Margins in Medical Claim Liabilities under Future Accounting Models

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Abstract

In 2007 the International Accounting Standards Board (IASB) released a discussion paper proposing a new accounting model for insurance contracts, known as the current exit value model. One aspect of the proposed accounting model is that claim liabilities would need to include explicit margins satisfying certain criteria. Currently it is common for U.S. medical insurers to include explicit margins in their claim liabilities. However, we demonstrate that the margin approach most commonly used today by U.S. medical insurers does not satisfy the objectives articulated in the IASB discussion paper regarding the role of margins. We then propose a new formula for including explicit margins in U.S. medical insurance claim liabilities in a manner that is more compatible with the principles articulated in the IASB discussion paper. Finally, we illustrate our proposed claim liability formula using an example drawn from real-life data.

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1 Introduction

In May 2007 the International Accounting Standards Board (IASB) issued a discussion paper entitled *Preliminary Views on Insurance Contracts* (IASB 2007), in which a new accounting model for insurance contracts is proposed. In a previous article (Bell 2007), we presented an overview aimed at U.S. health actuaries of the IASB discussion paper's proposed accounting model.

In that article we noted that a number of aspects of the proposed accounting model clearly warrant additional analysis and discussion within the U.S. health actuarial community. The purpose of the current paper is to contribute to one specific facet of that discussion, namely, the issue of how one would calculate margins in claim liabilities for U.S. medical insurance products in a manner consistent with the overall approach to margins outlined in the IASB discussion paper.[1]

This paper starts in Section 2 by assembling a significant amount of background material, covering not only the IASB discussion paper but also the U.S. medical insurance industry and current claim liability estimation practices therein. In Section 3 we discuss issues relating to margins in claim liabilities for U.S. medical insurance products under the IASB discussion paper accounting model, culminating in the development of a proposed new liability formula. In Section 4 we illustrate our proposed liability formula via an extended example, including the use of real-life data to estimate some of the parameters needed in our formula. Finally, we conclude the paper in Section 5 with a brief summary discussion.

2 Background

This section is intended to provide sufficient background so as to make the remainder of the paper accessible to two distinct audiences: U.S. health actuaries who may not be particularly familiar with the IASB discussion paper, and other parties interested in the IASB discussion paper but who may not be particularly familiar with the U.S. medical insurance market and current claim liability estimation practices within that market.

2.1 Current Exit Value Accounting Model

This subsection provides a brief introduction to the IASB discussion paper accounting model, as it pertains to the estimation of claim liabilities in general, and to the margins contained in such

[1] In the United States, the term *health insurance* is often used as a synonym for medical insurance, and companies whose main product is medical insurance are generally referred to as health insurers rather than medical insurers. However, health insurance is also often used to refer more generally to a broader variety of insurance coverages for which morbidity is the primary risk. Because this article is intended to narrowly focus on medical insurance, rather than other types of health insurance, for purposes of clarity we will generally use the terms *medical insurance* and *medical insurers.* Note that medical insurance is very different from medical malpractice insurance, a common type of liability insurance coverage found in the U.S.; this article does not address medical malpractice insurance.

liabilities in particular. For a broader introduction to this subject aimed at U.S. health actuaries, see Bell (2007).

The IASB discussion paper proposes an accounting model referred to as current exit value (CXV). CXV is defined by IASB as the amount that an insurer would expect to pay at the reporting date to transfer its remaining contractual rights and obligations immediately to another entity. Although the IASB currently believes that CXV is the best measurement attribute for an insurer's claim liabilities, it recognizes that in practice an active market does not exist among insurers in which claim liabilities are traded. Consequently, because one cannot observe the CXV of a claim liability by reference to market transactions, one needs to estimate the CXV of a claim liability via actuarial models.

The IASB discussion paper asserts that an estimate of the CXV of a claim liability should be viewed as assembled from three building blocks: first, an explicit and unbiased estimate of future cash flows; second, an adjustment reflecting the time value of money; and third, an explicit margin for the service of bearing risk and/or other services provided by the insurer.

For the purposes of this paper, we are intentionally focusing only on the third building block as it pertains to claim liabilities for U.S. medical products. As such, this paper is intended to shed light on the following question: Assuming that a U.S. medical insurer has developed a preliminary claim liability estimate consistent with the first two CXV building blocks, how might the insurer determine the explicit margin to be added to that preliminary liability estimate?[2]

To address this question properly, it is important to first understand the intended function of the explicit margin in the CXV accounting model.

As alluded to above, the IASB discussion paper suggests that an insurance liability may need to include two distinct types of explicit margins, known as risk margins and service margins. Many parties, including the American Academy of Actuaries and the International Actuarial Association, have suggested to IASB that the distinction between risk margins and service margins is somewhat artificial and not particularly meaningful (see AAA 2007, p. 7; IAA 2007b, p. 8). However, our belief is that U.S. medical insurance is an example of a product for which IASB's attempt to distinguish between risk margins and service margins is legitimate; this will be discussed at greater length below. Consequently, in this paper we will be pedantic about distinguishing between risk margins and service margins and will use the more generic term "margins" only in situations in which we are referring to both types of explicit margins.

The viewpoint articulated in the IASB discussion paper is that the risk margin represents the insurer's compensation for bearing risk, and that it is necessary to include an explicit risk margin

[2] Although this is an important implementation issue for U.S. medical insurers with respect to the CXV model, it is by no means the only such important issue. In Bell (2007) we outlined a number of other issues that may need to be considered regarding claim liability estimation for U.S. medical insurance products, apart from the margin question considered herein. In addition, the actuarial community would benefit from further analysis of approaches to what the IASB discussion paper refers to as pre-claims liabilities (i.e., contract reserves and/or unearned premium reserves) for U.S. health insurance products.

in the measurement of an insurance liability to properly distinguish between a liability whose future cash flows are certain and one whose future cash flows are uncertain. Furthermore, in keeping with the CXV concept, IASB asserts that the risk margin included in the CXV liability estimate should represent an explicit and unbiased estimate of the margin that market participants require for bearing risk.

The IASB discussion paper does not prescribe specific techniques for how one would develop risk margins in practice. Indeed, IASB suggests in Appendix F of the discussion paper that multiple risk margin techniques may be acceptable, and no single technique is likely to be preferable in all circumstances. Much of the recent actuarial literature on potential risk margin techniques has focused on a particular family of techniques known as the cost of capital method (e.g., see EY 2007; IAA 2007a, Section 6.9).

An important aspect of the discussion paper's concept of risk margins is the need for a concrete link between the magnitude of the explicit margin included in the liability and the market price of risk. The discussion paper notes that, in general, only one point in time exists at which one can observe the market price of an insurance liability, namely, at the inception of the contract by reference to the premium charged by the insurer to assume the insurance risk. As such, IASB views the expected profit margin included in the premiums charged by the insurer as a relevant consideration in determining the level of explicit margin that the insurer should include in the insurance liability at the inception of the contract.

The discussion paper articulates two potential views, referred to as Implementations A and B, as to what role the actual premiums should play in calibrating the insurer's estimate of the initial risk margin. Under Implementation A, the initial risk margin would be a direct function of the premium, except perhaps in situations in which the insurer intentionally priced the product to include a lower profit margin than other market participants would demand. Implementation A would imply that the insurer would never recognize any profit immediately upon issuance of a contract. Instead, all potential profit associated with the contract would be recognized over time, via the release of the initially established risk margins as the insurer's exposure to the risks of the insurance contract declines over time. In the situation in which the insurer's pricing knowingly includes a lower profit margin than what other market participants would demand for the same risk, the initial risk margin would need to be based on the market price of risk rather than on the insurer's actual pricing; this could lead to the recognition of a loss at issue.

Under the alternative Implementation B, the insurer would use the actual premium level as a reasonableness check on the initial risk margin level. However, the insurer would not be obligated to directly link the initial risk margin to actual premiums, if evidence existed to support the insurer's contention that other market participants would require less compensation for bearing risk than what the insurer was able to obtain via its actual premiums. This approach would allow an insurer to recognize some portion of the contract's potential profit immediately at the time of issue, for example, in a situation in which the insurer possesses some form of competitive advantage allowing it to extract greater profitability from its products than other market participants could achieve.

Although IASB concluded in the discussion paper that Implementation B was its preferred approach, that conclusion was not unanimously held by IASB's members. Some parties have expressed varying levels of discomfort with Implementation B (e.g., see AAA 2007, p. 10; IAA 2007b, pp. 12–13), due to concerns about allowing companies to potentially recognize profit at the inception of a contract. In addition, one should keep in mind the following statement from the IASB discussion paper: "If there is no evidence that the insurer's pricing differs from the pricing that other market participants require, Implementations A and B lead to the same result at inception" (IASB 2007, para. 78[b]). As such, even under Implementation B, the possibility remains that margins would need to be calibrated to premiums to avoid recognition of a profit or loss at issue, in situations in which the insurer lacks compelling evidence that its pricing profitability targets differ from those of other market participants.

In light of this, for purposes of this paper we are intentionally focusing our attention on the situation in which the margins at issue are calibrated to the actual premiums charged by the insurer, avoiding any gain or loss at issue. We believe that a full understanding of the implications of this situation is important, even if ultimately the final IASB guidance were to evolve in a manner in which calibration was not mandatory.

Finally, it is important to note that under the IASB discussion paper's view of risk margins, the total amount of explicit risk margin included in a liability is the result of multiplying an estimate of the remaining amount of risk to which the insurer is exposed by an estimate of the amount of risk margin required for each risk exposure unit. Both of these component estimates would be reexamined at each reporting period. In a circumstance in which the insurer has no reason to believe that the market price of risk has changed since the last reporting period, the period-to-period change in the risk margin included in the liability would reflect only the change in the amount of risk to which the insurer is exposed.

The discussion of service margins in the IASB discussion paper is quite brief relative to the discussion of risk margins. Conceptually, the service margin is intended to address the situation in which an insurance contract requires the insurer to perform ongoing services other than bearing insurance risk and in which a market participant would be willing to perform those additional services without simultaneously bearing the insurance risk associated with the contract. Under this situation, some portion of the expected profit margin implicit in the insurer's premiums represents compensation for providing services rather than compensation for bearing risk. As such, just as the risk margin is the vehicle by which the insurer's profit from bearing risk gets recognized over the life of the contract commensurate with the insurer's release from risk, the service margin is the vehicle by which the insurer's profit from providing non-risk-bearing services gets recognized over the life of the contract commensurate with the insurer's provision of those services.

