Adverse Impact:
What is it?
How do you calculate it?

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What is Adverse Impact?

- A substantially different rate of selection in employment decisions that adversely affects a protected group
- Prima facie evidence of discrimination
- Includes almost any employment decision
- Protected groups:
  - Title VII of Civil Rights Act
    - Race
    - Color
    - Religion
    - Sex
    - National origin
  - Age Discrimination in Employment Act
  - Americans with Disabilities Act

Importance of Adverse Impact

- Disparate treatment: obvious legal, ethical, and moral issues
- Disparate impact: murky
  - Bias vs. true differences
  - Perceived tradeoff between diversity & utility
- Adverse impact could result in an investigation and/or litigation regardless of intent to discriminate
- If adverse impact exists, assumed to be discriminatory unless there is validity evidence to support procedure

2007 Title VII Discrimination

	Discrimination Charges[a]	Monetary Benefits for Charging Parties[b]
Race/Color	30,510	$ 67,700,000
Religion	2,880	$ 6,400,000
Sex	24,826	$ 135,400,000
National Origin	9,396	$ 22,800,000
Total	67,612	$ 232,300,000

[a]Includes all charges, not just those based on disparate impact.
[b]Does not include monetary benefits obtained through litigation.

Source: http://www.eeoc.gov/types/index.html

History of Adverse Impact

- 1964: U.S. Civil Rights Act, Title VII
  - Outlawed employment discrimination
- 1966: EEOC Guidelines on Employment Testing Procedures
  - 1st mention of the concept; no definition
- 1968: Employment Tests by Contractors & Subcontractors (U.S. Department of Labor)
  - Report data separately for groups when feasible
- 1970: Guidelines on Employee Selection Procedures (EEOC)
  - Revised version of 1966 guidelines
  - Differential validity; different rejection rates
- 1971: Employee Testing and Other Selection Procedures (U.S. Department of Labor)
  - Language similar to 1970 EEOC guidelines

Source: Biddle (2005); Lawshe (1987)

History of Adverse Impact

- 1971: Office of Federal Contract Compliance Guidelines
  - Defined discrimination
- 1971: Griggs v. Duke Power
  - Substantially higher rate
- 1971: Technical Advisory Committee on Testing (TACT)
  - California Fair Employment Practice Commission (FEPC)
    - Statistical test?
    - 70% v. 90%?
- 1972: State of California Guidelines on Employee Selection Procedures
  - 1st defined method for determining substantially different rate
    - 80% test
    - Only use statistical test if violation of 80% test

Source: Biddle (2005); Lawshe (1987)

History of Adverse Impact

- 1976: Federal Executive Agency Guidelines on Employee Selection Procedures (U.S. Dept. of Justice)
  - Dropped the differential validity term
  - Added unfairness: group members obtain lower test score when difference is not reflected in job performance
  - Added adverse impact: a substantially different rate of selection
- 1978: Uniform Guidelines on Employee Selection Procedures (EEOC, CSC, DOL, DOJ)
  - Maintained adverse impact definition and added 80% test
- 1979: Uniform Employee Selection Guidelines Interpretation and Clarification (Questions and Answers)
- Civil Rights Act of 1991
  - Prohibits adjusting score or using different cutoff scores on the basis of group membership

Source: Biddle (2005); Lawshe (1987)

California FEPC Definition

- ***Adverse effect*** refers to a total employment process which results in a significantly higher percentage of a protected group in the candidate population being rejected for employment, placement, or promotion. The difference between the rejection rates for a protected group and the remaining group must be statistically significant at the .05 level. In addition, if the acceptance rate of the protected group is greater than or equal to 80% of the acceptance rate of the remaining group, then adverse effect is said to be not present by definition.
- Statistical test 1st, then 80% rule
  - Appears you must violate both to claim AI exists

Source: Biddle (2005)

1978 EEOC Uniform Guidelines

- A selection rate for any race, sex, or ethnic group which is less than four-fifths (4/5) (or eighty percent) of the rate for the group with the highest rate will generally be regarded by the Federal enforcement agencies as evidence of adverse impact, while a greater than four-fifths rate will generally not be regarded by Federal enforcement agencies as evidence of adverse impact. Smaller differences in selection rate may nevertheless constitute adverse impact, where they are significant in both statistical and practical terms or where a user's actions have discouraged applicants disproportionately on grounds of race, sex, or ethnic group. Greater differences in selection rate may not constitute adverse impact where the differences are based on small numbers and are not statistically significant, or where special recruiting or other programs cause the pool of minority or female candidates to be atypical of the normal pool of applicants from that group…

