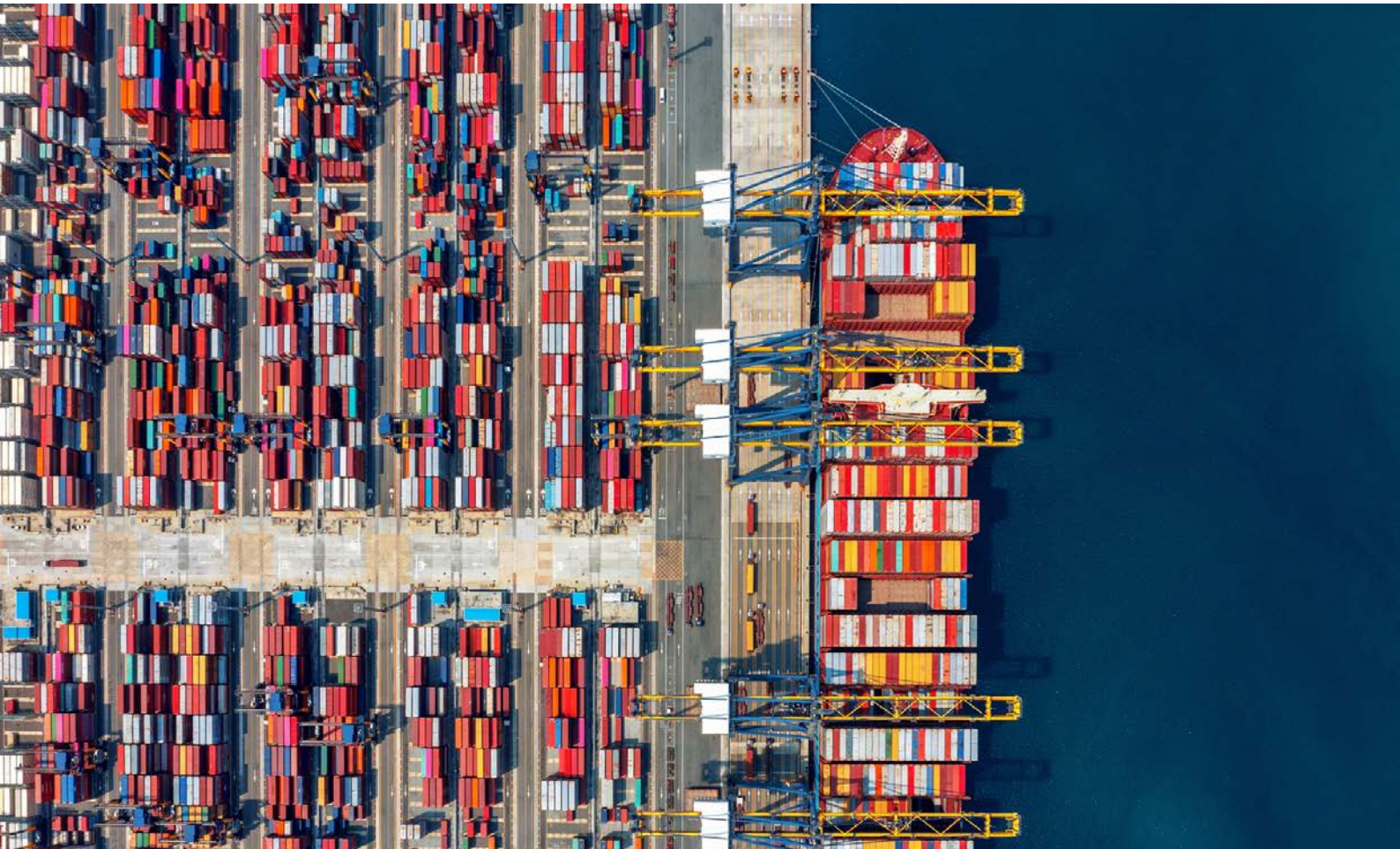




(De-)capitalisation of Export Credit Insurance Premiums

A General Framework for
Premium-Capital Interactions

Minimise risks. Maximise exports.

A whitepaper on export credit insurance pricing by

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Abstract

Export credit insurance premiums give rise to cash flows between the Export Credit Agency (ECA) and the policyholder. In certain situations, however, the economic effect of premium adjustments resulting from insurance policy modifications may be transmitted into the underlying financing transaction. Premium surcharges may be financed and capitalised into the insured credit amount, while premium refunds may be used to further reduce outstanding insured capital. In such situations, premium and insured capital become mutually dependent quantities, creating a feedback mechanism that cannot be addressed within conventional pricing frameworks.

Building upon SERV's previously published methodology for pricing insurance policy modifications, this paper develops a general framework for modelling premium-capital interactions. We demonstrate that both the capitalisation of premium surcharges and the decapitalisation of insured capital through premium refunding can be characterised by a common mathematical structure and admit a unique analytical solution. The framework provides a unified treatment of seemingly different business processes and establishes a consistent foundation for the treatment of premium-capital interactions in export credit insurance.

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1 Introduction and Motivation

Export Credit Agencies (ECAs) operate in an environment where insurance premiums and financing structures are closely interconnected. The pricing of an export credit insurance policy depends both on the characteristics of the underlying export transaction and on the insurance coverage of the financing transaction.

While the initial pricing of a policy is performed at inception, insurance contracts frequently require amendments throughout their lifetime. Changes to financing structures, repayment schedules, insured amounts or cover ratios may alter the insured capital and consequently require adjustments of the insurance premium. To address this problem, SERV recently introduced a unified framework for the pricing of insurance policy modifications [1]. The framework provides a consistent methodology for determining premium surcharges and premium refunds resulting from changes in the insured capital and thereby extends export credit insurance pricing beyond the initial underwriting of a transaction.

The financed premium surcharge considered in this framework is not an isolated phenomenon but rather a specific manifestation of a more general interaction between premium and insured capital. If the economic effect of premium adjustments is transmitted into the financing transaction, premium and insured capital become mutually dependent quantities. Such situations arise in practice whenever premium adjustments affect the outstanding insured capital of the financing transaction. Premium surcharges may be financed and capitalised into the insured credit amount, while premium refunds may be used to further reduce outstanding insured capital. In both cases, the premium adjustment no longer represents merely a consequence of the insured capital but becomes one of its determinants.

As a result, the relationship between premium and insured capital becomes bidirectional. Changes in insured capital generate premium adjustments, while premium adjustments may simultaneously affect the insured capital through the financing transaction. The resulting feedback mechanism creates a sequence of successive premium and capital adjustments that converges towards a unique limit. Although the interaction appears recursive in nature, its mathematical solution can be characterised through two economic consistency requirements. First, the interaction should not alter the intrinsic risk characteristics of the underlying export transaction. Second, any modification of the insured capital must be economically consistent with the premium adjustment transmitted into the financing transaction.