2.2 Medical Insurance and Claim Liabilities

This subsection has two distinct purposes. The primary purpose is to provide some relevant background on U.S. medical insurance and current claim liability estimation practice, with an emphasis on areas of difference between medical insurance and other non-life insurance coverages. The secondary purpose is to introduce notation that will be used in later sections.

An important caveat: The comments made below regarding U.S. medical insurance and claim liability estimation are not intended to be a description of the author's current employer's specific practices, or indeed of any single company's specific practices, but rather are intended to represent commonly followed practices in the U.S. health insurance industry as of the time that this paper was written.

Most medical insurance in the United States is sold by companies that do not themselves directly provide health care services, but instead have entered into a variety of contractual arrangements with hospitals, physicians, and other health care providers. As such, when an individual covered by a medical insurance policy obtains health care services from a provider with whom the insurance company has a contract, the provider agrees to accept a discounted payment level for those services as specified in its contract with the insurer, rather than the provider's retail charge for those services. It is important to note that this applies regardless of whether or not the insured individual is entitled to any insurance benefits from the insurer with respect to the health care services in question. For example, if the insurance policy includes a deductible that needs to be satisfied before the insurer is responsible for any claims, the insured nevertheless receives the benefits of the insurer's provider contracts for all health care services, regardless of whether or not the policy deductible has yet been satisfied.

As such, in the current environment a U.S. medical insurer is providing two important but distinct services to its customers. First, the insurer is assuming insurance risk—the insurer accepts premiums, typically paid on a monthly basis but fixed for a 12-month period, in exchange for paying valid claims under the insurance contract with respect to health care services incurred during the coverage period, regardless of when those claims are reported to the insurer. Second, insured individuals receive the benefit of the insurer's provider contracts with respect to all health care services they receive from contracted providers during the coverage period, and the insurer adjudicates the amounts owed to the providers for those services, regardless of whether those amounts are ultimately owed by the insurer or by the insured.

This second service has become extremely important in the context of the current U.S. health care system.[3] That the medical benefits adjudication process has value to the insured, independent of the claims to which the insured might be entitled under the policy, distinguishes U.S. medical insurance from many other non-life insurance coverages. Under many other types of non-life policies, the claims adjustment process may be of interest to the insured only as a means to an end, namely, the determination of insurance benefits. Under a medical policy,

[3] For example, in the popular press one frequently sees a statement to the effect that the uninsured do not have access to health care. Uninsured individuals may well have physical access to health care providers, but in addition to lacking the financing provided by medical insurance, they also lack access to the provider discounts that medical insurers have established with those providers. Consequently, an individual lacking a contractual relationship with a medical insurer may end up having to pay considerably higher amounts for health care services than what that individual (and/or the insurer) would pay for those same services if the individual had a contractual relationship with an insurer.

however, the claims adjustment process mitigates the insured's out-of-pocket costs even for health care services that do not generate insurance benefits.

At the present time, most purchasers of medical insurance are not individuals, but group benefit plans established by employers for their employees and dependents thereof. A sufficiently large group benefit plan (e.g., one covering thousands or even tens of thousands of individuals) derives very little economic benefit from transferring medical insurance risk to a third party, thanks to the law of large numbers, and would instead be willing to self-insure for that risk rather than pay a risk premium to an insurer. However, at the same time, the group benefit plan would like to be able to access the price discounts that medical insurers have negotiated with health care providers.

In light of this dynamic, most U.S. medical insurers offer large group benefit plans a type of contract in which the insurer does not assume any insurance risk, but the insurer does provide administrative services relating to medical insurance risk borne by the benefit plan, including the extension of the insurer's provider contracts to the individuals covered by the benefit plan and the adjudication of benefits under the plan. These Administrative Services Only (ASO) contracts for medical benefits are a ubiquitous part of the current U.S. health care landscape.[4]

The point of providing the above perspective on the U.S. medical insurance marketplace is to motivate the following observation: When an insurer enters into a medical insurance contract, it is not only accepting insurance risk; it is also providing a set of administrative services—including the extension of access to its provider contracts—that insurers also offer as a stand-alone contract.[5] Consequently, our belief is that a U.S. medical insurance contract is an example of a contract for which the IASB discussion paper's distinct notions of risk margin and service margin are both relevant.[6] This may not be the case for every type of non-life insurance contract.

In light of this observation, in later sections we will need to view the insurer's expected profit margin for a medical insurance contract as being composed of two pieces. One portion of the profit margin target represents the compensation that the insurer demands for providing those services that it would also provide under an ASO contract; the other portion represents the compensation that the insurer demands for bearing risk. In practice, it is likely the case that the

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[4] Tens of millions of Americans carry an identification card in their wallet or purse bearing the name of a major medical insurer, and likely think of themselves as possessing medical insurance from that insurer, but in fact are beneficiaries under a self-funded benefit plan that has entered into an ASO contract with that medical insurer, thereby gaining access to the insurer's provider contracts.

[5] Admittedly, a minor complication exists here, in that the set of customers to whom an insurer sells ASO contracts frequently has little overlap with the set of customers to whom the insurer sells insurance contracts. For example, a medical insurer would typically not be willing to offer an ASO contract to an individual; also, some medical insurers simply do not offer ASO contracts. Nevertheless, even if a particular customer would not be able to obtain an ASO contract from a particular insurer, the fact remains that some of the services provided under that customer's insurance contract are services that insurers do provide to other customers without simultaneously accepting insurance risk.

[6] One of our reasons for stressing this point is that IASB did not itself cite U.S. medical insurance as an example in the discussion of service margins in its discussion paper. The only examples relating to service margins provided by IASB involve insurance contracts where an insurer also provides investment management services, for example, U.S. variable universal life insurance.

insurer has established a total profit target for the insurance contract holistically, that is, without separately establishing a target margin for risk and a target margin for non-risk services. However, the insurer should be able, by reference to its pricing for ASO contracts, to make a reasonable estimate of the portion of its insurance contract profit target that represents compensation for services as opposed to compensation for risk.

In the remainder of this subsection, we shift our focus to issues relating to claim liability estimation for U.S. medical insurance.

The liability for unpaid claims under medical insurance contracts is usually the single largest item on the liability side of a U.S. medical insurer's balance sheet. This is in spite of the fact that, compared to other non-life insurance coverages, medical insurance is an extremely short-tailed line of business, in part because of increasing amounts of automation in recent years in the benefits submission and adjudication processes. For example, given the current state of payment processing speeds in the U.S. medical insurance industry, it would not be uncommon for a medical insurer to expect that over three-quarters of the claim liability established as of a given valuation date would be paid out during the first three months after the valuation date, over 99 percent of that liability would be paid out during the first 12 months after the valuation date, and the liability would be fully developed within three or four years.

In light of the short run-out period for medical insurance claims, generally the month is the temporal unit of interest in medical claim liability estimation, rather than the year (as is true for most other non-life lines). Because medical claim liabilities evolve so rapidly, most medical insurers will completely update the estimates of medical claim liabilities at the end of each calendar month, to take into account the impact of the claim payments made in the most recent month as well as the initial attachment of risk on premiums earned in the most recent month.

It is also worth noting that, for purposes of claim liability estimation, a medical insurer will typically segment its insurance business into multiple cells, with each cell representing a set of risk exposures that have relatively homogenous claim payment patterns. An insurer may use some or all of the following variables to determine its structure of liability cells: customer type (e.g., individual vs. small group vs. large group vs. Medicare Advantage); geographic area; type of health care service (e.g., hospital inpatient vs. hospital outpatient vs. professional); type of provider contracting arrangement (e.g., PPO vs. HMO); legal entity bearing the insurance risk (e.g., parent company vs. a subsidiary); claims administration unit (e.g., in-house administration vs. outsourced administration); etc. Consequently, a medical insurer of at least moderate size may have dozens—or even hundreds—of business cells for which separate claim liability calculations are made on a monthly basis.

Throughout this paper we use integers to index calendar months, and we use the notation V_t to indicate the insurer's claim liability for a particular business cell at the end of month t.

It is customary to view the medical claim liability as being a sum of pieces, each of which represents the liability for claims incurred in a particular calendar month; that is, we have

$$V_t = \sum_{n=0}^{N} V_t^n \ ,$$

where V_t^n is the liability at the end of month t for claims incurred in month $t-n$, and N is such that runout is complete as of month t for all claims incurred prior to month $t-N$ (e.g., if the insurer believes that the liability develops fully within three years, then $N = 35$). We refer to the V_t^n as being the *durational components* of the claim liability recorded at the end of month *t.*

For $k \le t$, we define I_t^k to be the insurer's estimate of the ultimate claims incurred in month k based on claim payment information available as of the end of month *t,* and we define C_t^k to be the cumulative claim payments made through the end of month t on claims incurred in month *k.* Note that we have

$$C_t^k = \sum_{j=k}^{t} D_{jk} \ ,$$

where $\{D_{jk}\}$ is the triangle of incremental claim payments, that is, for $j \ge k$, D_{jk} is defined to be the payments made during month j on claims incurred in month k.

Most medical insurers currently employ a claim liability estimation methodology that is loosely based on the Bornheutter-Ferguson approach. By this, we mean that the incremental payment triangle $\{D_{jk}\}$ is used to develop a vector of completion factors,[7] $\{\gamma_n\}$, and a preliminary estimate of the ultimate incurred claims for each incurral month $t-n$ is given by the equation $I_t^{t-n} = C_t^{t-n} \div \gamma_n$ for $0 \le n \le N$. However, for those small values of n where γ_n is significantly less than 1, the incurred claim estimate derived from the completion factor γ_n may be blended with, or completely overridden by, an alternate estimate of the ultimate incurred claims that does not directly depend on the cumulative payments C_t^{t-n}.