Source: Uniform Guidelines Section 4 (D)

1978 EEOC Uniform Guidelines

- …Where the user's evidence concerning the impact of a selection procedure indicates adverse impact but is based upon numbers which are too small to be reliable, evidence concerning the impact of the procedure over a longer period of time and/or evidence concerning the impact which the selection procedure had when used in the same manner in similar circumstances elsewhere may be considered in determining adverse impact. Where the user has not maintained data on adverse impact as required by the documentation section of applicable guidelines, the Federal enforcement agencies may draw an inference of adverse impact of the selection process from the failure of the user to maintain such data, if the user has an underutilization of a group in the job category, as compared to the group's representation in the relevant labor market or, in the case of jobs filled from within, the applicable work force.
- 80% rule 1st, then statistical test; no absolute criteria
  - Appears you only have to violate one or the other to claim AI exists

Source: Uniform Guidelines Section 4 (D)

AI Analysis Considerations

- Span covered
  - Single event (e.g., one administration, year, job class, group, location)*
  - Multiple events (more than one administration…)
- Comparison group
  - Hires vs. applicants*
  - Workforce vs. labor force
- Test/analysis type
  - Descriptive statistics
  - Practical significance*
  - Statistical significance*
- Decision/outcome in question
  - Pass/fail vs. hired/not hired
  - Total process vs. one component

**Focus of this presentation*

4/5ths (80%) Rule

1) Calculate the selection rate for each group
   - Each group that makes up > 2% of applicant pool
2) Observe which group has the highest selection rate
   - This is not always the white, male, or “majority” group
3) Calculate impact ratios by dividing the selection rate of each group by that of the highest group
4) Determine if the selection rates are substantially different (i.e., impact ratio < .80)

Source: Uniform Guidelines Q&A 12

4/5ths (80%) Rule

	Applicants	Hires	Selection Rate
White	80	48	48/80 =.6 (60%)
Black	40	12	12/40 = .3 (30%)
Impact Ratio			.3/.6 = .5 (50%)

The impact ratio (.5) is less than .8 which is evidence that, based on the 4/5ths rule, there is adverse impact.

Source: Uniform Guidelines Q&A 12

4/5ths (80%) Rule

- Could be considered a test of practical significance
  - Focuses on an effect size (impact ratio = ratio of selection rates)
- Excessive Type I & II errors
  - Subject to considerable sampling errors, especially with small sample size and selection ratio
  - Incorrectly indicates AI exists (i.e., Type I error) 20% or more of the time when 50 or fewer hires
    - Roth, Bobko, & Switzer (2006)

Is Adverse Impact a Viable Concept? (Lawshe, 1987)

- The Uniform Guidelines are intended to articulate public policy, and, although they bind practitioners, they are not professional standards
  - The term “adverse impact” does not appear in APA Standards for Testing or SIOP Principles
- Uniform Guidelines suggest that impact ratio is a characteristic of the test that accompanies it from place to place. However, it is more reasonable to expect
  - Between location differences:
    - The same test with same cutoff given to different populations may have different impact ratios
  - Within location differences:
    - Compared same test used in the same manner for same job across 2 consecutive years
    - Race AI changed significantly in 6/16 comparisons
    - In 9/21 comparisons, the 4/5ths rule was satisfied in one year, but not in the other

Statistical Significance: Decisions & Errors

Null hypothesis: There is no difference (no AI); any difference is due to chance.

		Truth (unknown)	
		No AI	**AI**
Decision	**No AI**	**Correct acceptance (1- α)**	**Type II error (β)**
	AI	**Type I error (α)**	**Correct rejection (Power; 1-β)**

Statistical Significance

- Impact ratio is much more powerful than significance test, but at the expense of Type I error
- Tests of statistical significance can control Type I error
  - α level = .05, probability (*p*) value < .05
  - Less than 5% (1/20) probability due to chance or sampling error
- Tests of statistical significance cannot control Type II error
  - Typically have low power in the context of selection decisions due to small sample size
  - When power is low, it is unclear if non-significant results
    - Are due to chance or lack of power
    - Indicate adverse impact truly does not exist