The objective of this paper is to establish a unified framework for modelling premium-capital interactions. To this end, we formulate the general interaction problem and derive a closed-form solution that directly determines the converged premium adjustment and the corresponding converged cover profile. A key result of the analysis is that the framework is universally applicable to different business interpretations of the interaction. Premium capitalisation, or equivalently premium financing, and premium decapitalisation are shown to represent different manifestations of the same underlying mathematical structure.

The remainder of this paper is organised as follows. Sec. 2 briefly revisits the key concepts of SERV's pricing framework for insurance policy modifications and introduces the notion of the specific risk premium. Next, Sec. 3 develops the general framework for premium-capital interactions and discusses its interpretation in the context of premium capitalisation and decapitalisation. Sec. 4 presents illustrative numerical examples and the paper is concluded in Sec. 5. The mathematical derivation of the premium-capital interaction formulas is provided in the Appendix.

2 Pricing Framework

2.1 Basics

Before introducing premium-capital interactions, we briefly revisit the key concepts of export credit insurance pricing that are required for the remainder of this paper. Figure 1 illustrates the three complementary perspectives underlying the pricing framework using a buyer-credit structure as an example.

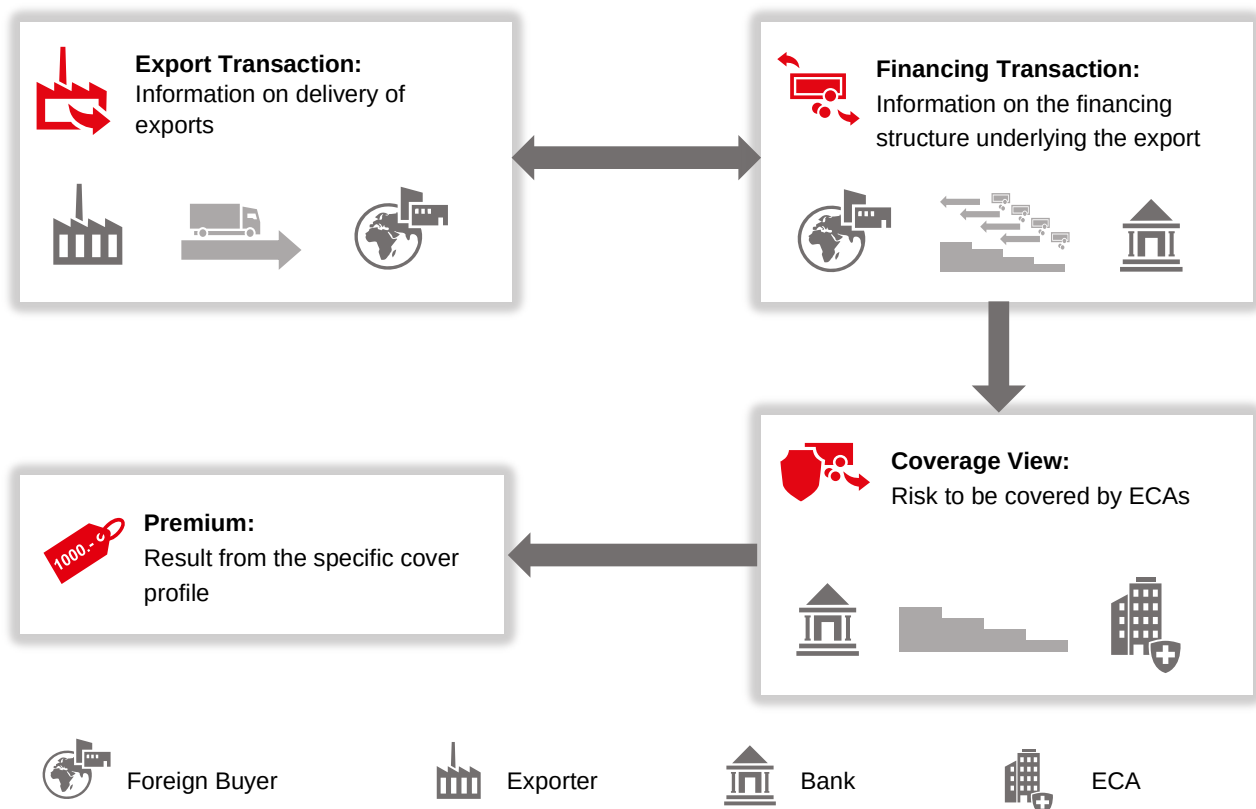


Figure 1: Three complementary perspectives of export credit insurance pricing, illustrated for a buyer-credit structure as an example.

- **Export Transaction:** The export transaction describes the underlying commercial relationship between the exporter and the foreign buyer. The exporter delivers goods or services to the foreign buyer and receives the corresponding purchase price. The characteristics of this transaction, including the exported goods or services, contractual arrangements, involved countries and counterparties, determine the intrinsic political and commercial risk profile of the insured business. Cash flows in this perspective are the commercial payment flows between the foreign buyer and the exporter.

- **Financing Transaction:** The financing transaction describes how the export transaction is financed. Depending on the insurance product, the borrower or debtor under the financing transaction may be the exporter, the foreign buyer, or a financial institution acting on behalf of the foreign buyer. In the buyer-credit example shown in Figure 1, the foreign buyer acts as borrower and receives financing from a financing institution. More generally, the financing transaction determines the evolution of the outstanding insured amount over time and can therefore be represented by a financing profile. Cash flows in this perspective include disbursements, repayments and, where applicable, adjustments of the outstanding insured credit amount.
- **Coverage View:** The coverage view describes the insurance relationship between the ECA and the policyholder. Depending on the product structure, the policyholder may be the exporter or a financing institution. In the buyer-credit example shown in Figure 1, the financing institution acts as policyholder and the ECA covers its credit exposure to the foreign buyer. More generally, the ECA insures a defined portion of the relevant credit exposure, determined by the applicable cover ratio. The resulting cover profile represents the insured part of the financing profile and quantifies the credit risk assumed by the ECA throughout the lifetime of the policy. Cash flows in this perspective are the insurance premium cash flows between the policyholder and the ECA.

The premium is therefore determined from the combination of the intrinsic risk characteristics of the export transaction and the insured exposure represented by the cover profile. Importantly, the financing transaction and the coverage view may be economically connected through the policyholder, the financing institution, or an assignment/refinancing arrangement. In the illustrative structure shown in Figure 1, the exporter delivers goods or services to the foreign buyer, while the foreign buyer obtains financing from a financing institution. The ECA cover relates to the credit exposure arising from this financing transaction, with the financing institution acting as policyholder.

