**Insuring Police Cars**

A medium sized City has just replaced its old police cars by purchasing new ones. Each cost $40,000. As part of the job, police cars sometimes crash and must be replaced or repaired. If a crashed car is a total loss (“totaled”), the City replaces it with a new $40,000 car. If it can be fixed, the City sends it to a private repair shop. Crashes also can result in liability claims against the City in which the City has to pay compensation to the injured parties.

The City is trying to determine if it is in their best interests to purchase insurance for the cars. It did not carry insurance for its previously purchased cars. But of course because of that, it had to pay the full amount to replace a totaled car, to repair a damaged one, and to cover any liability claims against the City.

Using data from recent years, the City’s data scientists estimate that the number of cars totaled in a year can be described by a Poisson distribution with mean (rate) 2.5 cars per year. Its total annual private repair shop bill for damaged cars can be described by a normal distribution with a mean of $30,000 per year with a standard deviation of $5,000. Annual liability claims against the City can be estimated to be normally distributed with a mean of $300,000 and a standard deviation of $50,000.

The City has been considering the purchase of one of three insurance policies. The first (Policy A) has an annual premium (the cost of the insurance up front) of $305,000. This policy covers all costs with a deductible of 35%. That means the City pays 35% and the insurance company pays 65% of all replacement, repair and liability costs.

Policy B only covers replacement costs. It does not cover repair or liability costs (i.e., the City has to pay those costs.) This policy has an annual premium of $307,000. As for replacement costs, the policy have a 20% deductible with a $42,000 limit to what the City would have to pay for replacement vehicles. As such the City would pay 20% of the cost of replacement vehicles or $42,000, whichever is smaller.

Policy C only covers liability costs. The policy covers 60% of the liability costs. The City covers the other 40% no matter how large or small the liability bill is for that year. This policy does not cover replacement or repair costs. Its premium is $200,000.

The City would like to know if it should continue not to purchase insurance or whether it is wise to buy one of these three policies. It is interested in finding the one with the minimum expected annual cost. In addition it would like to know for each option, what the risks are of incurring a total cost of over $500,000.

1. Use a simulation with 10,000 Monte Carlo trials and a seed of 123 to evaluate the no-insurance policy, policy A, policy B, and policy C. For each policy give the estimates of the average total annual cost and of the probability that the annual cost will exceed $500,000. Which policy should Bergen County choose?
2. Are you certain (95% confident) you have recommended the option with the lowest expected cost?