We thus know the price of the security now.
Now recall the price of a caplet with Bachelier's formula:

$$C_{Pl\,Bach}(t,T_0,T_1) = \delta P(t,T_1)\,\sigma_{Bach}\sqrt{T_0-t}\,\big(D\,\Phi(D)+\phi(D)\big)$$

with

$$D = \frac{F(t,T_0,T_1)-K}{\sigma\sqrt{T_0-t}}$$

If the caplet is ATM, i.e $F(t,T_0,T_1)=K$, this simplifies to

$$C_{Pl\,Bach}(t,T_0,T_1) = \delta P(t,T_1)\,\sigma_{Bach}\sqrt{T_0-t}\;\phi(0)$$

Plugging the price we found for $C_{Pl\,Bach}$ and solving for σ_{Bach} gives:

$$\sigma_{Bach} = \frac{0.13049947392014823}{1\cdot e^{-0.03\cdot 5}\sqrt{4}\;\underbrace{\phi(0)}_{=\frac{1}{\sqrt{2\pi}}}} = 0.01900259322048915$$