2.2 Insurance Policy Modifications

Once an insurance policy has become effective, amendments to the export transaction may require modifications of the insurance contract. Such modifications may originate from changes in any of the three perspectives introduced above. Examples include:

- modifications of the financing structure,
- changes in repayment schedules,
- increases or reductions of insured amounts,
- changes in cover ratios,
- early repayments or premature termination of the insured financing.

Regardless of their origin, these amendments ultimately manifest themselves through a modification of the insured cover profile $CP(t)$.

The framework presented in Ref. [1] demonstrated that the pricing of such modifications can be reduced to the pricing of the corresponding change in covered credit risk. Central to this framework is the concept of the specific risk premium SRP , defined as the ratio between risk premium RP and cover profile area A :

$$SRP = \frac{RP}{A} = \frac{RP}{\int_{t=-\infty}^{\infty} CP(t) \cdot dt}.$$

The specific risk premium can be interpreted as a premium density that quantifies the compensation required by the insurer per unit of insured credit risk. Its importance stems from the observation that policy modifications generally alter the magnitude of the insured credit risk but do not necessarily alter the intrinsic characteristics of the underlying risk. If the risk assessment of the insured transaction remains unchanged, the specific risk premium remains invariant under the modification. This invariance property provides a consistent and economically intuitive mechanism for determining premium adjustments associated with modifications of active insurance policies.

Under the assumption of an unchanged specific risk premium, the change in risk premium ΔRP associated with any modification at time t_m is given by [1]

$$\Delta RP = SRP \cdot \int_{t=-\infty}^{\infty} [\widetilde{CP}(t) - CP(t)] \cdot dt = SRP \cdot \int_{t=t_m}^{\infty} [\widetilde{CP}(t) - CP(t)] \cdot dt.$$

Here, $\widetilde{CP}(t)$ and $CP(t)$ denote the modified and initial cover profiles, respectively, and SRP is the specific risk premium of the transaction.

It follows from the above equation that a premium surcharge arises whenever the modification increases the insured capital, while a premium refund arises whenever the modification reduces the insured capital. The corresponding total premium adjustment is subsequently obtained by including the applicable administrative premium component³ [2].

The framework described above determines the premium adjustment associated with a given modification of the insured capital. In doing so, the premium adjustment and the modified insured capital are treated as separate quantities. In practice, however, the economic effect of a premium adjustment may be transmitted into the underlying financing transaction. In these situations, the premium adjustment modifies the insured capital that gave rise to it, creating an interaction between premium and insured capital. The characterisation of this interaction is the subject of the following section.

3 Premium-Capital Interactions

3.1 Premium-Capital Interaction Framework

Consider a modification of an active insurance policy that generates a premium adjustment ΔP . This adjustment is settled as a cash flow in the coverage view between the policyholder and the ECA. Its economic effect, however, may simultaneously be transmitted into the financing transaction and thereby modify the insured capital. For example, a premium surcharge may be financed and capitalised into the insured credit amount, while a premium refund may be used to further reduce the outstanding insured capital. In both situations, the premium adjustment remains a cash flow within the coverage relationship while simultaneously affecting the financing transaction. Consequently, premium and insured capital become mutually dependent quantities, as illustrated in Figure 2.

³ In the following, the auxiliary variable $PF = \Delta RP / \Delta P$ is used to link the total premium and the risk premium across all classes of modifications. For premium surcharges ($\Delta P > 0$), it holds that $PF = \omega = 0.8$, while for premium refunds ($\Delta P < 0$) one has $PF = 1/\Omega = 1.25$.

To illustrate this mechanism, consider a policy amendment that results in an additional premium surcharge. The surcharge is paid by the policyholder to the ECA in the coverage view. If the financing transaction is amended such that this amount is capitalised into the insured credit amount, the financing profile increases. Since the cover profile is derived from the financing profile, the insured capital increases accordingly. This increase in insured capital generates an additional premium surcharge, which may again be capitalised. The process therefore repeats recursively.

