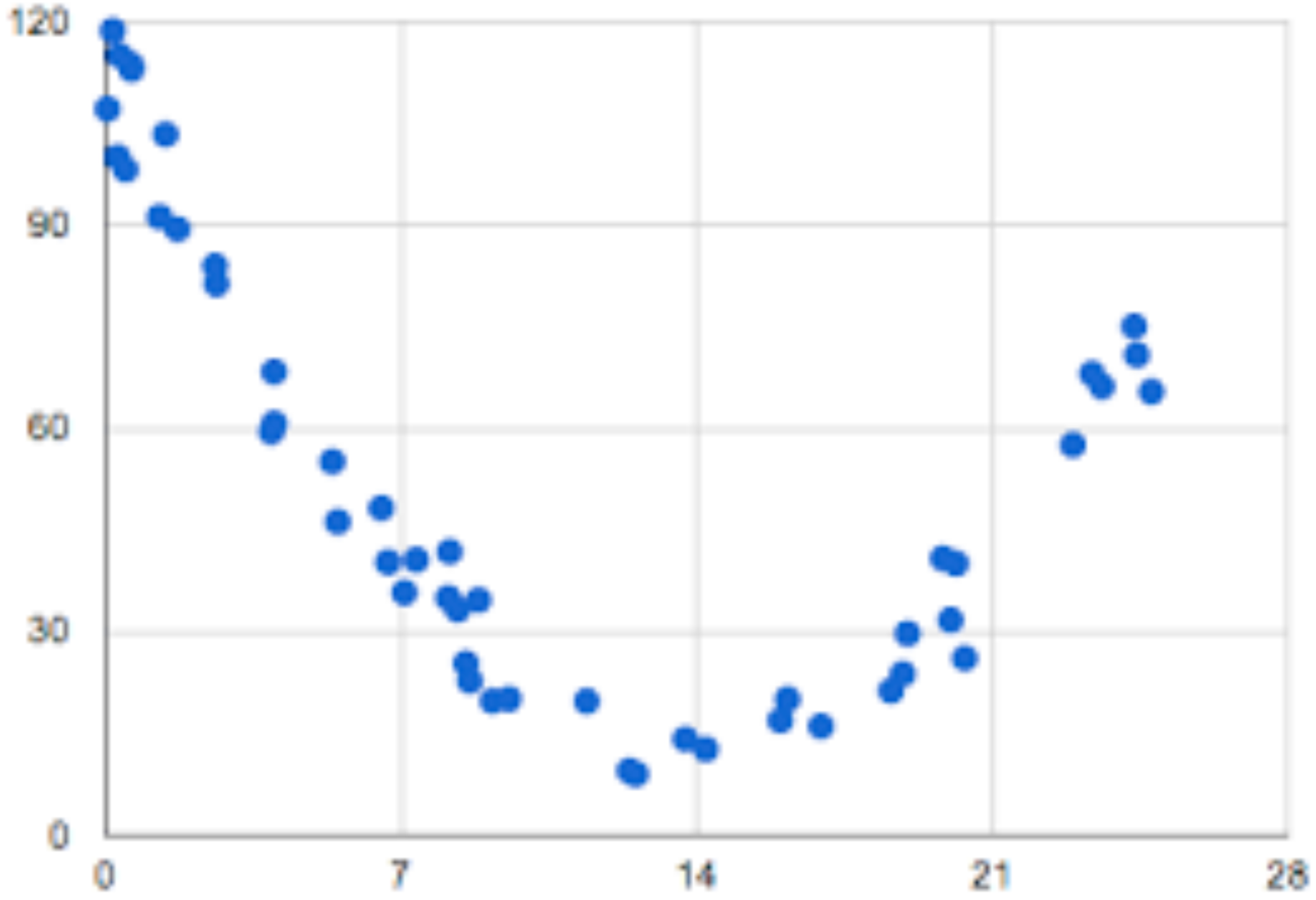


Steps in OVB Problem

1. Choose an omitted variable
2. Sign β_2: correlation between omitted variable and outcome. Provide economic or real-world intuition for this sign.
3. Sign γ_1: correlation between omitted variable and variable of interest. Provide economic or real-world intuition for this sign.
4. Based on the above two, say the bias is positive or negative.
5. Conclude whether we have overstated or understated the causal effect. (Is α_1 too big or too small?)
6. (Optional) Draw a number line.

Functional Form Bias

- Does your regression fit the form of your data?