In particular, in our experience it is almost always the case that the insurer's estimate of I_t^t, the ultimate claims incurred during the most recent month, is independent of C_t^t, the payments made in the most recent month for claims incurred in that same month. This observation is particularly noteworthy since V_t^0, the claim liability component corresponding to claims incurred during the most recent month, frequently represents between one-half and two-thirds of the insurer's total claim liability V_t, given the current state of medical claim processing in the industry.

Readers with a background in non-life insurance may be somewhat surprised to hear that U.S. medical insurers are still predominantly using deterministic approaches to claim liability estimation, in light of the many different stochastic approaches that have emerged for non-life insurance over the last 25 years (see England and Verrall 2002 for a survey). In recent years indications of interest in nondeterministic reserving methods have been found among health actuaries; for example, see the discussion in Litow and Fearrington (2007, pp. 860–65), as well as Sections 3 and 4 of Gamage et al. (2007). Although further discussion of this issue is outside

[7] Common practice among U.S. health actuaries is to estimate completion factors that are usually less than one, and to *divide* cumulative paid claims by completion factors. By contrast, the comparable practice among U.S. casualty actuaries is to estimate development factors that are usually greater than one and to *multiply* cumulative paid claims by development factors. This deviation between health actuarial jargon and casualty actuarial jargon may be largely attributable to the influential role played by Litow (1989), which is written in terms of completion factors, in the education of recent generations of U.S. health actuaries.

the scope of this paper, we note in passing that there may be difficulties in adapting some common stochastic reserving models to a U.S. medical insurance context.[8]

As discussed in Section 2.1, the IASB discussion paper proposes that the insurer's estimate of any claim liability should include an explicit margin. In our experience, it is currently very common among U.S. medical insurers to include an explicit margin in the estimation of claim liabilities. This margin usually takes the form of a factor that is multiplied, uniformly for all monthly components of the claim liability, against the preliminary estimate of the liability derived from the insurer's estimate of ultimate incurred claims. That is, for many U.S. medical insurers today the formula for the claim liability V_t recorded for a particular business cell is given by

$$V_t = (1+\mu_t)\sum_{n=0}^{N}\left(I_t^{t-n} - C_t^{t-n}\right),$$

where $\mu_t > 0$ is the insurer's choice at month t of explicit margin factor for that cell. Put differently, we have

$$V_t^n = (1+\mu_t)\left(I_t^{t-n} - C_t^{t-n}\right)$$

for $0 \le n \le N$, where the margin factor μ_t included in V_t^n does not depend on *n.* Subsequently, we will use the phrase *current practice liability formula* in reference to this formula.

One of the main objectives of this paper is to examine the question of whether the general approach currently used by U.S. medical insurers to establish margins in claim liabilities is consistent with the objectives stated in the IASB discussion paper for explicit margins under the CXV accounting model. Toward that end, it is appropriate to make some additional observations regarding current practice around margins. We should reiterate that the material in this subsection represents a composite assessment of current common practice in the U.S. medical insurance industry and is not intended to depict the specific practice of any particular insurance company.

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[8] For the benefit of a reader interested in exploring this train of thought, we wish to share two observations. The first observation is that many stochastic methods are not well suited to situations in which the triangle of incremental claim payments frequently has negative values. For example, some stochastic methods assume that the incremental payments are lognormally distributed, which presupposes that they cannot be negative. However, it is quite common for a medical insurance claim payment triangle to include a large number of negative incremental values, some of which can be highly material. Negative increments in medical insurance arise not only from salvage and subrogation recoveries, as can also happen for other non-life coverages, but also from other sources, such as coordination of benefits recoveries (for an insurer using a "pay & pursue" approach) and adjustments made to previously processed claims (such as recoveries of amounts previously paid to providers in error). The influence of negative incremental values in the claims triangle can be so strong with medical insurance that, for many business cells, there will be some $0 \le M < N$ such that $C_t^{t-n} > I_t^{t-n}$ for all $M \le n \le N$; the example presented in Section 4 has this attribute.

The second observation is that some stochastic methods explicitly view the incremental claim payments as being the product of a frequency component and a severity component. This approach appears to presuppose that the insurer has a meaningful way of counting claims, and that a single probability distribution is appropriate to model the severity of all claims. With medical insurance, each of these assumptions is doubtful. The severity of medical insurance claims is extremely heterogenous: one claim might be a $5 charge for a diagnostic test, whereas the next might be a charge of tens or hundreds of thousands of dollars for a complex hospital inpatient admission. Also, it may be difficult for an insurer to develop a coherent and consistent approach for counting medical insurance claims, because of variations in benefits submission practices among providers.

The main impetus behind the historical existence of margins in U.S. medical insurance claim liabilities appears to be regulatory considerations. Most U.S. medical insurers are required to file annually with state insurance regulators an actuarial opinion that includes a statement that the balances recorded by the insurer under Statutory Accounting Principles (SAP) make a "good and sufficient provision" for the insurer's liabilities.[9] U.S. health actuaries have generally interpreted the good and sufficient provision language as implying that the medical insurer's recorded claim liability needs to be at a level that will prove to be adequate considerably more than half of the time.[10] More specifically, U.S. Actuarial Standard of Practice (ASOP) 28 asserts that, in issuing a regulatory actuarial opinion for a health insurance company under the good and sufficient provision requirement, the actuary "should be satisfied that the reserves and related items opined on are adequate to cover obligations under moderately adverse conditions" (ASB 1997, Section 3.3.1).[11]

The discussion in the previous paragraph pertains specifically to the insurer's regulatory financial statements prepared under SAP, rather than the insurer's general-purpose financial statements prepared under GAAP. However, language similar to that found in ASOP 28 also appears in a broader context in ASOP 5, which provides general guidance to U.S. health actuaries regarding estimation of incurred claims for health insurance products: "Recognizing the fact that determination of liabilities for incurred but unpaid health and disability claims is an estimate of the true liabilities that will emerge, the actuary should consider what margin for uncertainty, if any, might be appropriately included. If a margin is included, the unpaid claims liability should be appropriate, in the actuary's judgment, under moderately adverse conditions" (ASB 2000b, Section 3.3.1c). Some major U.S. medical insurers appear to allude to this ASOP 5 language in articulating the insurer's accounting policy for medical claim liabilities in GAAP financial statement filings with the U.S. Securities and Exchange Commission.[12]

More generally, the prevailing attitude among U.S. medical insurers appears to be that there is no particular need to introduce a difference between the GAAP and SAP estimates of the insurer's

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[9] This language comes from the actuarial opinion instructions for companies filing the NAIC Orange Blank, which includes most major writers of U.S. medical insurance. By contrast, U.S. companies that issue property and casualty insurance file the NAIC Yellow Blank, and the Yellow Blank actuarial opinion instructions use the phrase "reasonable provision" instead of good and sufficient provision.

[10] This view is underscored by the fact that the NAIC health risk-based capital (RBC) formula does not contain any capital requirement related to the risk of unfavorable development in the insurer's medical claim liabilities; see the discussion in Bell and Cumming (2007, pp. 384–85). This is another area in which U.S. regulation of medical insurers differs from that of property and casualty insurers, as the NAIC property and casualty RBC formula does impose capital requirements relating to reserving risk.

[11] Note also that this "moderately adverse conditions" phrase does not appear in ASOP 36 (ASB 2000a), the analogous guidance for U.S. casualty actuaries regarding the Yellow Blank actuarial opinion.

[12] We provide two representative examples. First, "Liabilities for both claims incurred but not reported and reported but not yet processed through our systems are determined in aggregate employing actuarial methods that are commonly used by health insurance actuaries and meet Actuarial Standards of Practice. Actuarial Standards of Practice require that the claim liabilities be adequate under moderately adverse circumstances" (WLP 2007, p. 32). Second, "Actuarial standards of practice generally require the actuarial developed medical claims estimates to cover obligations under an assumption of moderately adverse conditions. Adverse conditions are situations in which the actual claims are expected to be higher than the otherwise estimated value of such claims. In many situations, the claims paid amount experienced will be less than the estimate that satisfies the actuarial standards of practice" (CVH 2007, p. 35).

medical claim liabilities.[13] Hence, to the extent that, in order to satisfy the good and sufficient provision standard, the insurer includes explicit margins in estimating the liabilities reported on the SAP financial statement, those margins will likely also be included in the liabilities reported on the insurer's GAAP financial statement.

As such, the inclusion by U.S. medical insurers of margins in claim liabilities for general-purpose financial reporting is largely a reality today, even though existing U.S. GAAP literature does not specifically prescribe the practice.

Having said that, little or no guidance exists today relating to margins, and practice may vary from insurer to insurer. Nevertheless, the following observations appear to apply relatively widely in the current environment:

- Margin factors are not explicitly related to the expected profitability of insurance contracts. Instead, the magnitude of the margin factor is viewed as an expression of the degree of variability that exists in the insurer's claim liability estimate. This practice reflects a point of view that the primary role of the margin is to provide the opining actuary with comfort that the claim liabilities will be adequate under moderately adverse conditions, per the discussion above.
- Because deterministic methods rather than stochastic methods are generally used to produce claim liability estimates, the recorded liability (inclusive of the margin factor) may not explicitly correspond to a specific confidence level. However, many insurers base their selection of a margin factor on an analysis of the historical volatility in their own claim liability estimates. Through such analysis, the insurer could select a margin factor that, when applied retrospectively, would have produced recorded liabilities that were adequate a specified percentage of the time.
- Frequently, the margin factor is established at a portfolio level that is significantly less granular than the business cell level at which claim liabilities are estimated. For some insurers, all medical insurance business may make up a single portfolio. For others, multiple portfolios are established, with separate margin factors for each portfolio. One common approach is to establish a separate margin factor for each legal entity assuming insurance risk.[14] It appears to be relatively uncommon for different medical insurance products written by the same legal entity to employ different margin factors in their respective claim liabilities.

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[13] Many medical insurers have little or no long-duration contract liabilities of the type that dominate a life insurer's balance sheet. For a life insurer, clear and material differences exist between the GAAP and SAP accounting guidance applicable to these liabilities, and consequently a life insurer's balance sheet is replete with GAAP-SAP differences relating to insurance contracts. A medical insurer, by contrast, may not have any material insurance contract liabilities for which the accounting literature clearly imposes a GAAP-SAP difference. As such, it is relatively natural for a medical insurer to assume that GAAP and SAP insurance contract liability balances should be identical, unless the accounting literature clearly indicates otherwise.