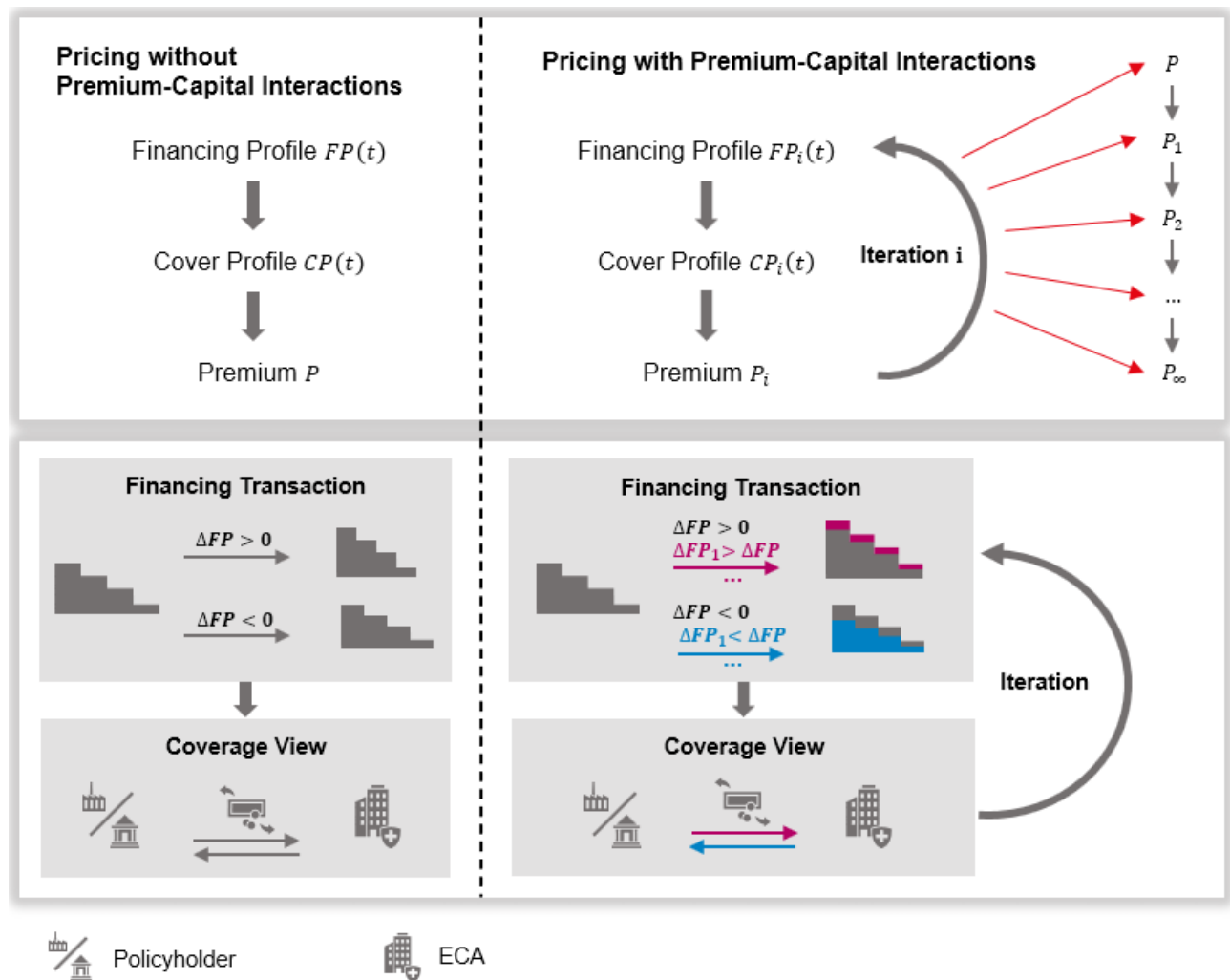


Figure 2: Premium adjustments are determined by changes in insured capital and settled via cash in the coverage view between policyholder and ECA, as shown on the left. Alternatively, as depicted on the right, premium-capital interactions arise when the economic effect of these premium adjustments is transmitted into the financing transaction and thereby modifies the insured capital itself. The resulting recursive interaction converges to a unique limit for both the premium adjustment and the cover profile.

An analogous mechanism arises in the opposite direction. A risk-reducing modification generates a premium refund, which is paid by the ECA to the policyholder in the coverage view. If this refund is used to reduce the outstanding insured credit amount, the resulting reduction in insured capital generates an additional premium refund. This refund can again be used to reduce the insured amount and the process continues recursively.

Although these two situations differ substantially from a business perspective, they share the same structural characteristic: premium and insured capital interact with each other through a feedback mechanism between the coverage view and the financing transaction. The resulting interaction can be viewed as an infinite sequence of successively smaller premium and capital adjustments. Since every additional adjustment is proportional to the previous one, the process converges towards a unique limit. The quantities of practical interest are therefore not the individual intermediate iterations but rather the converged premium adjustment and the corresponding converged cover profile.

In the following, we denote by ΔP the premium adjustment resulting from an insurance policy modification in the absence of premium-capital interactions and by $\widetilde{CP}(t)$ the corresponding modified cover profile. Further, let the converged premium change and converged modified cover profile be represented by ΔP_∞ and $\widetilde{CP}_\infty(t)$. The objective is to determine the two converged quantities without explicitly modelling every iteration of the interaction process. To obtain a mathematically unique solution, two economically motivated consistency requirements are introduced.

First, the interaction between premium and insured capital should not alter the intrinsic risk characteristics of the underlying export transaction. The political, commercial and structural risks associated with the transaction remain unchanged irrespective of whether premium adjustments are settled only in the coverage view, financed and capitalised through the financing transaction, or used to reduce outstanding insured capital. Consequently, the specific risk premium introduced in the previous section must remain invariant under the interaction process.

Second, the modification of the financing and cover profile must be economically consistent with the premium adjustment that generated it. In other words, the increase or decrease of the insured capital caused by the interaction must exactly correspond to the premium amount whose economic effect is transmitted into the financing transaction.

Under these assumptions, the converged premium adjustment and the converged cover profile are given by:

$$\Delta P_\infty = \frac{1}{1 - \frac{\mu \cdot SRP \cdot \int_{t=t_m}^{\infty} \widetilde{CP}(t) \cdot dt}{PF \cdot \max(\widetilde{CP}(t \geq t_m))}} \cdot \Delta P,$$

and

$$\widetilde{CP}_\infty(t \geq t_m) = \left[1 + \frac{\mu \cdot \Delta P}{\max(\widetilde{CP}(t \geq t_m))} \cdot \frac{1}{1 - \frac{\mu \cdot SRP \cdot \int_{t=t_m}^{\infty} \widetilde{CP}(t) \cdot dt}{PF \cdot \max(\widetilde{CP}(t \geq t_m))}} \right] \cdot \widetilde{CP}(t \geq t_m).$$

The derivation of these formulas is deferred to the Appendix.

An important observation is that the above formulas are independent of the specific business interpretation of the interaction. They therefore provide a universal description of premium-capital interactions for insurance policy modifications. Whether the premium adjustment is a surcharge or a refund that is capitalised or decapitalised only affects the interpretation of the resulting quantities, while the mathematical structure remains unchanged.

3.2 Business Interpretations

The formulas derived in the previous section provide a universal description of premium-capital interactions. Their applicability is not restricted to a specific type of insurance policy amendment but extends to any situation in which premium adjustments modify the insured capital itself.

In the following, two common business scenarios are considered. Although their economic interpretation differs substantially, both are governed by the same mathematical framework.

3.2.1 Capitalisation of Premium Surcharges

Consider an insurance policy amendment that increases the insured capital $\int_{t=t_m}^{\infty} \widetilde{CP}(t) > \int_{t=t_m}^{\infty} CP(t)$. Typical examples include increases in cover ratios, extensions of repayment periods, or increases of the insured credit amount. According to the pricing framework for modifications, such modifications generate an additional premium surcharge $\Delta P > 0$. In the standard case, this surcharge is settled as a cash payment from the policyholder to the ECA and does not affect the financing transaction. In practice, however, an alternative treatment may be desired. Although the surcharge is paid to the ECA in the coverage view, the financing transaction may be amended such that the premium amount is capitalised into the outstanding insured credit amount. Consequently, the financing profile increases, and the cover profile is adjusted accordingly. Since the cover profile determines the insured capital, the increase of insured capital generates an additional premium surcharge. This additional surcharge may again be capitalised, leading to a further increase of the insured amount. The process continues recursively until convergence is reached.