Measurement Error

- Often mistakes are made in collecting data or copying it
- Classical Measurement Error: error is normally distributed and independent
- Measurement error in X -> Attenuation Bias
- Measurement error in Y -> Wider CIs but no bias

Attenuation Bias (Errors in Variables Bias)

- When there’s error in your X variable, your coefficient will be biased toward 0.
- When you include control variables, you include more randomness
- This increases attenuation bias
- Which makes the magnitude of our coefficient smaller
- Intuition:
  - No correlation (100% random): coefficient at 0
  - Perfect correlation (no randomness): coefficient at true value
  - Some randomness: coefficient between 0 and true value

Bad Controls

- When you control for an endogenous (outcome) variable
- Example: Controlling for lung cancer
- Generally, controls should be measured before the “treatment

Sample Selection Bias

- Three types of missing data:
  - Missing Completely at Random
  - Missing depending on X
  - Missing depending on Y
- Only the third one leads to bias!
- This is known as sample selection bias

Simultaneous Causality Bias

- Sometimes called reverse causality
- When X causes Y
- But Y also causes X
- How can we rule this out?
    - When X is measured **before** Y

Use Correct Standard Errors

- In economics, we almost never assume homoskedasticity
- For panel data, cluster standard errors at the level of policy variation

Use Correct Critical Values

- For t-test, use 1.96
- For F-test, use $F_{q,\infty}$ distribution rather than $F_{q,n-k}$

What does a Hypothesis Test Mean?

- When we reject the null hypothesis:
  - we have found the coefficient is statistically significant -> we believe X has an effect on Y
- When we fail to reject the null hypothesis:
  - it depends!
  - If we have a wide confidence interval, we can’t say much
  - If we have a narrow confidence interval, we can conclude X doesn’t have an effect on Y

External Validity

- Usually a judgement/intuition question
- Read carefully about the population studied
- How does that population differ from others?

Imperfect Multicolinearity

- When two or more variables are highly correlated (think x and x^2)
- Not a threat to internal validity!
- Can get around this with joint hypothesis tests or predicted effects

Causal vs. Control Variables

- Must treat these differently
- We can’t typically make the same interpretations for both
- OVB not a problem in control variables, because we don’t care about causality

Exercises!

Q1: What are some factors that could hurt the validity and usefulness of our model?

- Internal Validity Concerns: Estimated Result is Biased
- External Validity Concerns: Can’t generalize estimates to other situations

Q2: What do most threats to internal validity have in common?

- Violate conditional mean independence assumption.

Q3: Which of the following are threats to internal validity?

- 3.1) Sample Selection Bias
- 3.2) Omitted Variable Bias
- 3.3) Simultaneous causality when RHS variable measured later than outcome variable on LHS
- 3.4) Perfect/Imperfect Multicollinearity
- 3.5) Simultaneous causality when RHS variable measured earlier than outcome variable on LHS

Q3: Which of the following are threats to internal validity?

- **3.1) Sample Selection Bias**
- **3.2) Omitted Variable Bias**
- **3.3) Simultaneous causality when RHS variable measured later than outcome variable on LHS**
- 3.4) Perfect/Imperfect Multicollinearity
- 3.5) Simultaneous causality when RHS variable measured earlier than outcome variable on LHS

Q3: Which of the following are threats to internal validity?

- 3.6) Wrong Functional Form
- 3.7) Errors-in-variables bias
- 3.8) Bad Controls
- 3.9) Low/High R-squared

Q3: Which of the following are threats to internal validity?

- **3.6) Wrong Functional Form**
- **3.7) Errors-in-variables bias**
- **3.8) Bad Controls**
- 3.9) Low/High R-squared

Q4: What threat to internal validity does not violate the assumption of conditional mean independence? How does it affect our model?

- Wrong Standard Errors
- Leads to incorrect CIs
- and Incorrect uncertainty

2.2

- “Sensation Seeking, Overconfidence, and Trading Activity”
- Using Traffic Tickets as proxy for sensation seeking
- Data from household investors in Finland from 1995 - 2002
- Data from HEX stock data, data from Finnish Vehicles Administration, data from Finnish army

Q5: Can you think of any external validity concerns with these data sets?

- Timeframe
- Just men?
- Only Finland

Q6: Can you imagine any internal validity concerns? What would we want to know?

- Reverse causality?
- Survivorship bias?

Q7: What do we mean by "Measurement Error in X"? What does this look like in practice?

- Misreporting/mis-measurement leads to error in X.
- We typically model this as $X_i^* = X_i + m$
- X_i^* is the X we observe
- X_i is the true X
- m is the error term

Q8: What is this type of bias called?

- Attenuation Bias

Q9: How does this bias our models?

- Attenuation Bias moves estimates closer to 0

Q10: How is Measurement error in Y different?

- Doesn’t bias estimates
- Does increase standard errors

Q11: T/F, Adding controls helps eliminate attenuation bias

- False
- Makes it worse

Q12: Why do we add controls?