[14] Note that, for a combination of regulatory and historical reasons, most major U.S. medical insurers use multiple legal entities to underwrite their medical insurance business. Medical business written by multiple related legal entities is not subsequently pooled via intercompany reinsurance arrangements, as is sometimes the case in the U.S. property and casualty insurance industry; instead, the risk typically remains with the original entity.

- In a 2002 survey (reported in Kan, Shih, and Staehlin 2003) of actuaries participating in an SOA medical insurance valuation webcast, 46 percent of participants reported that their employer used a margin factor between 3.5 and 7.5 percent, with 34 percent reporting a margin factor between 7.5 and 12.5 percent.
- Fluctuations from period to period in an insurer's margin factor are uncommon. This may reflect concern from independent auditors that frequent and/or unsupported changes in the margin factor could represent a vehicle by which the insurer's management could shift earnings from one accounting period to another. Those changes that do occur in a margin factor may be related to specific operational situations. For example, when an insurer introduces a new administrative system for claims adjudication, it is not uncommon for claim payment patterns to be disrupted for a period of time because of implementation difficulties. This disruption will likely increase the amount of uncertainty in the insurer's claim liability estimates, because the historical payment patterns may no longer be representative of future payment patterns. Therefore, to the extent that the intended purpose of the margin is to reflect the level of variability in the claim liability, the insurer may temporarily increase its margin factor until claim payment patterns stabilize.

3 CXV Margins and Medical Insurance

The background material in Section 2 included two main observations. The first observation was that the CXV accounting model proposed in the IASB discussion paper requires that medical insurance claim liabilities include explicit margins, reflecting the insurer's compensation not only for bearing risk, but also for providing non-risk services such as the extension to customers of the insurer's provider discounts. The second observation was that, even though the subject is not addressed within existing U.S. GAAP literature, many U.S. insurers currently include explicit margins in their medical claim liability estimates.

This section starts by exploring the issue of whether or not current practice regarding explicit margins in medical claim liabilities is sufficiently well aligned with the objectives of the CXV accounting model's use of explicit margins. After that, we propose a new approach for calculating explicit margins included in medical claim liabilities.

3.1 Evaluation of Current Practice

To reiterate from Section 2.2, by *current practice liability formula* we mean that the insurer's claim liability V_t at the end of month *t* for a particular business cell is given by

$$V_t = \sum_{n=0}^{N} V_t^n = \sum_{n=0}^{N} (1+\mu_t)\left(I_t^{t-n} - C_t^{t-n}\right),$$

where μ_t is the explicit margin factor selected by the insurer at month *t,* and other notation is as defined in Section 2.2. Furthermore, under current practice, the margin factor is selected to provide the insurer with confidence that the claim liability V_t will be adequate under moderately adverse conditions; that is, the margin factor is intended to be an expression of the variability inherent in the claim liability.

To help evaluate the implications of this approach, we now want to focus on a fixed incurral month *k,* and we want to follow this incurral month through time. For $n \geq 0$, V_{k+n}^{n} represents the insurer's estimated liability for claims incurred in month *k* after *n* months have elapsed since the end of month *k,* that is, after $n+1$ months of claim payments have been made. We want to consider the evolution of V_{k+n}^{n} as *n* changes, and the implications thereof on the insurer's income statement, under a model office projection, meaning under the assumption that actual experience emerges just as we would have predicted in advance. We also assume for purposes of this example that the insurer's margin factor does not change over time, that is, that there is some $\mu > 0$ such that $\mu = \mu_{k+n}$ for all *n.*

We need some additional notation. Let P_k be the premium received by the insurer for incurral month *k;* let ρ_k be the insurer's expected profit margin for that month, expressed as a percentage of P_k; and let λ_k be the insurer's expected loss ratio for that month (i.e., the expected value of claims incurred in month *k,* expressed as a percentage of P_k). We also assume that we have a vector $\{\gamma_n\}$ of completion factors that, in a model office projection, perfectly predict the pattern of future claim payments.

With this notation, for $n \geq 0$ we have

$$V_{k+n}^{n} = (1+\mu)(\lambda_k P_k)(1-\gamma_n)$$

because, in a model office projection, we always have $I_{k+n}^{k} = \lambda_k P_k$ and $C_{k+n}^{k} = \gamma_n \lambda_k P_k$.[15] Now let π_n^k be the profit that the insurer expects to recognize during month $k+n$ for incurral month *k.* We leave it to the reader to verify that, under the above assumptions, we have[16]

$$\pi_0^k = [\rho_k - \mu\lambda_k(1-\gamma_0)]P_k\,,$$

and, for $n > 0$,

$$\pi_n^k = \mu\lambda_k(\gamma_n - \gamma_{n-1})P_k\,.$$

(Note that

$$\sum_{n=0}^{N} \pi_n^k = \rho_k P_k - \mu\lambda_k(1-\gamma_N)P_k = \rho_k P_k$$

as expected, because by definition we have $\gamma_N = 1$.)

Here is the underlying meaning of the formulas presented above. During the first month (i.e., month *k* itself), the insurer does not get to recognize in full the expected profit on the premiums for month *k,* because of the need to initially establish the explicit margin in the claim liability recorded at the end of the month *k* for claims incurred in that month. In each successive month,

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[15] Throughout we intentionally ignore the impact of the time value of money on the claim liability, for simplicity.

[16] Note that we are assuming in these formulas that all premium and expenses associated with month *k* are fully recognized in the insurer's income statement during month *k.* For premium, this is consistent with current financial reporting practices. For expenses, this is not entirely accurate to the extent that the insurer establishes a liability for unpaid loss adjustment expenses (LAE) in proportion to the claim liability; the release of claim liability margin over time will have a commensurate impact on the insurer's recognition of LAE. Alternatively, for purposes of this presentation we could view the claim liability as being inclusive of the LAE liability, to avoid this difficulty.

the insurer expects to recognize profit on the premiums for month k equal to the margin factor multiplied by the amount of claims that were paid during that month but incurred in month k. Eventually the liability is extinguished, and the explicit margin that had been established at the end of the first month has been released gradually into income. As such, ultimately the sum of the insurer's month-by-month recognized profit for risks incurred in month k is equal, in the model office projection, to the expected profit.

We see from this that the explicit margin in the claim liability is the vehicle by which the insurer's recognition of the expected profit on the premium earned in a particular month is deferred to accounting periods beyond that month. If the claim liability contained no explicit margin, then, as seen by setting $\mu = 0$ in the formulas above, at the end of every month the insurer would expect to fully recognize its expected profit for risks incurred in that month, even though uncertainty exists in reality (as opposed to in a model office projection) as to whether or not actual profit on risks incurred in that month will ultimately equal the expected profit. Indeed, this is perhaps the best argument as to why it is representationally faithful for a medical insurer's general-purpose financial statements to include margin in claim liabilities.

Taking this view one step further, let us consider what happens at the beginning of month k, rather than at the end.[17] If the insurer were to establish a claim liability at the beginning of month k for claims incurred in month k, then that liability would be equal to $(1+\mu)\lambda_k P_k$, because no claims incurred in month k have yet been paid. As such, the profit immediately recognized by the insurer at the beginning of month k relating to premiums for month k would be equal to $(\rho_k - \mu\lambda_k)P_k$. (Note that this is what π_0^k would be if γ_0 happened to be zero.) We refer to this quantity as being the insurer's gain at issue if positive, or loss at issue if negative.

We have arrived at the first major disconnect between current practice and the principles articulated in the IASB discussion paper. As discussed in Section 2.1, for purposes of this paper we make the simplifying assumptions that the margin in the claim liability needs to be calibrated to the actual premium level, to avoid a gain at issue, or a loss at issue on a product that is ultimately expected to be profitable. In light of the previous paragraph, this implies that the margin factor would need to satisfy the equation $\mu = \rho_k \div \lambda_k$. However, as discussed in Section 2.2, under current practice no explicit connection is drawn between the margin factor and the expected profitability of the insurer's contracts, so this equation holds only by coincidence.

Suppose, as an example, that we have $\lambda_k = 85\%$ and $\rho_k = 5\%$. This implies that the calibrated choice of margin factor using the current practice claim liability formula would be $5\% \div 85\% = 5.88\%$. If the insurer, based on (say) its analysis of historical claim liability variability, selects a margin factor of 5 percent, then implicitly the insurer is inappropriately recognizing a gain at issue. Conversely, if the insurer selects a margin factor of 10 percent, then implicitly the insurer is inappropriately recognizing a loss at issue on a profitable product.

[17] For purposes of this discussion, we assume that the insurer would be allowed to recognize the full month's premium P_k as revenue at the beginning of the month, and that the insurer would concurrently recognize the full month's incurred expenses. Although this may not be realistic, it is instructive to consider.

The conclusion from the above discussion is that the current practice claim liability formula could be made compliant with the desire that no gain or loss be recognized at issue, by altering our approach to establishing the margin factor; instead of basing the margin factor on an assessment of claim liability variability, it would need to be calibrated to expected profitability. Below we shall refer to this as being the *calibrated version* of the current practice liability formula. However, thus far we have focused only on the implications of current practice on the emergence of profit at issue. We now assume that the margin factor has been calibrated to premiums to produce no gain or loss at issue, and we turn our attention to the implications of the current practice liability formula on the subsequent emergence of profit.

Note that if we set $\mu = \rho_k \div \lambda_k$, then for $n > 0$ our previous formula for π_n^k reduces to

$$\pi_n^k = (\gamma_n - \gamma_{n-1})(\rho_k P_k),$$

and, similarly, we have

$$\pi_0^k = \gamma_0(\rho_k P_k).$$

That is, the proportion of total profit that is expected to be recognized in each month is equal to the proportion of total incurred claims that are expected to be paid during that month. We now evaluate whether or not this pattern of profit recognition makes sense under CXV.

In Section 2.2 we argued that medical insurance was an example of a product for which the insurer's total profit margin could be meaningfully decomposed into compensation for bearing risk versus compensation for non-risk services, where the relevant non-risk services involve the extension to policyholders of the insurer's provider contracts and other services relating to adjudication of benefits. As such, under CXV, the claim liability explicit margin that we have been discussing needs to be viewed as the sum of a risk margin and a service margin.