Using the model developed in this paper, the converged premium surcharge and the corresponding cover profile are obtained directly from the general interaction formulas. For the case of a premium surcharge (*i.e.* $PF = \omega$), it holds that

$$\Delta P_{\infty} = \frac{1}{1 - \frac{\mu \cdot SRP \cdot \int_{t=t_m}^{\infty} \widetilde{CP}(t) \cdot dt}{\omega \cdot \max(\widetilde{CP}(t \geq t_m))}} \cdot \Delta P > \Delta P ,$$

$$\widetilde{CP}_{\infty}(t \geq t_m) = \left[1 + \frac{\mu \cdot \Delta P}{\max(\widetilde{CP}(t \geq t_m))} \cdot \frac{1}{1 - \frac{\mu \cdot SRP \cdot \int_{t=t_m}^{\infty} \widetilde{CP}(t) \cdot dt}{\omega \cdot \max(\widetilde{CP}(t \geq t_m))}} \right] \cdot \widetilde{CP}(t \geq t_m) > \widetilde{CP}(t \geq t_m) .$$

The above expressions quantify the total premium surcharge and the corresponding increase of insured capital after all recursive interaction effects have been considered. It is noteworthy that the framework also reproduces the classical problem of premium financing at policy inception. In the limiting case, $t_m \rightarrow -\infty$, where a modification mathematically corresponds to the initial pricing of an insurance policy, the interaction formulas for the converged quantities simplify to the well-established results for financed upfront premiums:

$$P_{\infty} = \frac{1}{1 - PR} \cdot P > P, \quad CP_{\infty}(t) = \frac{1}{1 - PR} \cdot CP(t) > CP(t) ,$$

where PR is the premium rate defined as the total premium divided by the maximum of the financing profile.

3.2.2 Decapitalisation through Premium Refunding

Next, consider a policy modification that reduces the insured capital $\int_{t=t_m}^{\infty} \widetilde{CP}(t) < \int_{t=t_m}^{\infty} CP(t)$. Examples include reductions of cover ratios, early repayments, decreases in insured credit amounts, or premature termination of insured financing. Such modifications generate a premium refund $\Delta P < 0$ according to the pricing framework for modifications. In the standard case, this refund is paid by the ECA to the policyholder and retained by the policyholder. However, an alternative treatment is possible. Instead of retaining the refunded amount, the policyholder may use it to further reduce the outstanding insured credit amount.

In this case, the reduction of insured capital exceeds the reduction originally implied by the policy amendment itself. Since the cover profile decreases further, an additional premium refund is generated. This additional refund may again be used to reduce the insured amount, creating a recursive interaction between premium and insured capital. Although the business interpretation differs fundamentally from the capitalisation scenario discussed above, the mathematical structure remains unchanged. The converged premium refund and the corresponding cover profile are therefore obtained from the same interaction formulas.

For the case of a premium refund (i.e. $PF = 1/\Omega$), it follows that

$$\Delta P_{\infty} = \frac{1}{1 - \frac{\Omega \cdot \mu \cdot SRP \cdot \int_{t=t_m}^{\infty} \widetilde{CP}(t) \cdot dt}{\max(\widetilde{CP}(t \geq t_m))}} \cdot \Delta P < \Delta P,$$

$$\widetilde{CP}_{\infty}(t \geq t_m) = \left[1 + \frac{\mu \cdot \Delta P}{\max(\widetilde{CP}(t \geq t_m))} \cdot \frac{1}{1 - \frac{\Omega \cdot \mu \cdot SRP \cdot \int_{t=t_m}^{\infty} \widetilde{CP}(t) \cdot dt}{\max(\widetilde{CP}(t \geq t_m))}} \right] \cdot \widetilde{CP}(t \geq t_m) < \widetilde{CP}(t \geq t_m).$$

The resulting quantities quantify the total premium refund and the corresponding reduction of insured capital after all recursive interaction effects have been incorporated.

This observation represents one of the central results of the present paper. Premium financing and decapitalisation through premium refunding are commonly regarded as distinct operational processes. From a mathematical perspective, however, both correspond to the same interaction mechanism between premium and insured capital. The difference between the two cases lies in the economic interpretation, in the direction of the premium cash flow in the coverage view, and in the corresponding adjustment of the financing transaction. The governing equations and their solution remain identical. Consequently, capitalisation of premium surcharges and decapitalisation through premium refunding can be treated within a single, mathematically consistent framework. The relationship between these two business processes and the underlying interaction model is summarised in Figure 3.

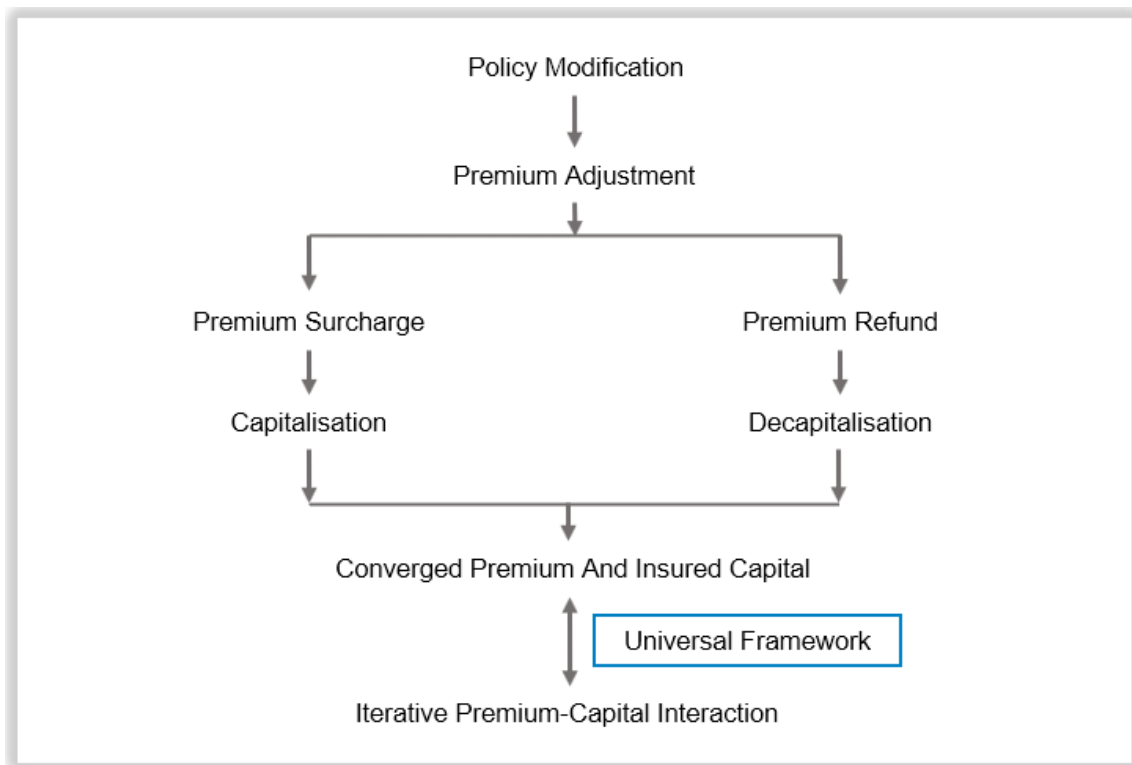


Figure 3: Capitalisation and decapitalisation as different business interpretations of the same premium-capital interaction mechanism.