- Eliminate some OVB
- Satisfy conditional mean independence

Q12: What makes a control variable bad?

- Controlling for outcome variables
- Controlling for causal channels

Midterm!

Logistics

- During normal class time tomorrow
- Need to write your HUID on every page
- Please Bring
  - A pen
  - a calculator
  - 1 double-sided sheet of notes

Format

- Similar to problem sets: a dataset is given and explained, along with the question(s) we want to answer
- 2 parts (probably 1 cross-sectional and 1 panel data)
- 2 packets
  - Packet 1: background info, tables, graphs, p-value charts
  - Packet 2: Questions + **your answers**
- All regressions will already be run for you

Questions to Expect

- Interpret this coefficient
- OVB problem (especially for panel data)
- Hypothesis Testing (t-test for 1 value, f-test for multiple values)
- Calculate predicted probability/value + change in predicted probability/value
- Identify different types of bias (What threats to internal validity do we see?)

Questions to Expect

- Something about log(0)
- “Special Case” where OLS, probit, logit, all the same
- What extra info do we need to calculate SE of predicted effect? Calculate SE if this is given.
- Compute 95% Confidence Interval
- How should we compute SEs (homoskedastic, heteroskedastic, clustered)
- Open-ended policy question
  - Feel free to wait till later
  - Try to weave in concepts from class (internal/external validity)

Note Page

- List of internal validity concerns
- Interpretation rules (log-linear, log-log, etc.)
- OVB steps (and some number lines)
- Logit + profit formulas
- “Special Case”
- Formula: $Var(aX + bY) = a^2Var(X) + b^2Var(Y) + 2abCov(X, Y)$
- How to get t-statistic

T-Test Table

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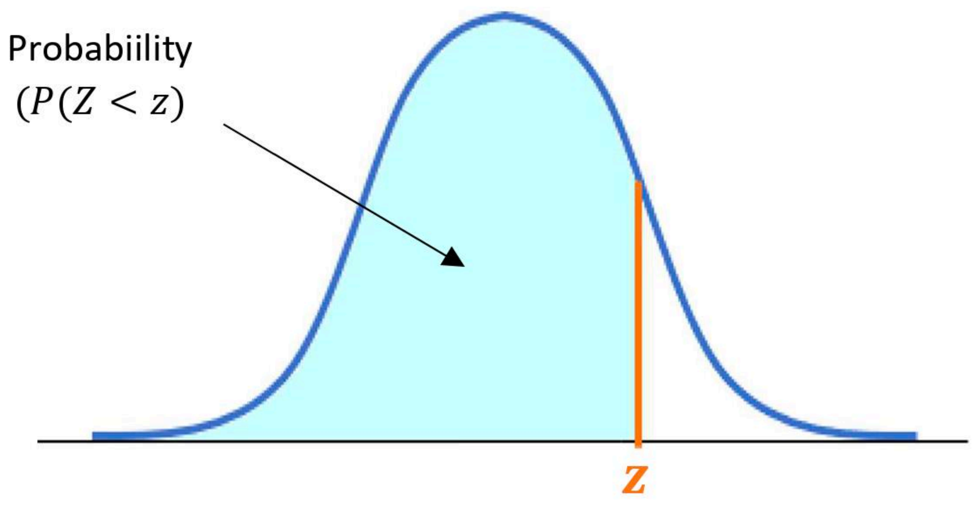
(2.12)



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0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7258	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7518	0.7549
0.7	0.7580	0.7612	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7996	0.8023	0.8051	0.8079	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
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1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9430	0.9441
1.6	0.9452	0.9463	0.9474	0.9485	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9700	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9762	0.9767
2.0	0.9773	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9865	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
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2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9980	0.9980	0.9981
2.9	0.9981	0.9982	0.9983	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
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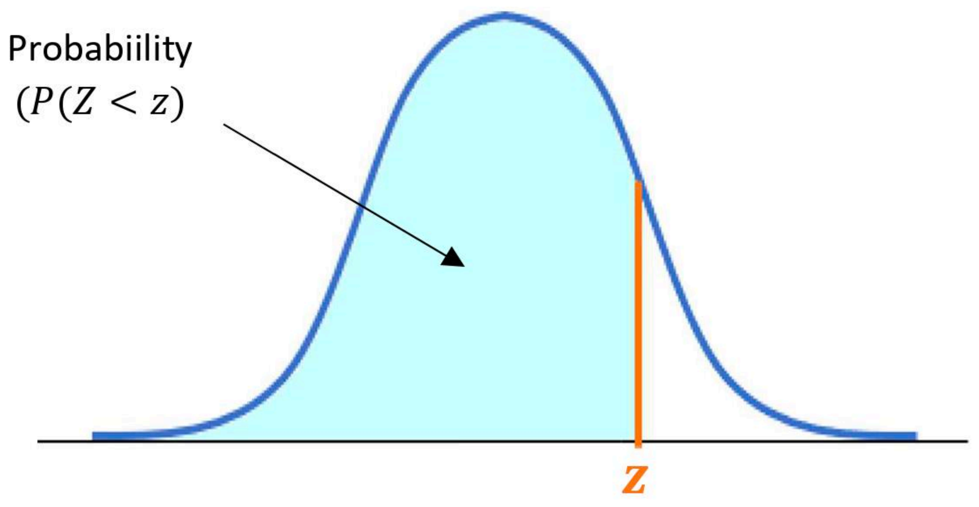
T-Test Table

