DYNXT Vault

@dev

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1 DYNXT Yield Calculations

Simple interest formula:

$$A = P(1 + rt) \tag{1}$$

Compound interest formulas:

$$A = P\left(1 + \frac{r}{n}\right)^{nt} \tag{2}$$

$$r = n\left(\left(\frac{A}{P}\right)^{1/nt} - 1\right) \tag{3}$$

The DYNXT yield rates are as follows:

Minimum deposit	*Term*	*Compounded yield*
10,000,000	7 *days*	0.5%
100,000,000	30 *days*	3.0%
1,000,000,000	90 *days*	10.0%
10,000,000,000	180 *days*	22.0%

With daily compounding ($n = 1$), per equation 3, the appropriate daily values of the interest rate r to compound to the desired yield rate at the end of the given terms are

$$\begin{aligned}
r_1 &= (1.005)^{1/7} - 1 &&= 0.00071275982 = 0.071275982\% \\
r_2 &= (1.03)^{1/30} - 1 &&= 0.00098577896 = 0.098577896\% \\
r_3 &= (1.1)^{1/90} - 1 &&= 0.00105956293 = 0.105956293\% \\
r_4 &= (1.22)^{1/180} - 1 &&= 0.00110533742 = 0.110533742\%
\end{aligned}$$

Solidity tracks time in Unix time, which is seconds since 1970-01-01 00:00:00 +00:00 UTC. So the time parameter t for equation 2 must account for the conversion from seconds to days by dividing by $24 \times 60 \times 60 = 86400$. Using the calculated rate values, equation 2 for each vault option becomes

$$\begin{aligned}
A_1 &= P\,(1.00071275982)^{t/86400} \\
A_2 &= P\,(1.00098577896)^{t/86400} \\
A_3 &= P\,(1.00105956293)^{t/86400} \\
A_4 &= P\,(1.00110533742)^{t/86400}
\end{aligned}$$

The maximum value which should ever be yielded is up to the term completion. After that time, no additional compounding should occur.

$$
\begin{aligned}
max(A_1) &:= P\,(1.00071275982)^7 \\
max(A_2) &:= P\,(1.00098577896)^{30} \\
max(A_3) &:= P\,(1.00105956293)^{90} \\
max(A_4) &:= P\,(1.00110533742)^{180}
\end{aligned}
$$

In the event that the user chooses to disable the "auto-deposit" feature, they will be allowed to withdraw their yields earned up to this point so far. However, for simplicity, in these cases, yields are treated as simple interest as opposed to compound interest and calculated according to equation 1 using the same rates r as their compounded counterparts. This results in slightly smaller yields overall. Assuming such a deposit is held to term, the yields are then computed by

$$
\begin{aligned}
A_1 &:= P\,(1 + 0.00071275982 \cdot t) \\
A_2 &:= P\,(1 + 0.00098577896 \cdot t) \\
A_3 &:= P\,(1 + 0.00105956293 \cdot t) \\
A_4 &:= P\,(1 + 0.00110533742 \cdot t)
\end{aligned}
$$

For which the maximum yields after the term is mature are

$$
\begin{aligned}
max(A_1) &:= P\,(1 + 0.00071275982 \cdot 7) && = P \cdot 1.0049893187 \\
max(A_2) &:= P\,(1 + 0.00098577896 \cdot 30) && = P \cdot 1.0295733688 \\
max(A_3) &:= P\,(1 + 0.00105956293 \cdot 90) && = P \cdot 1.0953606637 \\
max(A_4) &:= P\,(1 + 0.00110533742 \cdot 180) && = P \cdot 1.1989607356
\end{aligned}
$$

Which makes the effective yield rates Y_{eff} for the "non-auto-deposit" cases

$$
\begin{aligned}
Y_{eff,1} &= 0.49893187\% = 0.498\% \; vs. \; 0.5\% \\
Y_{eff,2} &= 2.95733688\% = 2.96\% \; vs. \; 3.0\% \\
Y_{eff,3} &= 9.53606637\% = 9.54\% \; vs. \; 10.0\% \\
Y_{eff,4} &= 19.89607356\% = 19.9\% \; vs. \; 22.0\%
\end{aligned}
$$

Compounded effective yield included for context.