It is noteworthy that the treatment of premium adjustments should be understood as a choice made for a specific policy state, such as at inception or following a particular modification. Capitalising or decapitalising a premium adjustment in one instance does not, by itself, imply that subsequent premium adjustments must be treated in the same way. Future modifications may again be settled as ordinary premium cash flows, capitalised into the insured credit amount, or used to reduce outstanding insured capital, irrespective of how the previous premium adjustment was settled. The framework therefore applies to each modification state individually and naturally accommodates changes in the treatment of premium adjustments over the lifetime of the policy.

4 Numerical Illustrations

The previous sections established a general framework for premium-capital interactions and demonstrated how both capitalisation and decapitalisation mechanisms can be interpreted within a common mathematical structure. While the resulting formulas provide a complete analytical solution to the interaction problem, it is instructive to study simple examples that illustrate the practical implications of the framework and provide additional intuition regarding the underlying mechanism.

In the following, two stylised examples are considered. The first example demonstrates the capitalisation of a premium surcharge resulting from a cover-profile-area-increasing policy modification. The second example illustrates the decapitalisation of insured capital through recursive premium refunding following a cover-profile-area-reducing modification.

Although the economic interpretation of the two cases differs, both examples are governed by the same interaction formulas derived in Section 3.1 and therefore provide a practical demonstration of the unified nature of the framework.

For simplicity, all quantities are assumed to be dimensionless and the following parameter values are used throughout the examples:

$$\mu = 0.95, \quad SRP = 0.01, \quad t_i = 0, \quad t_m = 4, \quad t_f = 8, \quad \max(CP(t)) = 1'000'000.$$

4.1 Capitalisation of a Premium Surcharge

Consider a policy modification that increases the insured capital by extending the capital coverage period while leaving the level of the cover profile unchanged, $\max(\widetilde{CP}(t \geq t_m)) = \max(CP(t))$, as illustrated in Figure 4. According to the pricing framework introduced in Section 2.2, this modification generates a risk premium surcharge.

Assume that this surcharge is paid to the ECA in the coverage view but capitalised into the insured credit amount through the financing transaction. The economic effect of the premium payment is therefore reflected in the financing structure and increases the insured capital. As discussed previously, this increase in credit amount generates an additional premium surcharge, giving rise to the premium-capital interaction mechanism.

Based on the parameter values introduced above, the policy modification generates the following premium surcharge when premium-capital interactions are ignored:

$$\Delta P = \frac{SRP \cdot \int_{t=t_m}^{\infty} [\widetilde{CP}(t) - CP(t)] \cdot dt}{\omega} = \frac{0.01 \cdot [(8 - 4) \cdot (1'000'000 - 0)]}{0.8} = 50'000.$$

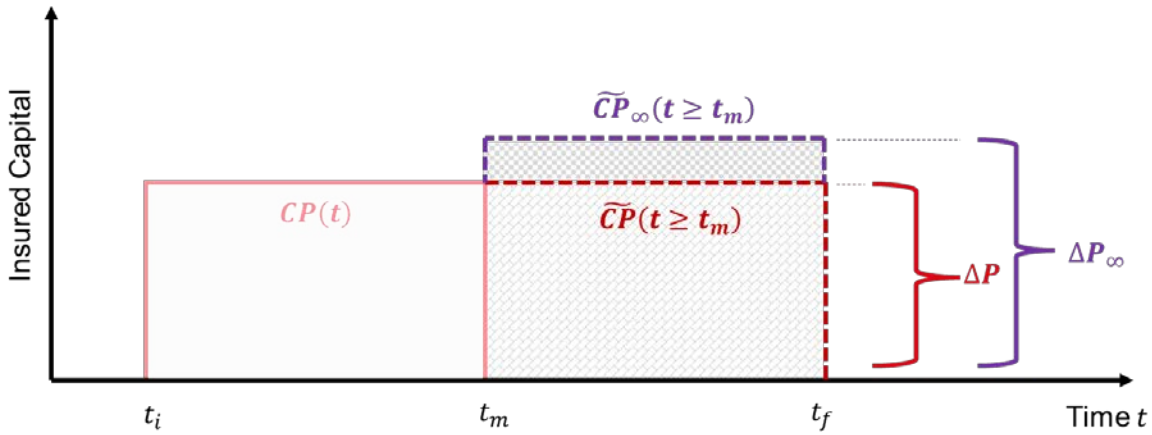


Figure 4: Visualisation of the cover profile before the modification (CP), after the modification without premium-capital interactions ($\widetilde{CP}$), and after convergence with premium-capital interactions ($\widetilde{CP}_\infty$). The additional cover profile areas reflect the increase in insured capital caused first by the policy modification itself (ΔP) and subsequently by the financing of the premium surcharge (ΔP_∞) through the financing transaction.

Applying the interaction framework developed in Section 3.1 yields the following converged premium surcharge after capitalisation:

$$\Delta P_\infty = \frac{1}{1 - \frac{\mu \cdot SRP \cdot \int_{t=t_m}^{\infty} \widetilde{CP}(t) \cdot dt}{\omega \cdot \max(\widetilde{CP}(t \geq t_m))}} \cdot \Delta P = \frac{1}{1 - \frac{0.95 \cdot 0.01 \cdot 4'000'000}{0.8 \cdot 1'000'000}} \cdot 50'000 = 52'493.$$

The capitalisation mechanism increases the effective premium surcharge beyond the amount directly implied by the policy modification. The difference corresponds to the additional premium generated because the surcharge paid in the coverage view is capitalised into the insured credit amount and thereby increases the insured capital. This reflects the recursive nature of the premium-capital interaction.

The resulting cover profile after incorporating all interaction effects is given by

$$\begin{aligned} \widetilde{CP}_\infty(t \geq t_m) &= \left[1 + \frac{\mu \cdot \Delta P}{\max(\widetilde{CP}(t \geq t_m))} \cdot \frac{1}{1 - \frac{\mu \cdot SRP \cdot \int_{t=t_m}^{\infty} \widetilde{CP}(t) \cdot dt}{\omega \cdot \max(\widetilde{CP}(t \geq t_m))}} \right] \cdot \widetilde{CP}(t \geq t_m) \\ &= \left[1 + \frac{0.95 \cdot 50'000}{1'000'000} \cdot \frac{1}{1 - \frac{0.95 \cdot 0.01 \cdot 4'000'000}{0.8 \cdot 1'000'000}} \right] \cdot \widetilde{CP}(t \geq t_m) = 1.052 \cdot \widetilde{CP}(t \geq t_m). \end{aligned}$$

Compared with the modification in isolation, the capitalisation of the premium surcharge leads to an additional increase of insured capital. Both the premium and the insured capital therefore converge to levels above those implied by the original modification alone.