5.26
(2.12)

$$t = \frac{5.26}{2.12} = 2.481$$



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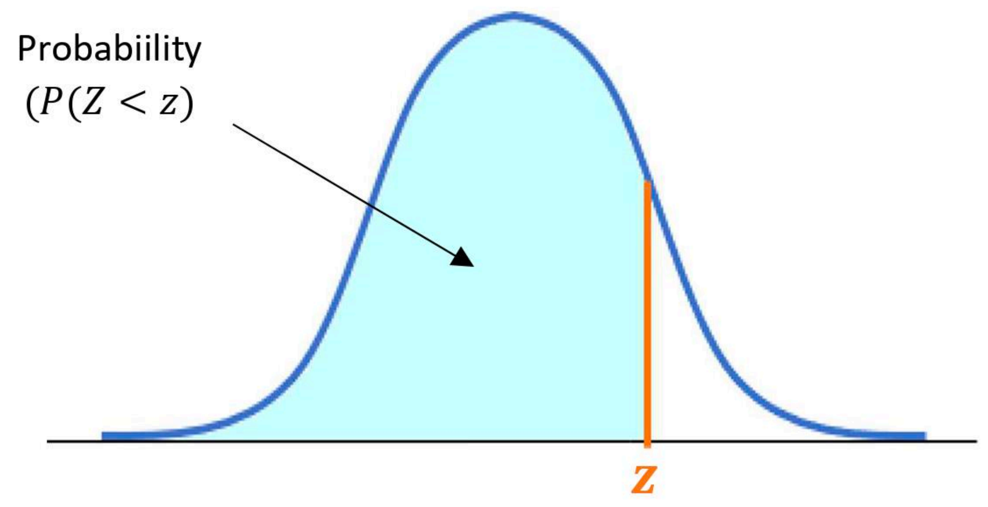

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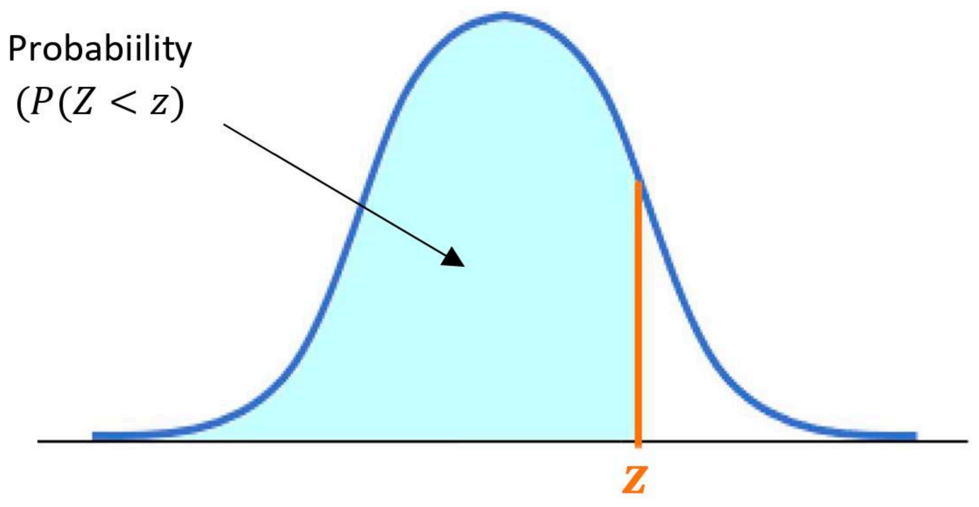
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9762	0.9767
2.0	0.9773	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9865	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	$\boxed{0.9934}$	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9980	0.9980	0.9981
2.9	0.9981	0.9982	0.9983	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998	0.9998