Statistical Significance & Power

- Power depends on sample variability
  - Effect size (gap b/t groups)
    - Greater power as effect size increases
  - Error variance
    - Greater power when less error variance
  - Selection rate
    - Greater power when high selection rate (e.g., 50%)
  - Proportion of minority applicants
    - Greater power with large proportion of minority applicants (e.g., 50%)
- Have no control over any of these at time of impact analysis

Statistical Significance & Power

- Power depends on sample size (N)
  - Widen timeframe
  - Combine geographic areas
  - Combine events from several jobs, job groups or divisions
  - Combine selection procedures
  - Combine different ethnic groups
- Have some control over these if circumstances are appropriate

Source: Biddle (2005); Uniform Guidelines Section 4 (D)

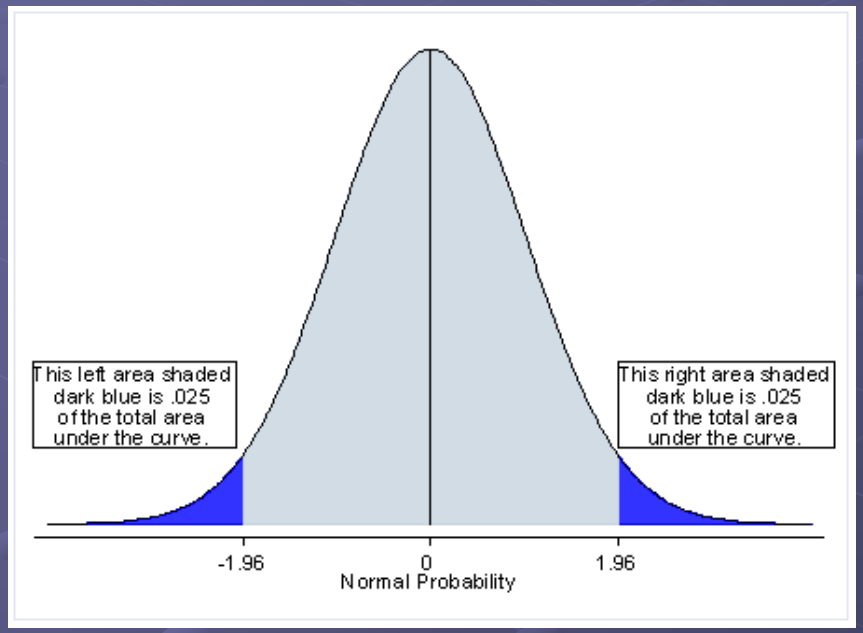
Combined Samples Warning!

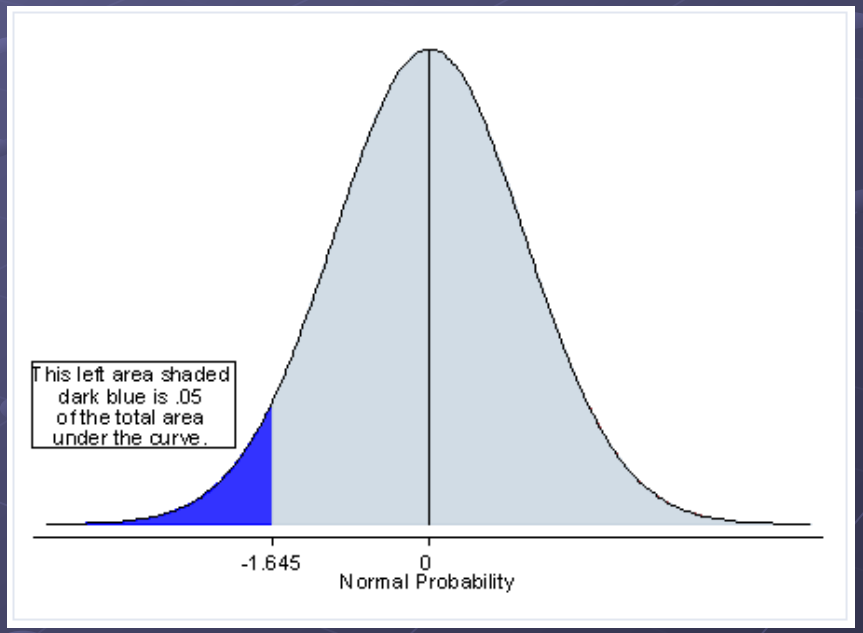
Region	Group	# Hired	Total N	Pass Rate	IR
Dallas	White	100	200	50.0%	1.00
	Hispanic	15	30	50.0%	
Ft. Worth	White	40	300	13.3%	1.00
	Hispanic	30	225	13.3%	
Combined	White	140	500	28.0%	0.63
	Hispanic	45	255	17.6%	