Finally, we verify that the specific risk premium remains unchanged after incorporating the premium-capital interactions:

$$SRP_{\infty} = \frac{SRP \cdot \int_{t=t_m}^{\infty} CP(t) \cdot dt + \omega \cdot \Delta P_{\infty}}{\int_{t=t_m}^{\infty} \widetilde{CP}_{\infty} \cdot dt} = \frac{0.01 \cdot (8 - 4) \cdot 0 + 0.8 \cdot 52'493}{(8 - 4) \cdot 1'049'900} = 0.01 = SRP.$$

As expected, capitalising the premium surcharge alters the magnitude of the insured capital but does not affect the intrinsic risk characteristics of the underlying export transaction. The specific risk premium therefore remains invariant.

4.2 Decapitalisation through Premium Refunding

Next, Figure 5 depicts a policy modification that reduces the insured capital by halving the covered capital, $\max(\widetilde{CP}(t \geq t_m)) = 500'000$, and thereby reducing the cover profile area. In the absence of premium-capital interactions, this modification generates a premium refund according to the pricing framework for insurance policy amendments. The refund is paid by the ECA to the policyholder in the coverage view. Instead of retaining the refunded amount, however, we assume that it is used to further reduce the outstanding insured credit amount.

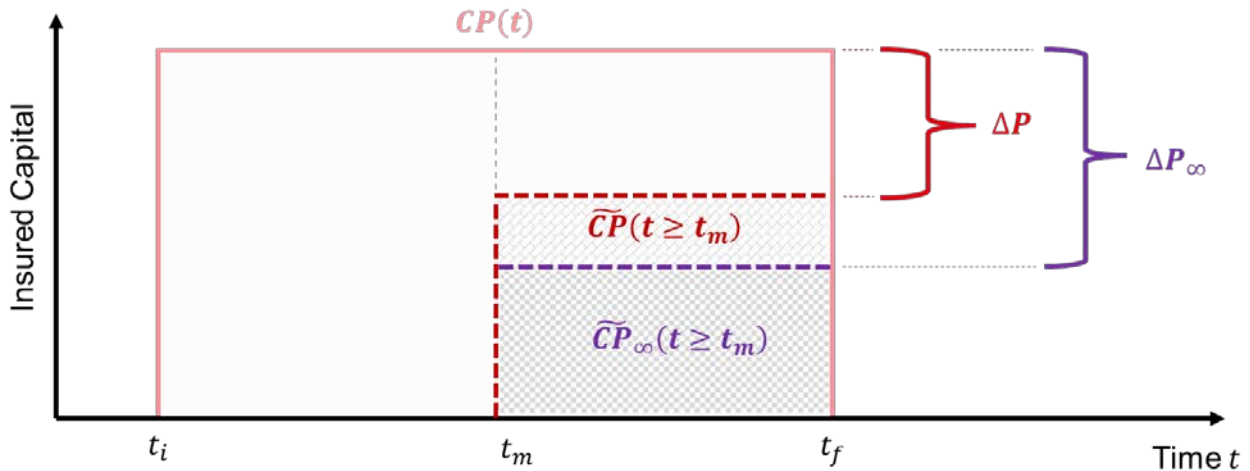


Figure 5: Visualisation of the cover profile before the modification (CP), after the modification without premium-capital interactions ($\widetilde{CP}$), and after convergence with premium-capital interactions ($\widetilde{CP}_{\infty}$). The reduced cover profile areas reflect the decrease in insured capital caused first by the policy modification itself (ΔP) and subsequently by the decapitalisation of the premium refunding (ΔP_{∞}) through the financing transaction.

Consequently, the reduction of insured capital becomes larger than originally implied by the policy modification itself. The additional reduction generates a further premium refund, which again may be used to reduce the insured capital. The process therefore represents the decapitalisation counterpart of the premium-capitalisation example discussed above.

Based on the parameter values introduced above, the policy modification generates the following premium refund when premium-capital interactions are ignored:

$$\Delta P = \Omega \cdot SRP \cdot \int_{t=t_m}^{\infty} [\widetilde{CP}(t) - CP(t)] \cdot dt = 0.8 \cdot 0.01 \cdot [(8 - 4) \cdot (500'000 - 1'000'000)] = -16'000.$$

Applying the interaction framework developed in Section 3.1 yields the following converged premium refund after decapitalisation:

$$\Delta P_{\infty} = \frac{1}{1 - \frac{\Omega \cdot \mu \cdot SRP \cdot \int_{t=t_m}^{\infty} \widetilde{CP}(t) \cdot dt}{\max(\widetilde{CP}(t \geq t_m))}} \cdot \Delta P = \frac{-1}{1 - \frac{0.8 \cdot 0.95 \cdot 0.01 \cdot 4'000'000}{500'000}} \cdot 16'000 = -16'501.$$

The decapitalisation mechanism increases the total premium refund relative to the original modification. This additional refund arises because every reduction of insured capital generates a further reduction in premium, which in turn can be applied to further reduce the outstanding insured capital.

The resulting cover profile after incorporating all interaction effects is given by

$$\begin{aligned} \widetilde{CP}_{\infty}(t \geq t_m) &= \left[1 + \frac{\mu \cdot \Delta P}{\max(\widetilde{CP}(t \geq t_m))} \cdot \frac{1}{1 - \frac{\mu \cdot SRP \cdot \int_{t=t_m}^{\infty} \widetilde{CP}(t) \cdot dt}{\omega \cdot \max(\widetilde{CP}(t \geq t_m))}} \right] \cdot \widetilde{CP}(t \geq t_m) \\ &= \left[1 - \frac{0.95 \cdot 16'000}{1'000'000} \cdot \frac{1}{1 - \frac{0.8 \cdot 0.95 \cdot 0.01 \cdot 4'000'000}{500'000}} \right] \cdot \widetilde{CP}(t \geq t_m) = 0.9687 \cdot \widetilde{CP}(t \geq t_m). \end{aligned}$$

Consequently, the final reduction of insured capital exceeds the reduction directly implied by the policy modification itself. The interaction therefore amplifies the economic effect of the original refund.

