$$\binom{2n}{n} = \frac{2n!}{n!(2n-n)!}$$

$$= \frac{2n!}{n! * n!}$$

$$= \frac{(2n) * 2n - 1 * (2n-2) * ... * (n+2) * (n+1)}{n!}$$

$$= \prod_{k=1}^{n} \frac{n+k}{k}$$

$$= \prod_{k=1}^{n} (\frac{n}{k} + \frac{k}{k})$$

$$= \prod_{k=1}^{n} (\frac{n}{k} + 1)$$

We will now factor out the first term (when $k = 1$)

$$\prod_{k=1}^{n} (\frac{n}{k} + 1) = (\frac{n}{1} + 1) \prod_{k=2}^{n} (\frac{n}{k} + 1)$$

$$= (n+1) \prod_{k=2}^{n} (\frac{n}{k} + 1)$$

However if we have $n = 1$, we will get:

$$(n+1) \prod_{k=2}^{1} (\frac{n}{k} + 1) = (n+1) * 1$$

Therefore as long as $n > 1$, the binomial expression will have a factor of $n + 1$. Since it has this factor, the binomial will always be divisible by $n + 1$