

→ Uncertain Exposures / Premiums

→ Uncertain exposures are the portion of the written exposures for which coverage has not yet been provided as of a specific point in time. Similarly, uncertain premium represents the portion of written premium for which coverage has not yet been provided as of a specific point in time. If a insurer cancels their policy, the insurer must return the coverage premium to the policyholder since the insurer has not yet provided coverage for that portion of insurance.

→ The following relationships hold for an individual policy or a group of policies aggregated using either the CY aggregation method or the PY aggregation method:

$$\begin{aligned} \text{Written Exposure} &= \text{Known Exposure} + \text{Uncertain Exposure} \\ \downarrow &= \downarrow + (\text{Eoy Uncertain Exposure} - \text{Beg Uncertain Exposure}) \end{aligned}$$

$$\begin{aligned} \text{Written Premium} &= \text{EP} + \text{Change in Uncertain Premium} \\ \downarrow &= \downarrow + (\text{Eoy Uncertain Premium} - \text{Beg Uncertain Premium}) \end{aligned}$$

→ Rearranging the equations above, we can write the uncertain exposure/premium as follows or together:

$$\text{Eoy Uncertain Exposure} = \text{Written Exposure} - \text{Known Exposure} + \text{Beg Uncertain Exposure}$$

$$\text{Eoy Uncertain Premium} = \text{UP} - \text{EP} + \text{Beg Uncertain Premium}$$

→ For example, using the same 4 policies, we have the following table for CY2023:

	CY 2023
WP	\$150
EP	\$150
Shaded UEP	\$150
UEP	\$150

The starting UEP for CY2023 is the same as the UEP at the end of the previous CY, which is \$150.

The UEP for CY2023 can be calculated as follows:

$$\text{CY 2023 UEP} = \text{CY 2023 EP} - \text{CY 2023 UP} + \text{CY 2023 Shaded UEP}$$

$$\downarrow = (150 - (150 + 450))$$

$$= -500$$

Since the starting uncertain exposure/premium for a policy year will always be 0, the relationships above can be simplified to the following if policy year aggregation is used:

$$\boxed{\text{UEP} = \text{EP} + \text{UEE}}$$

$$\boxed{\text{UEE} = \text{EP} - \text{WP}}$$

→ In-force Exposures / Premiums

→ In-force exposures are the number of insured units that are exposed known at a specific point in time. Insurance companies do not all quote "in-force units" in the same way. For example, to insure a unit, for an auto insurance policy that insures 3 cars could be one of the following:

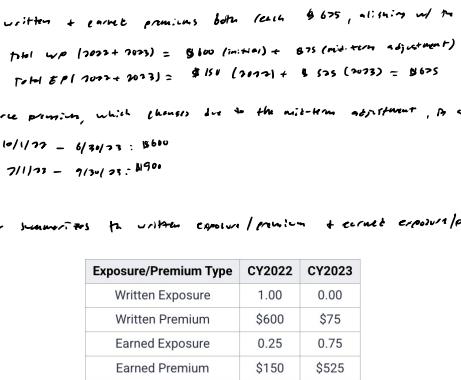
→ 60% weight: 3 insure exposures

→ 100% weight: 2 insure exposure

→ Written exposures: 3 insure exposures (annual) or 1.00 insure exposures (semi-annual timing)

→ In-force premium is the total amount of full term premiums for all policies in effect as of a specific point in time. For example, the in-force premium as of 3/1/23 is the total of the full term premiums for all policies w/ inception dates on or before 3/1/23, + expiration dates on or after 3/1/23.

→ Graphically, the specific point in time, or the valuation date, is represented by a vertical line, any policies that intersect the line are regarded as "in-force" on the valuation date.



→ The following table shows the in-force premium at different valuation dates.

Policy	Effective Date	Expiration Date	Premium	In-force Premium as of			
				03/15/2023	09/30/2023	01/01/2024	01/01/2024
A	10/01/2022	09/30/2023	\$600	\$600	\$600	\$0	\$0
B	01/01/2023	12/31/2023	\$500	\$500	\$500	\$0	\$0
C	04/01/2023	03/31/2024	\$700	\$0	\$700	\$700	\$700
D	07/01/2023	06/30/2024	\$650	\$0	\$650	\$650	\$650
Total			\$2,450	\$1,100	\$2,450	\$1,350	

→ A couple things to note regarding in-force exposures & premiums:

1) Since the in-force exposures & premium are measured at a single point in time, the method of aggregation is irrelevant.

2) The in-force premium is always determined by the full term premium amount, irrespective of the policy duration.