Statistical Significance & Power

- Power depends on statistical decisions
  - α level
    - Higher α level results in greater power
    - Court prefers α = .05
  - Tails
    - 1 tail (directional) has greater power than 2 tail (non-directional)
    - Court prefers 2 tails
      - Some argue that 1 tail would be more appropriate
  - Statistical test chosen (tests vary in power)
    - Stay abreast of best practices
    - Seek guidance if needed

α Level & Tails





Note: Blue shaded area = α

Statistical Tests: Chi-Square

- Test of association between two qualitative variables
  - 2 X 2 contingency table
  - E.g., association between pass vs. fail X male vs. female
- Compares fit between observed frequencies and expected frequencies
  - Expected frequencies are what you would expect if there was no relationship between the 2 variables

Statistical Tests: Chi-Square

Actual Frequency

	Male	Female	Total	Total
Pass	15	5	20	20.0%
Fail	50	30	80	80.0%
Total	65	35	100	100.0%

Expected Frequency

	Male	Female	Total	Total
Pass	13.0	7.0	20	20.0%
Fail	52.0	28.0	80	80.0%
Total	65	35	100	100.0%

Statistical Tests: Z_D

- Z-test of the difference in selection rates
  - A.k.a. 2-SD test or Pooled Two-Sample Z-Score test
  - Difference between two proportions or selection rates
  - Mathematically equivalent to chi-square (when testing 2 X 2 table)
    - Chi-square = Z_D squared; square root of chi-square = Z_D

$$Z_D = \frac{SR_{min} - SR_{maj}}{\sqrt{SR_P(1 - SR_P)\left(\frac{1}{N_{min}} + \frac{1}{N_{maj}}\right)}}$$

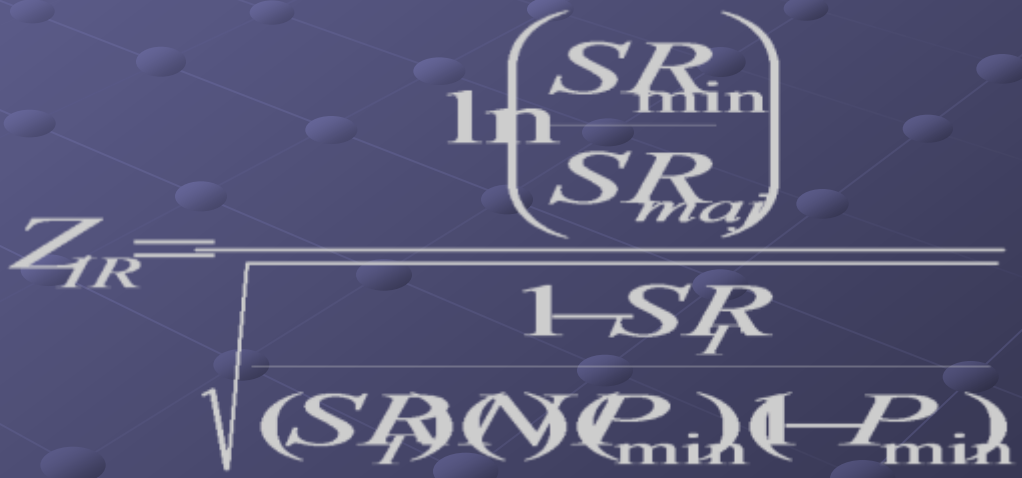
Source: Moore & McCabe (1993); Morris (2001); OFCCP (1993)

Comparison Problem

- When comparing test results, we are comparing apples and oranges
  - 4/5ths = ratio of selection rates
  - 2-SD = difference in selection rates
- Absolute difference ≠ relative difference
- .10/.15 vs. .45/.50
  - Difference in selection rate = .5 vs. .5
  - Ratio of selection rate = .67 vs. .90