T-Test Table



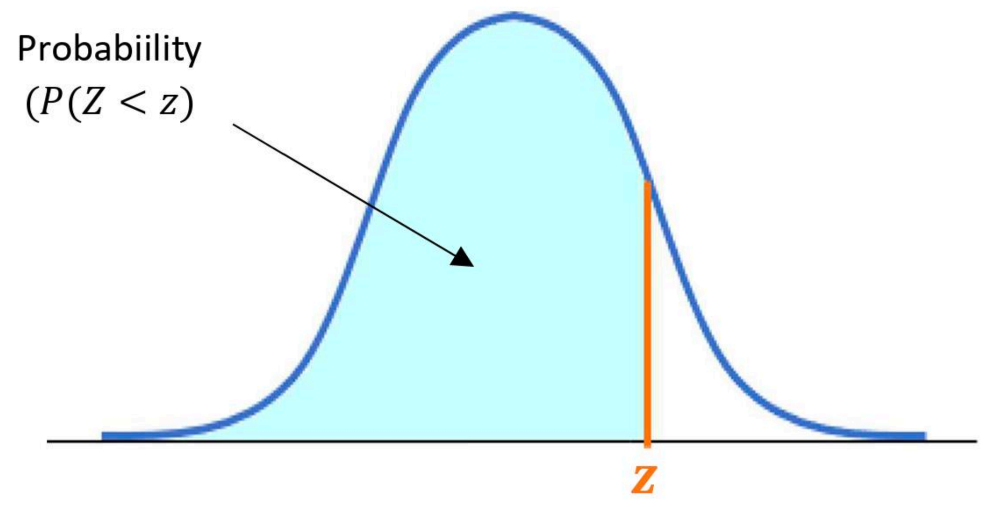
5.26
(2.12)

$$t = \frac{5.26}{2.12} = 2.481$$

$$p = 1 - .9934 = .0066$$

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5754
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7258	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7518	0.7549
0.7	0.7580	0.7612	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7996	0.8023	0.8051	0.8079	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9430	0.9441
1.6	0.9452	0.9463	0.9474	0.9485	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9700	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9762	0.9767
2.0	0.9773	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9865	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	$\boxed{0.9934}$	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9980	0.9980	0.9981
2.9	0.9981	0.9982	0.9983	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998	0.9998

T-Test Table



5.26
(2.12)

$$t = \frac{5.26}{2.12} = 2.481$$

$$p = 1 - .9934 = .0066$$

Reject!

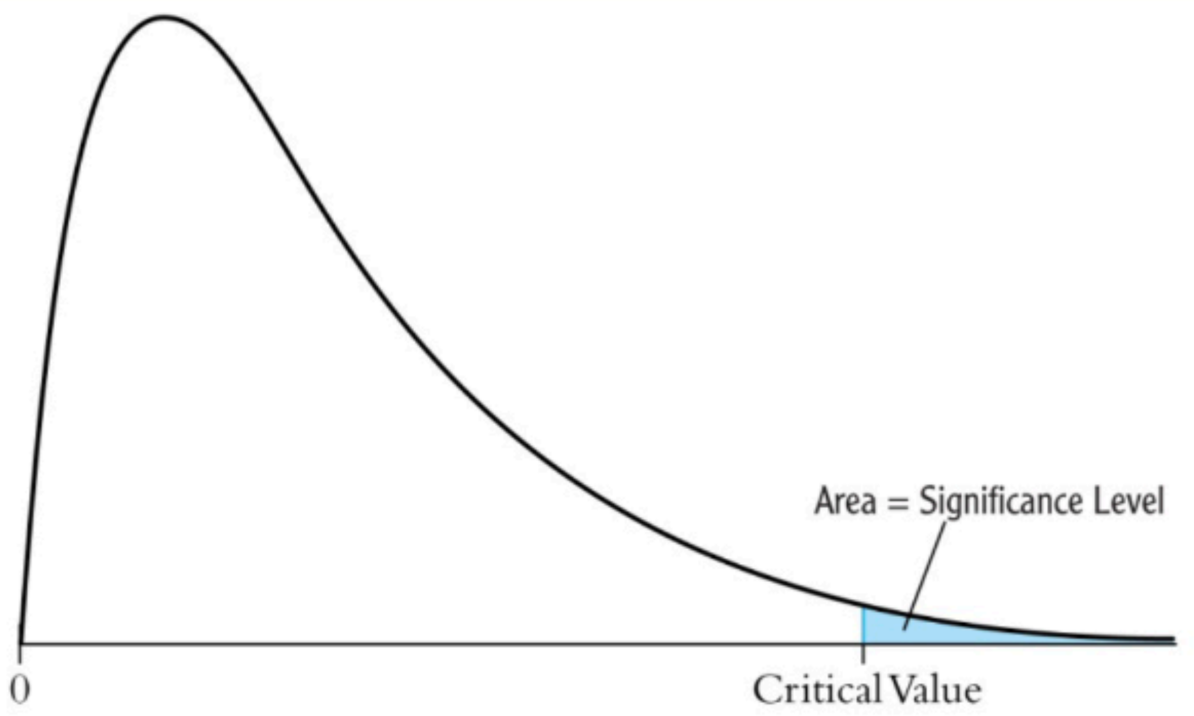
z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5754
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7258	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7518	0.7549
0.7	0.7580	0.7612	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7996	0.8023	0.8051	0.8079	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9430	0.9441
1.6	0.9452	0.9463	0.9474	0.9485	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9700	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9762	0.9767
2.0	0.9773	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9865	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	$\boxed{0.9934}$	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9980	0.9980	0.9981
2.9	0.9981	0.9982	0.9983	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998	0.9998