We define ρ_k^R as being the portion of the insurer's expected profit margin that represents compensation for bearing risk, and ρ_k^S as being the portion of the insurer's expected profit margin that represents compensation for non-risk services. By definition, $\rho_k^R + \rho_k^S = \rho_k$. As such, we can proportionately decompose our explicit margin factor $\mu = \rho_k \div \lambda_k$ into a risk component and a service component. From this perspective, the implication of the above discussion is that, under current practice, both the explicit risk margin and the explicit service margin are expected to be released over time in proportion to paid claims.

For the service margin, this is intuitively sensible, because the non-risk services provided by the insurer largely relate to the act of paying claims. For example, the policyholder derives value from the insurer's provider contracts as claims are paid, and the extent of that value is proportional to the provider discounts associated with those claim payments, which will tend to be proportional to the claim payments themselves. Although not every service provided is precisely proportional to insured claim payments, we believe it is reasonable to argue that the service margin could, as a convenient approximation, be released in proportion to paid claims.

But what about the risk margin? The intent under CXV is that the risk margin should be reduced as the insurer is released from risk. Consequently, if we argue that it is correct for the risk margin to be reduced proportionately as claims are paid, what we are really arguing is that the insurer's release from risk is proportional to the payment of claims. Is this a reasonable argument?

In our view, the answer to this fundamental question is no.

To address this question, we need to start by asking: What does risk mean in this context? The risk that the insurer is bearing in exchange for accepting premiums for month *k* is the risk that the ultimate incurred claims for month *k* will be different than the insurer's original expectation. As such, our belief is that the definition of risk that is pertinent to this discussion is the insurer's risk of misestimating the ultimate incurred claims for month *k.*

As we move from one month to the next, the insurer refines its estimate of the ultimate incurred claims for month *k* with the benefit of an additional month of paid claims data. To the extent that this additional month of data improves the insurer's ability to estimate the ultimate incurred claims for month *k,* then the insurer has experienced some release from the risk it bears with respect to month *k,* proportionate with the extent to which estimation accuracy has improved. Conversely, to the extent that the insurer's ability to estimate the ultimate incurred claims for month *k* is not enhanced by the existence of the additional data, then we would argue that the insurer has not experienced any such release from risk during that month.

As a critical example, consider what happens during month *k* itself from a risk release standpoint. We have $C_k^k = \gamma_0 \lambda_k P_k$, meaning that γ_0 is the proportion of the expected ultimate incurred claims for month *k* that were paid during month *k.* So the relevant question is: Is it reasonable to assume that the insurer's risk of misestimating the ultimate incurred claims for month *k* has decreased proportionately by γ_0 during month *k?*

We would argue that, by contrast, little or no decrease occurs during month *k* in the insurer's risk of misestimating the ultimate incurred claims for month *k.* In Section 2.2 we observed that the insurer's estimate of I_k^k is usually independent of C_k^k, due to a belief among practitioners that when γ_0 is small, the predictive value of the actual paid claims is minimal and other methods provide a more reliable estimate of the incurred claims. A corollary to this observation is that the estimate the insurer makes of the ultimate incurred claims for month *k* at the end of month *k* is based on essentially the same information that was available to the insurer at the beginning of month *k:* namely, estimates of ultimate incurred claims for months $t < k$, estimates of medical claims inflation trend, estimates of the influence of seasonality on incurred claims, etc. It is true that the quality of some or all of these inputs may have improved during month *k,* which could lead to a marginal improvement in the accuracy of the end-of-month estimate of the ultimate incurred claims for month *k* relative to the beginning-of-month estimate. However, in this case, the actual value of γ_0 does not affect the extent to which the insurer's risk of misestimating the ultimate incurred claims has decreased during the month. In particular, it therefore does not seem reasonable to assume that the insurer's release from risk during this month is dependent on γ_0.

Looking at the same situation from a different angle, consider the perspective of a hypothetical party that is interested in assuming the insurer's liability for claims incurred in month *k* as of the end of month *k.* Under CXV, the risk margin included in V_k^0 is intended to reflect the compensation that this hypothetical party would demand to accept the liability. Suppose that $\rho_k^R = 4\%$ and that $\gamma_0 = 0.25$. If one believes that the insurer's release from risk is proportional to paid claims, then the implication is that the hypothetical party would require only a risk margin of 3 percent of premium as compensation for assuming the risk of adverse development in the liability after one month of runout, as opposed to the 4 percent of premium that the market demanded to assume the risk before any claims were paid. Although such liability transfers are virtually nonexistent in practice, this result does not pass the smell test. It seems much more reasonable to assume that the hypothetical party would demand all, or almost all, of the original 4 percent of premium risk margin, on the grounds that the modest amount of claims paid during month *k* has not materially impacted the amount of risk associated with the premiums received for month *k*.

As such, we have arrived at a second major disconnect between current practice and the IASB discussion paper, which we can articulate as follows: A margin approach based on applying a single margin factor μ_t across all of the durational claim liability components V_t^n does not adequately reflect the insurer's pattern of release from risk over time. In particular, such a margin approach will tend to cause an inappropriate acceleration in the insurer's recognition of profit associated with a specific incurral month, relative to what a CXV notion of risk margin would appear to require. (This observation will be made more concrete in Section 4.)

3.2 Toward a New Approach

The conclusion to be drawn from the analysis found in Section 3.1 is that the approach most commonly used today by U.S. medical insurers to incorporate explicit margins within their claim liabilities is, at its core, not compatible with the objectives articulated in the IASB discussion paper regarding margins. In this subsection we propose a new formula for including margins in the medical insurance claim liability in a manner that we believe to be compatible with the objectives of the CXV accounting model.

As an outgrowth of earlier discussion, we can identify four principles to which we would want our new liability formula to adhere:

1. The total margin included in the claim liability needs to be explicitly decomposed into a risk margin and a service margin.
2. We want to initially calibrate the risk margin and service margin to the expected profitability of the insurance contract, so that the insurer recognizes no gain or loss at issue. (As noted in Section 2.1, this would not be required under Implementation B in a situation in which the insurer's profit margin target demonstrably differs from those of other market participants, but we have intentionally scoped that case out of this paper.)
3. The risk margin initially included in the claim liability for a given incurral month needs to be released over time in proportion to changes in the insurer's risk of misestimating the ultimate incurred claims for that incurral month.
4. The service margin initially included in the claim liability for a given incurral month needs to be released over time in proportion to the payment of claims for that incurral month.

These principles have a number of implications as to the form of our new liability formula.

Taken together, the first two principles imply that the inputs required in our formula include the expected profit margin in the insurance contracts contained in this business cell, decomposed into a profit margin for bearing risk and a profit margin for providing non-risk services. As before, we use ρ_k^R (respectively, ρ_k^S) to denote the proportion of the insurer's premium for incurral month *k* that the insurer originally expects to retain as compensation for bearing risk (respectively, compensation for providing non-risk services).

The fourth principle implies, in light of our discussion in Section 3.1, that the service margin can be implemented by multiplying the base liability estimate (i.e., estimated incurred claims less cumulative paid claims) by a service margin factor, in a manner analogous to current practice. However, unlike current practice, different service margin factors may need to be used in different durational components of the claim liability, to the extent that the insurer's profit margin targets have changed over time.

To have no gain or loss at issue from the service margin component, the service margin factor that we multiply against the base estimate of the claim liability for incurral month *k* needs to be equal to $\rho_k^S \div \lambda_k$, where as before λ_k is the insurer's pricing loss ratio for month *k.* To see this, consider the case in which $C_k^k = 0$. Here, because no claims have been paid yet, the service margin included in V_k^k needs to be equal to the originally expected profits from non-risk services for month *k,* namely, $\rho_k^S P_k$, because the insurer is not yet entitled to recognize any profit from such services. However, in the case we are considering, we also have $I_k^k = \lambda_k P_k$, from which the result follows.

We saw in Section 3.1 that the third principle implies that the risk margin cannot be implemented simply by multiplying the base liability estimate by a risk margin factor. Instead, a new paradigm is needed.

Let I_U^k denote the ultimate incurred claims for month *k,* after runout is complete. For $n \geq 0$, we define ε_n^k to be the percentage by which the insurer's estimate of incurred claims for month *k* using $n+1$ months of paid claims, namely, I_{k+n}^k, differs from the ultimate value, I_U^k; that is,

$$\varepsilon_n^k = \frac{I_{k+n}^k - I_U^k}{I_U^k}.$$

If we now fix *n,* and view *k* as being a variable rather than a specific incurral month, then we can define σ_n to be the standard deviation of the set $\{\varepsilon_n^k\}$. With these definitions, σ_n is a proxy for the amount of risk inherent in the insurer's estimates of ultimate incurred claims using $n+1$ months of paid claims.

For $n \geq 0$, we define φ_n to be the amount of risk in the insurer's estimates of a month's ultimate incurred claims after $n+1$ months of paid claims, relative to the amount of risk in the insurer's estimates of ultimate incurred claims before any claims have been paid. For $n > 0$, it will be useful to express this relationship as

$$\varphi_n = \varphi_0 \frac{\sigma_n}{\sigma_0},$$

where we use φ_0, the amount of risk in the insurer's estimates of a month's ultimate incurred claims after one month of paid claims, as a benchmark. We refer to the vector $\{\varphi_n\}$ as being the insurer's *risk release factors* for this business cell.

In theory, if $m < n$, then we should have $\sigma_m \geq \sigma_n$, and hence $\varphi_m \geq \varphi_n$, because more information about the ultimate incurred claims for month *k* exists at the end of month $k+n$ than at the end of month $k+m$, so the estimation risk cannot have increased between the two months. Also, if $n > N$, then by definition we have $I_{k+n}^k = I_U^k$ for every incurral month *k,* so $\sigma_n = 0$, and hence $\varphi_n = 0$. It follows from this that the risk release factors $\{\varphi_n\}$ form a nonincreasing sequence of numbers in the interval [0,1]. The nonnegative quantity $\varphi_{n-1} - \varphi_n$ can be viewed as the proportion of the original estimation risk that dissipates during the *n*th month.

