

### Presidential approval

**Parameter:**

$p_{2010}$  = the true proportion of all U.S. adults who approved of President Obama's job performance in September 2010

$p_{2009}$  = the true proportion of all U.S. adults who approved of President Obama's job performance in August 2009.

**Assess Conditions:**

- Random: The data came from separate random samples.
- Normal:  $n_{2010}\hat{p}_{2010} = 512$ ,  $n_{2010}(1 - \hat{p}_{2010}) = 512$ ,  $n_{2009}\hat{p}_{2009} = 535$ ,  $n_{2009}(1 - \hat{p}_{2009}) = 475$  since all values are all at least 10 we can consider the normal/large sample size condition satisfied.
- Independent: The samples were taken independently and there are more than  $10(1024) = 10,240$  U.S. adults in 2010 and  $10(1010) = 10,100$  U.S. adults in 2009.

**Name Interval:** two-sample z interval for  $p_{2010} - p_{2009}$

$$\text{Interval: } (0.50 - 0.53) \pm 1.645 \sqrt{\frac{0.50(1-0.50)}{1024} + \frac{0.53(1-0.53)}{1010}} = -0.03 \pm 0.036 = (-0.066, 0.006)$$

We are 90% confident that the interval from  $-0.066$  to  $0.006$  captures the true change in the proportion of U.S. adults who approve of President Obama's job performance from August 2009 to September 2010.

**Conclude in context:** That is, it is plausible that his job approval has fallen by up to 6.6 percentage points or increased by up to 0.6 percentage points. Since 0 is included in the interval, it is plausible that there has been no change in President Obama's approval rating. Thus, we do not have convincing evidence that his approval rating has changed.

### Hearing Loss

**Parameter:**

$p_1$  = the proportion of all teenagers with hearing loss in 2012-2013

$p_2$  = the proportion of all teenagers with hearing loss in 1988-1994

**Hypothesis:**

$$H_0: p_1 = p_2$$

$$H_a: p_1 > p_2$$

**Assess Conditions:**

- Random: The data came from separate random samples.
- Normal:  $n_1\hat{p}_1 = 351$ ,  $n_1(1 - \hat{p}_1) = 1449$ ,  $n_2\hat{p}_2 = 450$ ,  $n_2(1 - \hat{p}_2) = 2550$  are all at least 10.
- Independent: The samples were taken independently and there were more than  $10(1800) = 18,000$  teenagers in 2012-2013 and  $10(3000) = 30,000$  teenagers in 1988-1994.

**Name Test:** two-proportion z test for  $p_1 - p_2$

$$\text{Test Statistic: } \hat{p}_c = \frac{450 + 351}{3000 + 1800} = 0.167, z = \frac{(0.195 - 0.15) - 0}{\sqrt{\frac{0.167(1-0.167)}{1800} + \frac{0.167(1-0.167)}{3000}}} = 4.05,$$

**Obtain  $P$ -value:**  $p\text{-value} \approx 0$

**Make a Decision:** Since the  $P$ -value is practically zero, which is less than 0.05, we reject  $H_0$ .

**State Conclusion in Context:** We have convincing evidence that the proportion of all teens with hearing loss has increased from 1988-1994 to 2012-2013.

(b) No. Since we didn't do an experiment where we randomly assigned some teens to listen to iPods/iPhones and other teens to avoid listening to iPods/iPhones, we cannot conclude that iPods/iPhones are the cause. It is possible that teens who listen to iPods also like to listen to music in their cars and perhaps the car stereos are causing the hearing loss.