F-Test Table

$H_0 : x$ and x^2 have no effect

F stat: 2.76

TABLE 4 Critical Values for the $F_{m,\infty}$ Distribution



Degrees of Freedom	Significance Level 10%	5%	1%
1	2.71	3.84	6.63
2	2.30	3.00	4.61
3	2.08	2.60	3.78
4	1.94	2.37	3.32
5	1.85	2.21	3.02
6	1.77	2.10	2.80
7	1.72	2.01	2.64
8	1.67	1.94	2.51
9	1.63	1.88	2.41
10	1.60	1.83	2.32
11	1.57	1.79	2.25
12	1.55	1.75	2.18
13	1.52	1.72	2.13
14	1.50	1.69	2.08
15	1.49	1.67	2.04
16	1.47	1.64	2.00
17	1.46	1.62	1.97
18	1.44	1.60	1.93
19	1.43	1.59	1.90
20	1.42	1.57	1.88
21	1.41	1.56	1.85
22	1.40	1.54	1.83
23	1.39	1.53	1.81
24	1.38	1.52	1.79
25	1.38	1.51	1.77
26	1.37	1.50	1.76
27	1.36	1.49	1.74
28	1.35	1.48	1.72
29	1.35	1.47	1.71
30	1.34	1.46	1.70

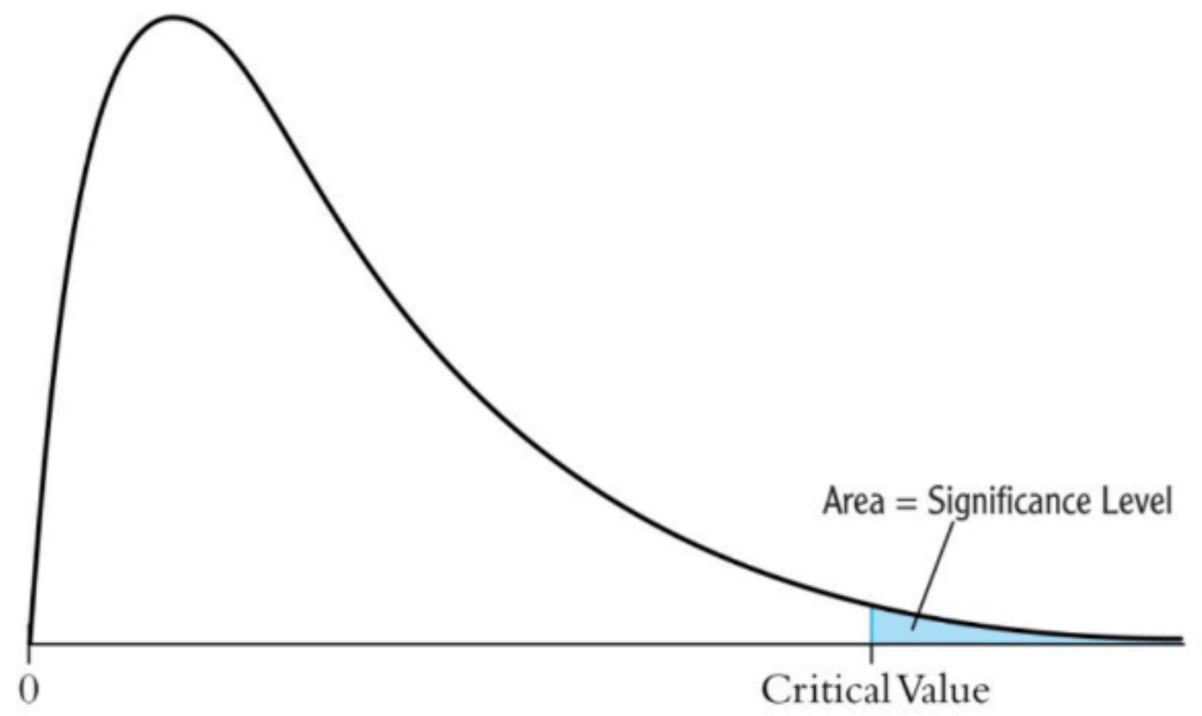
This table contains the 90th, 95th, and 99th percentiles of the $F_{m,\infty}$ distribution. These serve as critical values for tests with significance levels of 10%, 5%, and 1%.