We plan on employing these risk release factors as follows. The risk margin included in a durational claim liability component at a given point in time will be a product of three quantities: a risk margin factor, a risk release factor, and an incurred claims estimate.

At first glance, it may seem odd that the risk margin included in the liability is not itself an explicit function of the base estimate of the liability. This reflects the fact that the CXV risk margin is measuring the risk inherent in estimating the incurred claims, as opposed to the variability in the base liability estimate. Recall from Section 2.1 that, under CXV, the risk margin is intended to be the result of multiplying two quantities: an estimate of the number of units of risk to which the insurer is still exposed, and an estimate of the risk margin required per unit of risk exposure. From that perspective, the former role will be played by the incurred claims estimate multiplied by the risk release factor, while the latter role will be played by the risk margin factor. It may also be unclear at first glance that the proposed approach will produce a risk margin that appropriately grades to zero over time. However, because $\lim_{n \to N} \varphi_n = 0$, the risk margin included in the durational claim liability component will reach zero when the base liability estimate itself reaches zero.

Finally, in accordance with the second principle, we need to calibrate the risk margin factor to the profit margin target inherent in the premium. Reasoning similar to that discussed above for the service margin factor reveals that, to have no gain or loss at issue, the risk margin factor for incurral month *k* needs to be equal to $\rho_k^R \div \lambda_k$.

Putting all of the above pieces together, we propose the following formula for the durational claim liability component V_t^n:

$$V_t^n = \left(1 + \frac{\rho_{t-n}^S}{\lambda_{t-n}}\right)\left(I_t^{t-n} - C_t^{t-n}\right) + \frac{\rho_{t-n}^R}{\lambda_{t-n}} \varphi_n I_t^{t-n}.$$

The first term includes both the base liability estimate for incurral month $t-n$, namely, $I_t^{t-n} - C_t^{t-n}$, and the service margin, obtained by multiplying the base liability estimate by the service margin factor in effect for incurral month $t-n$, which is $\rho_{t-n}^S \div \lambda_{t-n}$. The second term represents the risk margin, obtained by multiplying the current incurred claims estimate I_t^{t-n} for incurral month $t-n$ not only by the risk margin factor in effect for incurral month $t-n$, which is $\rho_{t-n}^R \div \lambda_{t-n}$, but also by the *n*th risk release factor, φ_n.

To verify that this liability formula possesses desirable characteristics, we return to a model office projection for a fixed incurral month *k,* as discussed in Section 3.1. Recall that here we have $I_{k+n}^{k} = \lambda_k P_k$ and $C_{k+n}^{k} = \gamma_n \lambda_k P_k$ for any *n.* From this, it quickly follows that our new formula for V_{k+n}^{n} reduces to

$$V_{k+n}^{n} = (1-\gamma_n)(\lambda_k P_k) + (1-\gamma_n)(\rho_k^S P_k) + \varphi_n(\rho_k^R P_k).$$

Consequently, for $n > 0$, the formula for the expected profit π_n^k recognized during month $k+n$ corresponding to premiums charged for incurral month *k* turns out to be

$$\pi_n^k = (\gamma_n - \gamma_{n-1})(\rho_k^S P_k) + (\varphi_{n-1} - \varphi_n)(\rho_k^R P_k),$$

and, similarly,

$$\pi_0^k = \gamma_0(\rho_k^S P_k) + (1-\varphi_0)(\rho_k^R P_k).$$

These formulas reveal that our proposed liability formula achieves what we had sought:

- The insurer's expected compensation for non-risk services for a particular incurral month is expected to be recognized as profit in proportion to the payment of claims.
- The insurer's expected compensation for bearing risk for a particular incurral month is expected to be recognized as profit in proportion to the insurer's release from risk.
- The initial margins are calibrated to the profit margin targets implicit in the premium, avoiding any gain or loss at issue. (This follows from the expected profit formulas by considering the case where $\gamma_0 = 0$ and $\varphi_0 = 1$.)

On the other hand, our proposed liability formula suffers from a drawback: We have needed to introduce a new theoretical concept—the risk release factors—not currently in use by practitioners. This likely makes it difficult for the reader to develop any intuition around the financial statement implications of employing the proposed formula in lieu of the current practice formula. More importantly, it raises implementation questions as to how insurers would derive these risk release factors in practice. In Section 4 we attempt to shed light on both of these issues via an extended example.

4 Illustration

In Section 3.2 we introduced a new medical insurance claim liability formula that includes explicit margins in a manner inspired by the CXV accounting model, namely,

$$V_t = \sum_{n=0}^{N} V_t^n = \sum_{n=0}^{N} \left[\left(1 + \frac{\rho_{t-n}^S}{\lambda_{t-n}}\right)\left(I_t^{t-n} - C_t^{t-n}\right) + \frac{\rho_{t-n}^R}{\lambda_{t-n}} \varphi_n I_t^{t-n} \right].$$

The purpose of this section is to illustrate this formula in a model office projection that is based on actual data. We start with an example of how actual data can be used to estimate the vector $\{\varphi_n\}$ of risk release factors. After that, we consider a model office projection to gain insight into the financial statement implications of our proposed claim liability formula, including a comparison to the current practice liability formula as well as sensitivity analysis.

Throughout this section we will work with one specific example of a business cell, which represents a major insurer's book of group medical PPO business in one particular U.S. state. For this cell, we were able to obtain the insurer's contemporaneous per-member incurred claims estimates over a 72-month period.[18] The insurer made no changes during the 72-month period in its definition of which insurance policies were included in this business cell, nor did it make any material changes during the 72-month period in its methodology for making estimates of incurred claims. Consequently, as real-life examples go, this one is unusually clean. Also, the business cell is relatively large, varying between 300,000 and 400,000 insured members during the relevant time period. For these reasons, we believe that this cell provides a useful example of the theory developed in the previous section.

4.1 Estimating Risk Release Factors

As described in Section 3.2, the vector $\{\varphi_n\}$ of risk release factors is a measure of the extent to which the insurer's theoretical ability to estimate a month's ultimate incurred claims improves over time as additional paid claims data become known. Risk release factors may vary from insurer to insurer, and from business cell to business cell within an insurer, much in the same way as completion factors vary by insurer and by business cell.

In principle, an insurer may be able to derive credible risk release factor estimates for a business cell by studying that cell's own historical experience. In this subsection we demonstrate how this could be done, using real-life data for one relatively large and stable business cell.

As noted above, we obtained an insurer's I_t^k estimates for a particular business cell over a 72-month period, with $t=1$ being the first month in the period and $t=72$ being the last month.[19] For purposes of attempting to estimate the risk release factors, we are focusing only on those incurral months *k* for which the full development of incurred claims estimates is included within our data, starting with I_k^k and ending with the fully developed value (or at least something that closely resembles it).

Table 1 shows the available data for a 48-month set of incurral months, namely, $1 \le k \le 48$. In Table 1 the rows are incurral months and the columns are durations, so that the entry found in row *k* and column *n* is I_{k+n}^k, the insurer's estimate at the end of month $k+n \le 72$ of per-member incurred claims in month *k*. For presentation purposes, we have normalized all of the data found in Table 1 so that $I_k^k = 1,000$, except when $k=14$ or $k=19$; for these two incurral months, I_k^k was not available, so we instead normalized the data so that $I_{k+1}^k = 1,000$. The purpose of normalizing the data in Table 1 was to mask aspects of the original data that the insurer views as being proprietary (e.g., trends over time in per-member incurred claims levels) and that are irrelevant for our purposes.

[18] Typically, a medical insurer's estimates of incurred claims for a particular incurral month are developed on a per-member basis and then are multiplied by an estimate of the number of members having insurance coverage for that month as part of the claim liability calculation. We have intentionally suppressed this nuance in our claim liability formula notation. In real life, variation in an insurer's estimates of ultimate incurred claims for a month may come from two sources: misestimates in per-member incurred claims, and misestimates in the number of members possessing coverage for that month. In this section we ignore the relatively minor issue of inaccurate member count estimates, and focus on the more important issue of uncertainty in per-member incurred claims estimates.

[19] There were two values of *t,* namely, $t=14$ and $t=19$, for which the I_t^k estimates were unavailable.

Table 1 (page 1 of 4)

Rows are incurral months, columns are durations. The entry in row *k* and column *n* is I_{k+n}^{k}, the insurer's estimate of incurred claims for incurral month k as of the end of month $k+n$. Entries have been normalized so that $I_k^k = 1,000$ (or $I_{k+1}^k = 1,000$, if I_k^k was unavailable). Italicized entries are those for which $I_{k+n}^k = I_{k+24}^k$ by definition (see text).

