

COMMON ERRORS IN FORMING ARITHMETIC COMPARISONS

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ABSTRACT

This paper reviews the three basic arithmetic comparisons (simple difference, simple ratio and relative difference), identifies some common arithmetic and grammatical errors and makes several recommendations.

INTRODUCTION

Arithmetic comparisons are both common and useful. Comparisons describe associations and associations are the doorways to causation. Arithmetic comparisons indicate the strength of an association by giving specific measurements. Making errors in arithmetic comparisons creates confusion and doubt in an argument; minimizing these errors will enhance statistical literacy.

RULES FOR COMPARISONS

To be statistically literate, one must be able to form arithmetic comparisons of any two numbers. First consider the three basic arithmetic comparisons. Each comparison has two values: *Test* and *Base*. The *Test* is the value being evaluated; the *Base* is the basis of comparison. Each comparison has certain keywords. Multiply the comparison by 100% to obtain a percentage.

Simple difference [*Test* – *Base*]

- When comparing numbers other than percentages, use ‘more/less than’ or ‘greater/smaller than’. Five is one more than four; four is one less than five.
- When comparing two percentages, use ‘percentage point(s) more/less than’. Five percent is one percentage point more than four percent. Four percent is one percentage point less than five percent.

Simple ratio [*Test* / *Base*] Use ‘times as much as’ or ‘percent (%) of’.

- When using ‘times as much as’: Five is 1.25 times as much as four; four is 0.8 times as much as five.
- When using ‘percent (%) of’: Four is 80% of five. Five is 125% of four. Never use ‘percent (%) as much as’. ** [Original: APDU2-Original.pdf]

Relative difference [$(Test - Base)/Base$]

Use ‘% more/less than’ or ‘times more/less than’.

- When using ‘% more/less than’: Five is 25% more than four; four is 20% less than five.
- When using ‘times more/less than’: Five is 0.25 times more than four. Four is 0.20 times less than five.

In comparing numbers in data having or allowing negative values, use only simple differences; never use simple ratios or relative differences. Weather forecast-

ers never say the temperature today (+20°F) is minus two times as much as that a year ago (-10°F). They use only simple differences: “It is 30°F warmer today than it was a year ago.” They don’t use simple ratios or relative differences even when both temperatures are positive since these temperatures lack a natural zero.

SEVEN COMMON ERRORS

The following are common errors in forming arithmetic comparisons. These errors are easily corrected.

1. *Mixing the grammar of comparisons:* Don’t say, “times as much than”, “percent as much as”, “percent times as much as” or “times more as”.
2. *Confusing a simple difference with a relative difference in comparing percentages.* If interest rates go from 5% to 7%, the increase is 40% – not 2%.
3. *Confusing ‘percent’ with ‘percentage points.’* If interest rates go from 5% to 7%, the increase is 2 percentage points – not 2%.
4. *Treating relative differences as numerically symmetric:* Five is 25% more than four. But four is 20% less than five – not 25% less than five.
5. *Confusing ‘times as much’ with ‘percent more than’.* If B is three times as big as A, then B is 200% greater than A – not 300% greater than A.
6. *Confusing ‘times as much’ with ‘times more than’.* If B is three times as much as A, then B is two times more than A – not three times more than A. The essential feature is the difference is between ‘as much as’ and ‘more than.’ ‘As much as’ indicates a ratio; ‘more than’ indicates a difference. ‘More than’ means ‘added onto the base’. This essential difference is ignored by those who say that ‘times’ is dominant so that ‘three times as much’ is really the same as ‘three times more than.’
7. *Using ‘times less’ as an inverted form of ‘times as much’.* Since six is three times as much as two, it is tempting to say that two is three times less than six. Two is definitely less than six and their ratio is definitely that of three to one. But if two were three times less than six, then six should be three times more than two. Recall that six is three times as much as two – two times more than two. ‘Times less than’ is an inverted form of ‘times more than’ – not ‘times as much’. This error is more common in speech than in writing. This error is a variation on error 6.

** V2: This bullet was re-written. The original erroneously recommended using ‘percent as much as’. Thanks to Dr. Peter Jackson, Benedict College, for noting that the original contradicted Recommendation #2. Oct, 2018

FOUR RECOMMENDATIONS

1. *When comparing two values, give both values being compared along with the comparison. The reader can then verify the comparison (e.g., Interest rates went from 5% to 7% – an increase of 40%).*
2. *Use ‘times as much as’ for simple ratios and ‘% more than’ for relative differences.*
 - *Do not use ‘% as much as’.* This is not common usage and it generates confusion with ‘% more than’ analogous to the confusion between ‘times as much as’ and ‘times more than’.
 - *Do not use ‘times more than’ or ‘times less than’.* This avoids errors 6 and 7.
3. *If you elect to use ‘times more than’, then state the comparison using both forms of ‘times’. E.g., nine is two times more than three (three times as much as three). This eliminates confusion and educates the reader on forming comparisons.*
4. *Use ‘times as much as’ when the simple ratio is more than one. Use ‘% more than’ if the ratio is less than three. Use either one (‘times as much’ or ‘% more than’) if the ratio is between one and three. Use ‘% less’ or ‘% of’ if the ratio is less than 1. This convention avoids small ratios (0.4 times) and large percentages (450% more). E.g., 30 is three times as much as 10; 15 is 50% more than 10, and 15 is 1.5 times as much as 10. 8 is 20% less than 10 and 8 is 80% of 10.*

CLOSING COMMENTS

There are other errors in forming arithmetic comparisons especially in comparing percentages and rates. But identifying and eliminating these common errors provides a strong foundation for taking on more complex comparisons.

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