F-Test Table

$H_0 : x$ and x^2 have no effect

F stat: 2.76

TABLE 4 Critical Values for the $F_{m,\infty}$ Distribution



Degrees of Freedom	Significance Level 10%	5%	1%
1	2.71	3.84	6.63
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9	1.63	1.88	2.41
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11	1.57	1.79	2.25
12	1.55	1.75	2.18
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25	1.38	1.51	1.77
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27	1.36	1.49	1.74
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30	1.34	1.46	1.70

This table contains the 90th, 95th, and 99th percentiles of the $F_{m,\infty}$ distribution. These serve as critical values for tests with significance levels of 10%, 5%, and 1%.

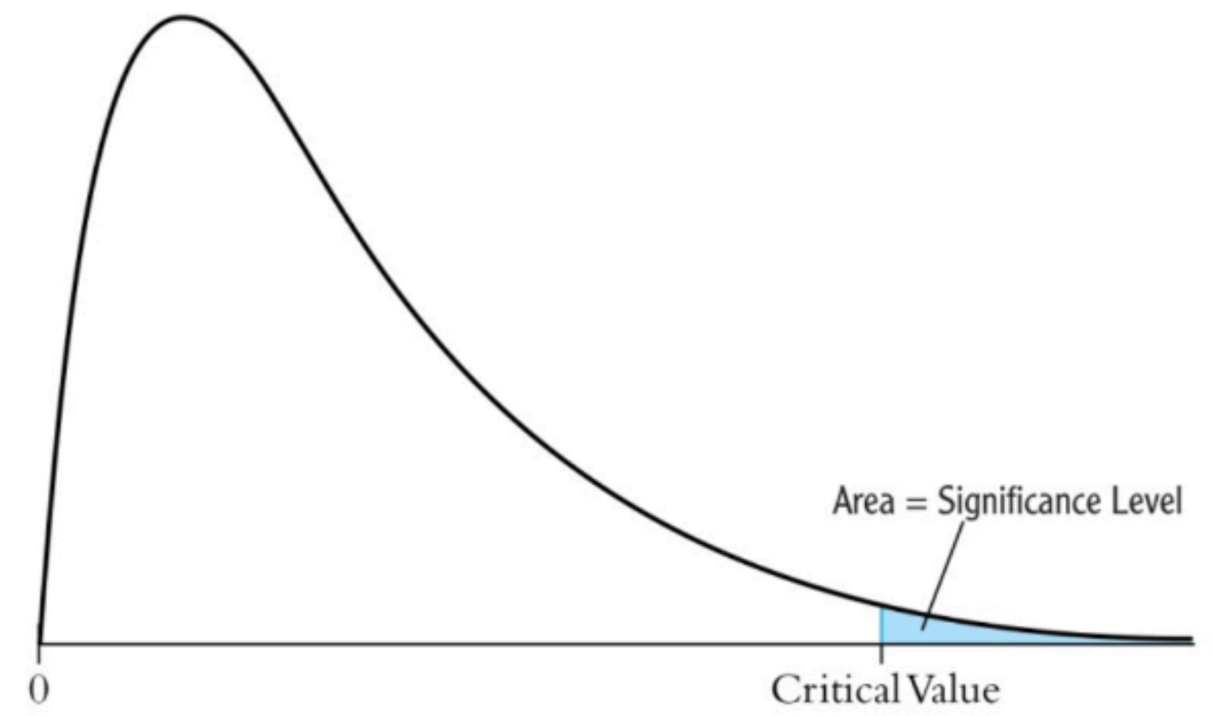
F-Test Table

$H_0 : x$ and x^2 have no effect

F stat: 2.76

2.76 < 3.00

TABLE 4 Critical Values for the $F_{m,\infty}$ Distribution



Degrees of Freedom	Significance Level 10%	5%	1%
1	2.71	3.84	6.63
2	2.30	$\boxed{3.00}$	4.61
3	2.08	2.60	3.78
4	1.94	2.37	3.32
5	1.85	2.21	3.02
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9	1.63	1.88	2.41
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This table contains the 90th, 95th, and 99th percentiles of the $F_{m,\infty}$ distribution. These serve as critical values for tests with significance levels of 10%, 5%, and 1%.