	0	1	2	3	4	5	6	7	8	9	10	11
1	1,000.00	1,005.90	1,061.85	1,059.32	1,055.94	1,056.50	1,057.75	1,063.26	1,062.85	1,059.48	1,060.69	1,058.04
2	1,000.00	1,006.03	993.11	1,000.29	1,018.99	1,020.08	1,035.02	1,031.88	1,028.74	1,028.37	1,026.24	1,034.98
3	1,000.00	972.92	968.85	932.11	930.00	931.63	931.31	928.84	929.66	928.94	944.35	N/A
4	1,000.00	1,024.85	1,051.01	1,051.23	1,057.80	1,060.00	1,055.55	1,054.90	1,052.17	1,057.76	N/A	1,058.29
5	1,000.00	1,012.38	1,012.53	990.77	985.84	981.69	983.36	980.81	985.57	N/A	983.53	982.19
6	1,000.00	995.59	958.82	948.63	940.68	945.83	939.58	945.54	N/A	944.50	943.06	942.14
7	1,000.00	1,012.94	1,023.06	1,038.01	1,030.56	1,042.55	1,048.80	N/A	1,049.19	1,048.12	1,046.97	1,045.55
8	1,000.00	996.91	1,031.68	1,020.03	1,024.18	1,041.33	N/A	1,042.08	1,042.05	1,041.35	1,040.18	N/A
9	1,000.00	985.30	994.98	957.15	965.95	N/A	965.40	964.57	966.16	967.86	N/A	967.23
10	1,000.00	988.01	1,032.91	1,042.22	N/A	1,030.25	1,066.82	1,066.00	1,066.22	N/A	1,057.20	1,057.77
11	1,000.00	1,001.64	1,045.46	N/A	1,076.32	1,073.20	1,071.85	1,071.71	N/A	1,067.52	1,065.77	1,062.42
12	1,000.00	1,011.36	N/A	1,056.15	1,056.44	1,055.03	1,058.53	N/A	1,048.82	1,053.30	1,053.07	1,053.10
13	1,000.00	N/A	1,069.25	1,110.31	1,099.32	1,110.16	N/A	1,103.22	1,102.01	1,098.97	1,098.68	1,097.38
14	N/A	1,000.00	991.96	988.07	992.00	N/A	981.15	981.26	975.77	973.58	973.00	975.75
15	1,000.00	1,011.25	982.88	989.74	N/A	990.07	989.10	986.52	986.01	987.59	988.56	984.48
16	1,000.00	1,117.47	985.99	N/A	1,002.65	1,026.19	1,022.71	1,022.22	1,019.43	1,018.94	1,023.90	1,020.96
17	1,000.00	883.37	N/A	887.48	890.46	885.19	883.90	882.52	881.08	878.27	877.65	877.35
18	1,000.00	N/A	1,007.05	1,031.46	1,013.11	1,008.67	1,008.86	1,008.16	1,005.70	1,004.68	1,001.77	993.26
19	N/A	1,000.00	1,012.29	996.14	1,003.43	1,005.68	1,007.20	1,002.80	1,002.47	1,002.03	998.62	1,001.32
20	1,000.00	962.84	936.39	931.97	944.62	941.66	937.99	938.44	937.79	935.13	933.94	935.18
21	1,000.00	958.48	942.15	952.47	956.04	947.76	947.84	946.24	943.38	942.91	942.52	941.91
22	1,000.00	1,003.15	992.81	1,015.18	999.48	996.85	997.41	998.18	1,001.91	1,002.02	1,001.97	1,000.05
23	1,000.00	950.39	941.91	941.88	942.83	939.76	936.66	938.83	939.55	938.74	935.23	935.76
24	1,000.00	1,025.32	1,036.01	1,048.06	1,060.78	1,057.15	1,060.73	1,060.66	1,059.99	1,056.69	1,056.77	1,056.95
25	1,000.00	1,013.21	1,013.35	1,021.38	1,017.22	1,025.38	1,026.88	1,020.79	1,021.24	1,021.46	1,021.73	1,022.72
26	1,000.00	965.80	940.94	942.56	945.95	951.97	949.23	949.44	948.15	949.94	951.13	949.82
27	1,000.00	1,062.22	1,031.96	1,053.05	1,052.65	1,052.02	1,049.78	1,048.93	1,049.65	1,053.20	1,057.11	1,058.55
28	1,000.00	901.31	908.04	914.25	908.83	906.84	907.79	908.45	907.72	909.23	910.46	911.04
29	1,000.00	1,000.34	999.90	1,003.18	1,000.03	1,001.58	1,002.59	1,003.32	1,005.93	1,007.27	1,007.15	1,009.58
30	1,000.00	1,020.41	1,013.24	1,014.92	1,018.92	1,019.59	1,023.21	1,025.87	1,028.24	1,027.19	1,027.82	1,026.28
31	1,000.00	982.22	973.81	978.07	974.16	972.49	975.26	977.37	977.96	982.22	980.94	982.22
32	1,000.00	966.11	938.25	924.32	921.42	920.86	923.28	924.33	927.71	925.76	926.42	926.63
33	1,000.00	1,027.97	1,024.26	1,024.10	1,027.97	1,025.73	1,023.36	1,028.25	1,027.41	1,027.54	1,027.34	1,027.41
34	1,000.00	992.80	1,034.81	1,032.29	1,025.05	1,021.24	1,025.90	1,025.98	1,027.35	1,026.75	1,026.08	1,025.94
35	1,000.00	1,042.19	1,052.88	1,032.23	1,022.81	1,025.74	1,024.02	1,025.32	1,024.97	1,023.91	1,025.45	1,025.16
36	1,000.00	1,027.00	1,013.72	1,007.18	1,019.33	1,020.78	1,039.56	1,039.56	1,038.80	1,041.22	1,040.47	1,040.30
37	1,000.00	966.58	960.94	965.45	962.45	967.28	963.00	964.10	965.65	964.51	965.21	965.59
38	1,000.00	1,030.41	1,093.36	1,068.87	1,085.39	1,087.62	1,082.65	1,081.88	1,080.62	1,079.46	1,080.26	1,080.71
39	1,000.00	1,056.28	1,022.53	1,017.15	1,012.02	1,008.54	1,006.53	1,005.23	1,004.96	1,004.01	1,004.91	1,005.44
40	1,000.00	985.67	988.32	979.48	978.60	970.53	975.89	975.75	975.43	975.62	975.09	975.20
41	1,000.00	1,023.62	1,004.03	1,009.43	1,005.16	1,004.96	1,021.98	1,026.22	1,029.03	1,028.99	1,028.10	1,028.14
42	1,000.00	1,031.47	1,011.93	1,034.52	1,043.51	1,054.65	1,047.45	1,047.24	1,045.33	1,044.29	1,044.13	1,044.68
43	1,000.00	991.54	1,008.16	1,005.75	997.71	976.63	973.04	971.85	972.14	971.73	973.00	973.40
44	1,000.00	990.91	990.51	1,007.51	1,016.96	1,019.52	1,012.78	1,010.56	1,010.79	1,013.18	1,014.77	1,013.96
45	1,000.00	999.71	1,016.58	1,011.18	1,013.67	1,013.83	1,011.58	1,010.73	1,017.80	1,018.67	1,018.05	1,017.00
46	1,000.00	1,014.03	972.75	961.93	959.51	957.63	954.70	955.46	955.07	954.59	955.64	954.94
47	1,000.00	996.23	1,018.81	1,052.85	1,052.67	1,050.02	1,054.71	1,060.83	1,060.56	1,060.17	1,059.11	1,059.51
48	1,000.00	949.50	956.04	939.97	922.85	921.03	920.76	918.98	917.57	918.02	920.38	920.78

Table 1 (page 2 of 4)

Rows are incurral months, columns are durations. The entry in row *k* and column *n* is I_{k+n}^{k}, the insurer's estimate of incurred claims for incurral month *k* as of the end of month $k+n$. Entries have been normalized so that $I_k^k = 1,000$ (or $I_{k+1}^k = 1,000$, if I_k^k was unavailable). Italicized entries are those for which $I_{k+n}^k = I_{k+24}^k$ by definition (see text).