→ Mid-term adjustments

→ Type 1: Cancellations

→ If a policy (lossless mid-term), the unearned portion of the written exposure/premium is shown as negative written exposure/premium in the year of cancellation because, for example, assume Policy A (effective 10/1/22) is canceled on 4/6/23, on that date, 7/12 of the policy is earned, & \$150 is unearned. Then the written exposure/premium + earned exposure/premium for this policy will be as follows:

Exposure/Premium Type	CY2022	CY2023
Written Exposure	1.00	$5/12 \times -1.00 = -0.417$
Written Premium	\$600	$5/12 \times -\$600 = -\250
Earned Exposure	$3/12 \times 1.00 = 0.25$	$4/12 \times 1.00 = 0.333$
Earned Premium	$3/12 \times \$600 = \150	$4/12 \times \$600 = \200

→ As seen in the table above, aggregation using the CY method will result in a policy contributing to the written exposures & premium at two different CYs if the policy is canceled in a different CY than the original effective date.

→ If aggregation is done using the PY method, the original written exposure/premium + written exposure/premium due to cancellation will always be in the same policy year, so a policy cannot contribute written exposure/premium due to two different policy years. This contrast w/ the CY method, where UP & cancellation premium may fall into two different CYs, depending on the timing of the cancellation.

→ Type 2: Premium adjustment

→ Sometimes, instead of cancelling mid-term, a policy change will occur mid-term.

→ Assume Policy A is a 12-month insurance policy in effect from 10/1/22 - 9/30/23, w/ an original full-term premium of \$150 on 8/1/23. A mid-term adjustment reduces the premium to \$100. At that point, 7 months (or 7/12) of the policy period have been earned, leaving 5 months (or 5/12) unearned. This adjustment leads to a blended total premium of:

$$\$150(4/12) + \$100(7/12) = \$675$$

The following breaks down how this change affects premium earning, exposure, WP, EP & in-force premium.

→ Premium Crediting Rates

→ The premium is earned at two different monthly rates, based on the mid-term adjustment:

→ Between 10/1/22 & 4/6/23, premium will be earned at an initial rate of $\$150 \div 12 = \$12.50/\text{month}$

→ Between 4/6/23 & 9/30/23, premium will be earned at a revised rate of $\$100 \div 12 = \$8.33/\text{month}$

→ Impact on exposure

→ The mid-term change does not alter exposure, which remains constant throughout the policy period.

→ WP → 1 in 2022, as the policy was issued in that year

→ 0 in 2023, as there was no new insurance

→ EP → 0.75 in 2022, representing the first 3 months (act-accrual)

→ 0.75 in 2023, representing the remaining 9 months (7/12 - 3/12) premium for mid-term adjustment.

→ Impact on premiums

→ Adjustment to the written & earned premiums reflect the mid-term adjustment, broken down as follows:

→ WP → 2022: initial \$600, in 10/1/22 - 9/30/22

→ 2022: $\$12.50 \times 7/12 = \62.50

→ \$62.50 from the first 6 months (0-6) & the original \$150/month

→ \$37.50 from the last 3 months (7-9) as the revised \$12.50/month premium for mid-term adjustment.

→ EP → 2022: \$150, calculated as $(\frac{7}{12}) \times \$600$

→ 2023: $\$12.50 \times 5/12 = \62.50

→ \$62.50 from the first 6 months (0-6) & the original \$150/month

→ \$37.50 from the last 3 months (7-9) as the revised \$12.50/month premium for mid-term adjustment.

→ The total written + earned premiums both result in \$675, reflecting w/ the blended premium calculation:

→ Total WP (2022+2023) = $\$600(\text{initial}) + \$62.50(\text{mid-term adjustment}) = \675

→ Total EP (2022+2023) = $\$150(\text{initial}) + \$62.50(\text{mid-term}) = \675

→ The in-force premium, which changes due to the mid-term adjustment, is as follows:

→ $10/1/22 - 4/6/23 = \$600$

→ $4/6/23 - 9/30/23 = \$100$

→ The table below summarizes the written exposure/premium & earned exposure/premium for this policy.

Policy	Effective Date	Expiration Date	Premium	In-force Premium as of
A	10/01/2022	09/30/2023	\$600	\$600
B	01/01/2023	06/30/2023	0.50	0.50
C	04/01/2023	09/30/2023	0.50	0.50
D	07/01/2023	12/31/2023	0.50	0.50
Total			\$2,450	\$1,350

→ Policy terms other than annual

→ So far, our discussion has focused on policies w/ annual terms. If the policies have policy terms other than annual, the aggregation for each type of exposure/premium will be calculated differently than described above. For example, assume the same 4 policies have non-annual policy terms. Then each policy would represent one-half a written exposure,

as shown in the table below.

Policy	Effective Date	Original Expiration Date	Cancellation Date
A	10/01/2022	03/31/2023	12/31/2022
B	01/01/2023	06/30/2023	03/31/2023
C	04/01/2023	09/30/2023	06/30/2023
D	07/01/2023	12/31/2023	09/30/2023

→ On a graph, each policy line will start on its respective date & end on its expiration date, while the policy policy lines have a different slope b/c some policies like semi-annual policy terms. The slope of the policy year parallel lines needs to be adjusted accordingly as well. The diagrams below show the CY & PY aggregation for the semi-annual policies.