F-Test Table

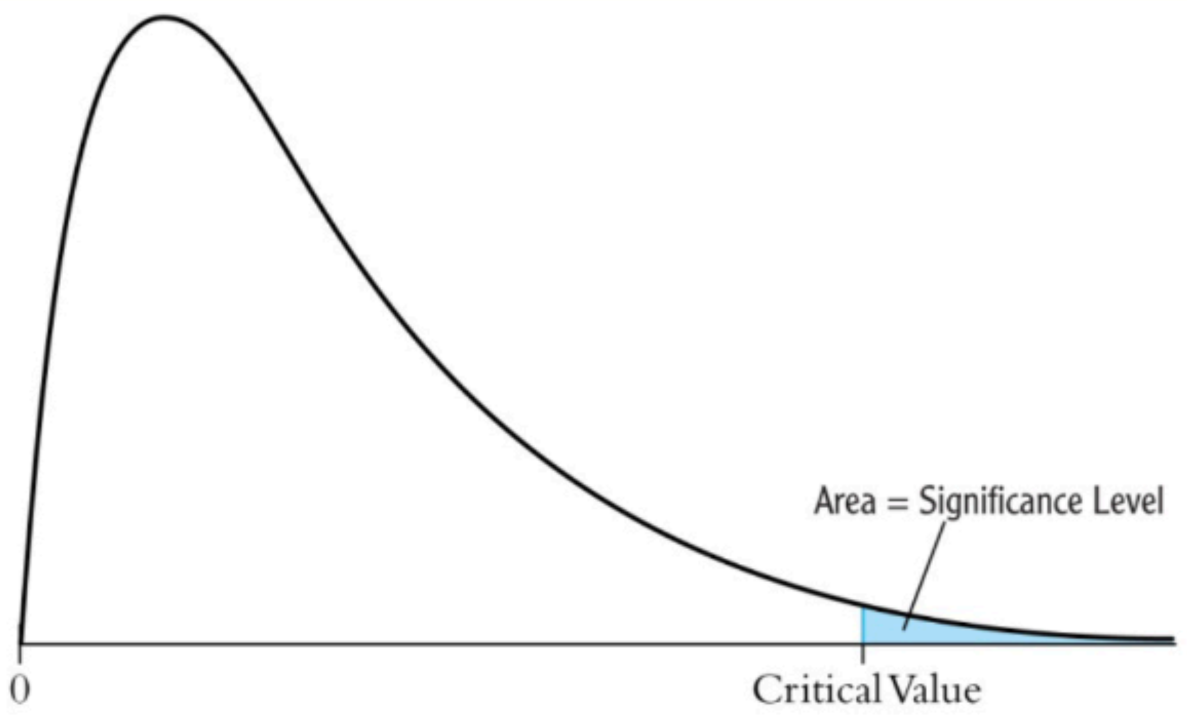
$H_0 : x$ and x^2 have no effect

F stat: 2.76

2.76 < 3.00

Fail to Reject!

TABLE 4 Critical Values for the $F_{m,\infty}$ Distribution



Degrees of Freedom	Significance Level 10%	5%	1%
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This table contains the 90th, 95th, and 99th percentiles of the $F_{m,\infty}$ distribution. These serve as critical values for tests with significance levels of 10%, 5%, and 1%.

Tips

- Spend Time Reading Problem Setup
- Be careful about which table you’re looking at
- Unless the question specifies it wants a paragraph, don’t write a paragraph
- Practice exam solutions are more detailed than necessary
- Be careful of sign of OVB problems
- Show work for partial credit

Be careful of sign of OVB problems

- Short:
  $life\_exp = \alpha_0 + \alpha_1 redwine$
- Long:
  $life\_exp = \beta_0 + \beta_1 redwine - \beta_2 heart\_cond$
- Auxiliary:
  $redwine = \gamma_0 + \gamma_1 heart\_cond$

	(1) OLS	(2) OLS
Red Wine	.723 (.034)	.343 (.077)
Heart Condition		-1.23 (.054)
Constant	72.34	71.34

Be careful of sign of OVB problems

- We know:
  - $\alpha_1 = .723$
  - $\beta_1 = .343$
  - $\beta_2 = -1.23$
- What direction should bias be in?
- What sign should γ_1 have?

	(1) OLS	(2) OLS
Red Wine	.723 (.034)	.343 (.077)
Heart Condition		-1.23 (.054)
Constant	72.34	71.34

Resources

- Practice Exams!!!
- Problem Set Solutions
- Review Lecture Video
- Slack
- Lecture Notes
- Section Notes

Resources

- Office Hours
  - Federico: 1-3pm today
  - Sahil: 2-4pm today
  - Me: 8-10pm today
  - Aden: 8-10am tomorrow
  - Me: 12:45-2:45pm tomorrow

Good Luck!