Statistical Tests: Z_{IR}

- Z-test of the ratio of selection rates
  - Sampling distribution is non-symmetric
  - 0 - 1, 1 - ∞
  - Take natural log of ratio



Source: Morris (2001)

Z_D vs. Z_{IR}

- Both
  - Numerator = effect size
  - Denominator = standard error of effect size when null hypothesis is true (i.e., no differences)
  - If |Z| > 1.96, then sig at two-tailed α =.05
- Z_{IR}
  - Effect size is same as the impact ratio (selection rate ratio)
  - *Slightly* more power (especially as proportion of minority applicants gets smaller)
  - Can build confidence intervals around impact ratio

Confidence Intervals for Z_{IR}

- Problem with statistical tests
  - Large N; is the significant result meaningful?
  - Small N; is it really non-significant or is it a result of low power?
- Advantage of confidence interval
  - Large N; helps distinguish b/t trivial & substantial statistical significance
  - Small N; help understand degree of potential Type II error when non-sig
- Effect size (i.e., impact ratio) provides best estimate of magnitude of the difference
- Confidence interval (CI) communicates degree of precision (i.e., sampling error) in that estimate
  - CI does not eliminate problem of low power, but provides more comprehensive picture of results
- If CI includes 1.0, degree of AI is not statistically significant
- Problem: still only accurate when expected frequency of minority hires $\geq$ 18 and IR $\geq$ .2

Statistical Tests: Fisher Exact Test

- For a 2 X 2 contingency table
- Calculates the exact probability of obtaining the observed frequency table or one more extreme (i.e., stronger association) assuming no true relationship between the two variables.
- The resulting probability level is taken as the significance level.

Sample Size: What is needed?

- Federal enforcement agencies offer no established threshold and little guidance
- Uniform Guidelines (Q&A #20)
  - Seem to suggest that 4 hires from an applicant pool of 30 is too small
- OFCCP
  - If the number of total persons in the pool of applicants/candidates is less than 30 and the number of expected minority/female selections is less than 5, a small numbers test (preferably Fisher's exact) should be used

Sample Size: What is needed?

- 4/5ths rule
  - Greatest power; requires smallest N
  - Does not control for Type I error
- Z_{IR}
  - Requires large samples for adequate power
- Chi-square or Z_D
  - Requires largest samples for adequate power
  - For normality assumptions, need minimum expected frequency of 5; 10 is much safer.

Source: Hays (1994); Morris (2001)

Sample Size: Small N

- When sample is small N (e.g., N < 100 and minimum expected frequency < 5)
  - Fisher's exact has lowest Type I error, but at the expense of power
  - 4/5ths has the highest power, but at the expense of Type I error
  - N of 1 rule is improvement over 4/5ths, but still relatively high Type I error
  - Z_D appears to be the best method available
  - All statistical methods have extremely low power when population impact ratio = .8

Source: Collins & Morris (2008)

Practical Tests

- N of 1 (flip-flop) rule
  - Calculates an adjusted impact ratio
    - Assume one more person from the minority group and one less person from the majority group were hired (and, consequently, one less minority and one more majority were hired).
  - If the resulting selection ratios are such that the minority selection ratio is now larger than the majority selection ratio, selection rate differences may be attributed to small sample size.
- One person rule
  - If the difference between *actual* minority hires and *expected* minority hires (rounded down to the nearest whole number) is less than 1, selection rate differences may be attributed to small sample size.

Source: Uniform Guidelines Q&A 21; Roth, Bobko & Switzer (2006)

Practical Tests

- Shortfall analysis
  - How many more in minority group would need to pass to exceed 80%?
  - How many more in minority group would need to pass to bring passing rates very close?
  - How many more in minority group would need to pass to eliminate statistical significance?
- Shortfall analyses typically assumes row and column totals stay the same
  - If 1 more minority passes, then 1 less minority fails, 1 less majority passes, & 1 more majority fails

Conclusions

- If IR < .8 and a statistical test is not significant
  - Use a small N practical test
    - If due to small sample, IR cannot be safely interpreted; may be required to broaden sample to determine if pattern exists
    - If not due to small sample, consider magnitude of IR and *p*-values of statistical tests; recognize differences in Type I error and power
- If IR > .8 and a statistical test is significant
  - Consider magnitude of IR
  - Confidence intervals may show promise
- Regardless of outcome, always ensure you have validity evidence to support your procedure!!

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