Again, the specific risk premium remains unchanged. Although the insured capital is reduced further through decapitalisation, the intrinsic risk characteristics of the transaction are unaffected and the consistency condition underlying the framework continues to hold:

$$SRP_{\infty} = \frac{SRP \cdot \int_{t=t_m}^{\infty} CP(t) \cdot dt + \frac{\Delta P_{\infty}}{\Omega}}{\int_{t=t_m}^{\infty} \widetilde{CP}_{\infty} \cdot dt} = \frac{0.01 \cdot (8 - 4) \cdot 1'000'000 - \frac{16'501}{0.8}}{(8 - 4) \cdot 484'300} = 0.01 = SRP.$$

The two examples demonstrate how capitalisation and decapitalisation mechanisms can be analysed within a common framework despite their differing economic interpretations. In both cases, premium cash flows arise in the coverage view between policyholder and ECA, while their economic effect is transmitted into the financing transaction and modifies the insured capital. The interaction between premium and insured capital changes the original premium adjustment and the corresponding cover profile while preserving the specific risk premium of the underlying transaction. The numerical illustrations therefore confirm both the practical applicability and the internal consistency of the proposed framework.

5 Conclusion and Outlook

In this paper, we investigated situations in which the economic effect of premium adjustments resulting from insurance policy modifications is transmitted into the underlying financing transaction and thereby modifies the insured capital underlying the policy. Such situations arise whenever premium surcharges paid to the ECA are capitalised into the insured credit amount or when premium refunds paid by the ECA are applied to further reduce insured capital. While these business processes appear substantially different from an operational perspective, they share a common structural characteristic: premium and insured capital become mutually dependent quantities. This interaction creates a recursive process in which changes in premium affect the insured capital and vice versa.

Building upon SERV's previously published framework for pricing insurance policy modifications, we demonstrated that these interactions can be characterised through a general mathematical framework based on the invariance of the specific risk premium and the economic consistency between premium adjustments and capital adjustments. Under these assumptions, a unique analytical solution exists that directly determines the converged premium and cover profile without requiring an explicit modelling of the underlying recursive process.

A key finding of this work is that capitalisation, i.e. the financing of premium surcharges, and decapitalisation through premium refunding are not distinct mathematical problems. Rather, they represent different business interpretations of the same premium-capital interaction mechanism. The resulting framework therefore provides a unified treatment of capitalisation and decapitalisation processes within export credit insurance.

More generally, the framework illustrates how the concept of the specific risk premium, originally introduced for the pricing of insurance policy modifications, can be extended beyond pricing itself and used as a fundamental consistency condition for modelling interactions between premium and insured capital. We believe that this perspective provides a useful foundation for future developments in export credit insurance pricing and demonstrates how pricing concepts can be extended beyond premium determination towards the consistent modelling of interactions between premiums and insured capital.

Appendix

Derivation of the premium-capital interaction formula

In this section, the formula universally characterising the interactions between the premium and the capital from Sec. 3.1 is derived. To this end, two scaling factors α and β are introduced to express the two unknown variables, the converged premium change ΔP_∞ and the modified cover profile $\widetilde{CP}_\infty(t \geq t_m)$, in terms of their known “raw” counterparts excluding interactions:

$$\begin{aligned}\Delta P_\infty &= \alpha \cdot \Delta P, \\ \widetilde{CP}_\infty(t \geq t_m) &= \beta \cdot \widetilde{CP}(t \geq t_m).\end{aligned}$$

This yields a two-dimensional system of equations that requires two independent consistency conditions for a mathematically unique solution. First, by definition, the change in the total credit amount must be equal to the total change in premium used to modify the financing and cover profile:

$$\max(\widetilde{CP}_\infty(t \geq t_m)) = \max(\widetilde{CP}(t \geq t_m)) + \mu \cdot \Delta P_\infty.$$

Next, the mutual interaction between the insured capital and the premium change should not change the intrinsic risks of the underlying export transaction that are encoded in the specific risk premium. In other words, it holds that

$$SRP_\infty = \frac{SRP \cdot \int_{t=t_m}^{\infty} CP(t) \cdot dt + PF \cdot \Delta P_\infty}{\int_{t=t_m}^{\infty} \widetilde{CP}_\infty(t) \cdot dt} = SRP.$$

Given these two consistency conditions, the solution is derived as follows. First, the two equations are expressed in terms of the above-introduced scaling factors

$$\begin{aligned}\max(\beta \cdot \widetilde{CP}(t \geq t_m)) &= \max(\widetilde{CP}(t \geq t_m)) + \mu \cdot \alpha \cdot \Delta P, \\ SRP \cdot \beta \cdot \int_{t=t_m}^{\infty} \widetilde{CP}(t) \cdot dt &= SRP \cdot \int_{t=t_m}^{\infty} CP(t) \cdot dt + PF \cdot \alpha \cdot \Delta P.\end{aligned}$$

Next, we isolate both equations for β

$$\begin{aligned}\beta &= 1 + \frac{\mu \cdot \alpha \cdot \Delta P}{\max(\widetilde{CP}(t \geq t_m))}, \\ \beta &= \frac{SRP \cdot \int_{t=t_m}^{\infty} CP(t) \cdot dt + PF \cdot \alpha \cdot \Delta P}{SRP \cdot \int_{t=t_m}^{\infty} \widetilde{CP}(t) \cdot dt},\end{aligned}$$

which, using the formula for the pricing of modifications from Sec. 2.2, leads to the following expression for α

$$\alpha = \frac{1}{1 - \frac{\mu \cdot SRP \cdot \int_{t=t_m}^{\infty} \widetilde{CP}(t) \cdot dt}{PF \cdot \max(\widetilde{CP}(t \geq t_m))}},$$

that in turn implies

$$\beta = 1 + \frac{\mu \cdot \Delta P}{\max(\widetilde{CP}(t \geq t_m))} \cdot \frac{1}{1 - \frac{\mu \cdot SRP \cdot \int_{t=t_m}^{\infty} \widetilde{CP}(t) \cdot dt}{PF \cdot \max(\widetilde{CP}(t \geq t_m))}}.$$

Combining these results, under the assumption that the specific risk premium remains invariant, we arrive at the following formulas describing the premium-capital interactions for any modification of an insurance policy

$$\Delta P_{\infty} = \frac{1}{1 - \frac{\mu \cdot SRP \cdot \int_{t=t_m}^{\infty} \widetilde{CP}(t) \cdot dt}{PF \cdot \max(\widetilde{CP}(t \geq t_m))}} \cdot \Delta P,$$

$$\widetilde{CP}_{\infty}(t \geq t_m) = \left[1 + \frac{\mu \cdot \Delta P}{\max(\widetilde{CP}(t \geq t_m))} \cdot \frac{1}{1 - \frac{\mu \cdot SRP \cdot \int_{t=t_m}^{\infty} \widetilde{CP}(t) \cdot dt}{PF \cdot \max(\widetilde{CP}(t \geq t_m))}} \right] \cdot \widetilde{CP}(t \geq t_m).$$

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