	12	13	14	15	16	17	18	19	20	21	22	23
1	1,062.22	N/A	1,062.02	1,061.51	1,061.59	1,061.36	N/A	1,060.84	1,060.46	1,061.46	1,061.24	1,061.09
2	N/A	1,037.45	1,037.50	1,037.14	1,037.07	N/A	1,036.58	1,035.65	1,035.59	1,034.75	1,034.75	1,034.73
3	947.81	946.03	945.70	943.59	N/A	943.82	942.89	943.22	943.20	943.16	943.08	942.72
4	1,056.92	1,057.17	1,057.28	N/A	1,056.66	1,055.90	1,055.48	1,055.02	1,053.98	1,053.68	1,052.60	1,052.64
5	983.01	982.31	N/A	976.87	976.49	975.83	975.80	975.14	977.55	976.84	977.01	977.04
6	942.73	N/A	941.68	940.66	940.14	938.52	937.41	937.27	936.34	936.41	936.18	935.44
7	N/A	1,043.60	1,043.16	1,042.95	1,041.91	1,041.64	1,041.41	1,040.63	1,040.83	1,040.71	1,040.47	1,040.40
8	1,039.48	1,038.02	1,038.14	1,037.03	1,037.37	1,037.49	1,037.36	1,037.40	1,037.18	1,037.24	1,036.22	1,035.73
9	965.04	964.23	963.18	963.19	963.30	962.76	963.09	962.58	962.38	962.23	962.11	962.08
10	1,055.04	1,054.41	1,054.61	1,054.66	1,054.37	1,054.53	1,054.13	1,053.92	1,053.93	1,053.89	1,053.79	1,054.11
11	1,062.18	1,059.47	1,060.35	1,059.23	1,057.78	1,057.45	1,058.24	1,057.09	1,056.98	1,056.91	1,056.90	1,056.62
12	1,052.82	1,052.32	1,050.55	1,049.52	1,049.82	1,048.74	1,048.24	1,047.78	1,047.58	1,048.21	1,047.72	1,047.64
13	1,096.20	1,095.85	1,095.46	1,095.02	1,094.41	1,092.99	1,093.19	1,093.34	1,099.98	1,099.72	1,099.38	1,099.44
14	971.45	971.46	971.61	970.55	970.26	969.91	969.26	970.05	969.51	969.65	972.18	973.20
15	984.25	983.75	983.45	983.02	982.60	982.73	982.91	983.18	982.34	983.82	983.92	983.91
16	1,019.66	1,009.92	1,018.66	1,018.61	1,018.54	1,018.13	1,016.49	1,017.05	1,016.73	1,016.70	1,016.93	1,016.99
17	867.66	874.96	874.54	876.63	876.67	876.50	876.37	877.46	876.95	877.10	877.05	877.29
18	1,004.68	1,004.48	1,005.01	1,004.81	1,005.14	1,004.67	1,005.66	1,006.06	1,005.71	1,005.61	1,005.69	1,005.49
19	1,006.39	1,006.53	1,006.48	1,006.38	1,005.71	1,006.47	1,006.95	1,007.56	1,007.02	1,007.68	1,007.49	1,007.43
20	935.38	934.80	934.60	935.19	935.47	936.26	937.01	937.28	937.08	937.12	936.93	936.96
21	939.49	939.24	938.87	938.68	939.16	940.30	941.27	941.64	940.32	940.26	940.10	940.00
22	1,000.34	1,000.50	1,001.29	1,002.03	1,002.93	1,003.64	1,004.51	1,003.73	1,004.03	1,003.73	1,003.10	1,003.61
23	935.03	935.42	936.31	936.75	937.64	938.33	937.75	937.53	937.37	936.67	936.53	936.30
24	1,056.91	1,057.79	1,059.76	1,059.85	1,061.19	1,059.61	1,060.15	1,059.92	1,059.39	1,059.11	1,058.91	1,058.79
25	1,023.49	1,024.85	1,024.87	1,025.34	1,024.37	1,025.02	1,025.17	1,024.45	1,024.71	1,024.34	1,024.36	1,023.96
26	950.62	951.35	951.41	950.56	950.77	950.99	950.37	950.22	950.13	949.99	950.58	950.75
27	1,058.72	1,059.49	1,058.68	1,058.96	1,059.13	1,057.84	1,058.12	1,057.98	1,058.04	1,058.27	1,057.67	1,058.63
28	911.30	911.05	912.94	913.62	912.81	912.83	913.33	913.44	913.77	913.79	913.84	913.52
29	1,006.41	1,008.48	1,008.58	1,007.84	1,007.72	1,007.73	1,007.82	1,007.92	1,007.94	1,008.17	1,008.19	1,008.00
30	1,027.58	1,027.57	1,029.00	1,028.75	1,028.81	1,028.12	1,027.57	1,027.44	1,027.18	1,027.54	1,027.72	1,027.65
31	982.17	981.85	981.11	982.20	982.95	983.49	983.44	983.56	983.38	983.51	983.49	983.70
32	927.21	927.10	926.86	926.55	926.03	926.25	926.11	926.08	926.05	925.71	925.97	925.95
33	1,027.54	1,026.97	1,026.43	1,026.03	1,025.98	1,026.17	1,025.81	1,025.80	1,025.85	1,024.93	1,025.13	1,024.79
34	1,026.63	1,026.15	1,025.61	1,024.77	1,027.14	1,027.11	1,027.03	1,027.13	1,027.17	1,027.38	1,027.05	1,026.52
35	1,025.66	1,025.18	1,024.79	1,025.18	1,023.04	1,024.73	1,024.58	1,024.46	1,023.14	1,022.99	1,023.50	1,023.47
36	1,040.81	1,040.84	1,040.74	1,040.48	1,040.79	1,040.49	1,040.53	1,040.33	1,039.97	1,039.75	1,039.61	1,039.89
37	966.27	966.02	965.31	966.23	966.20	966.10	965.62	970.11	970.32	970.58	967.41	967.10
38	1,080.41	1,080.07	1,080.09	1,081.50	1,081.08	1,081.91	1,082.25	1,081.89	1,082.42	1,083.10	1,082.95	1,082.79
39	1,004.56	1,004.68	1,009.15	1,008.59	1,008.43	1,008.46	1,008.49	1,007.87	1,007.84	1,007.46	1,007.65	1,007.52
40	975.45	976.82	976.16	975.99	976.21	975.92	976.54	975.80	975.45	975.43	975.84	975.65
41	1,029.13	1,029.90	1,029.05	1,029.38	1,029.30	1,029.09	1,028.92	1,027.97	1,028.10	1,028.05	1,027.98	1,027.98
42	1,044.63	1,044.06	1,043.82	1,043.92	1,044.02	1,043.39	1,042.30	1,042.03	1,042.02	1,041.86	1,041.80	1,041.88
43	973.19	972.89	972.81	972.26	972.34	971.58	971.68	971.05	971.24	971.06	971.24	971.28
44	1,014.36	1,014.56	1,013.77	1,011.95	1,011.06	1,010.88	1,011.12	1,010.48	1,010.27	1,010.21	1,010.32	1,009.88
45	1,016.75	1,016.59	1,015.91	1,014.86	1,014.72	1,014.73	1,014.54	1,014.03	1,014.06	1,014.03	1,013.80	1,013.79
46	954.61	954.24	952.79	952.72	952.65	952.21	951.61	951.56	951.70	951.53	951.80	951.57
47	1,058.82	1,057.70	1,056.72	1,057.52	1,057.18	1,056.55	1,056.68	1,056.82	1,056.93	1,056.91	1,056.74	1,056.76
48	920.08	919.90	919.60	919.55	919.11	919.36	919.74	919.54	919.59	919.50	919.54	919.46

Table 1 (page 3 of 4)

Rows are incurral months, columns are durations. The entry in row *k* and column *n* is I_{k+n}^{k}, the insurer's estimate of incurred claims for incurral month *k* as of the end of month $k+n$. Entries have been normalized so that $I_k^k = 1,000$ (or $I_{k+1}^{k} = 1,000$, if I_k^k was unavailable). Italicized entries are those for which $I_{k+n}^{k} = I_{k+24}^{k}$ by definition (see text).

	24	25	26	27	28	29	30	31	32	33	34	35
1	1,061.70	*1,061.70*	*1,061.70*	*1,061.70*	*1,061.70*	*1,061.70*	*1,061.70*	*1,061.70*	*1,061.70*	*1,061.70*	*1,061.70*	*1,061.70*
2	1,029.58	*1,029.58*	*1,029.58*	*1,029.58*	*1,029.58*	*1,029.58*	*1,029.58*	*1,029.58*	*1,029.58*	*1,029.58*	*1,029.58*	*1,029.58*
3	943.30	*943.30*	*943.30*	*943.30*	*943.30*	*943.30*	*943.30*	*943.30*	*943.30*	*943.30*	*943.30*	*943.30*
4	1,050.73	*1,050.73*	*1,050.73*	*1,050.73*	*1,050.73*	*1,050.73*	*1,050.73*	*1,050.73*	*1,050.73*	*1,050.73*	*1,050.73*	*1,050.73*
5	975.53	*975.53*	*975.53*	*975.53*	*975.53*	*975.53*	*975.53*	*975.53*	*975.53*	*975.53*	*975.53*	975.57
6	930.22	*930.22*	*930.22*	*930.22*	*930.22*	*930.22*	*930.22*	*930.22*	*930.22*	*930.22*	930.24	930.29
7	1,041.49	*1,041.49*	*1,041.49*	*1,041.49*	*1,041.49*	*1,041.49*	*1,041.49*	*1,041.49*	*1,041.49*	1,041.39	1,041.39	1,040.74
8	1,033.29	*1,033.29*	*1,033.29*	*1,033.29*	*1,033.29*	*1,033.29*	*1,033.29*	*1,033.29*	1,032.96	1,032.98	1,032.97	1,032.98
9	962.63	*962.63*	*962.63*	*962.63*	*962.63*	*962.63*	*962.63*	962.66	962.45	962.81	962.56	962.47
10	1,052.34	*1,052.34*	*1,052.34*	*1,052.34*	*1,052.34*	*1,052.34*	1,052.60	1,053.04	1,053.12	1,053.01	1,053.03	1,050.08
11	1,054.90	*1,054.90*	*1,054.90*	*1,054.90*	*1,054.90*	1,054.91	1,054.94	1,054.98	1,055.01	1,055.05	1,053.72	1,053.70
12	1,049.86	*1,049.86*	*1,049.86*	*1,049.86*	1,049.98	1,050.05	1,049.16	1,048.96	1,049.47	1,049.21	1,049.22	1,049.30
13	1,100.61	*1,100.61*	*1,100.61*	1,100.67	1,100.77	1,100.74	1,100.98	1,101.14	1,101.09	1,101.04	1,101.11	1,101.11
14	974.29	*974.29*	974.48	974.48	974.38	974.52	974.68	974.37	974.37	974.37	974.38	974.37
15	984.44	984.56	984.61	984.53	984.82	984.85	984.36	984.25	984.25	984.21	984.30	984.28
16	1,017.05	1,017.12	1,016.93	1,016.90	1,017.41	1,017.43	1,017.54	1,017.61	1,017.63	1,017.68	1,017.69	1,017.70
17	877.13	877.06	877.48	877.64	877.56	877.53	877.58	877.59	877.59	877.57	877.57	877.69
18	1,005.26	1,004.22	1,004.35	1,004.35	1,004.21	1,004.24	1,004.35	1,004.64	1,004.71	1,004.70	1,004.71	1,004.96
19	1,006.99	*1,007.34*	1,007.43	1,007.43	1,007.47	1,007.44	1,007.85	1,007.83	1,008.19	1,008.20	1,008.43	1,008.63
20	936.57	936.81	936.82	937.12	937.01	936.86	936.89	936.92	936.88	937.20	937.40	937.55
21	939.69	939.96	939.97	939.99	939.97	939.91	939.87	939.99	940.17	940.36	940.55	940.51
22	1,003.04	1,003.14	1,003.10	1,003.23	1,003.13	1,003.17	1,003.30	1,003.59	1,003.81	1,004.00	1,003.92	1,003.86
23	936.05	936.13	936.04	936.20	936.01	935.91	936.25	936.38	936.49	936.37	936.29	936.34
24	1,058.80	1,060.73	1,060.92	1,060.78	1,060.73	1,061.12	1,061.23	1,061.30	1,061.16	1,061.08	1,061.34	1,061.45
25	1,024.58	1,024.53	1,024.16	1,023.69	1,024.10	1,024.35	1,024.48	1,024.35	1,024.25	1,024.31	1,024.41	1,024.29
26	950.93	950.63	951.03	951.20	951.34	951.05	950.97	950.87	950.88	951.19	951.02	950.95
27	1,058.16	1,057.93	1,058.17	1,058.37	1,058.45	1,058.46	1,058.41	1,058.77	1,058.46	1,058.27	1,058.14	1,057.85
28	913.63	913.15	913.25	913.09	912.59	912.47	912.54	912.53	912.41	912.32	912.09	911.87
29	1,008.42	1,008.43	1,008.30	1,008.22	1,008.10	1,008.27	1,008.30	1,008.08	1,008.00	1,007.75	1,007.48	1,007.29
30	1,028.38	1,028.22	1,027.97	1,027.84	1,028.01	1,028.11	1,027.88	1,027.79	1,027.56	1,027.29	1,027.21	1,027.26
31	983.64	983.31	983.36	983.40	983.26	983.18	983.08	982.83	982.59	982.44	982.48	982.47
32	925.75	925.47	925.48	925.56	925.45	925.33	925.12	924.79	924.76	924.83	924.81	924.74
33	1,024.38	1,024.54	1,024.50	1,024.34	1,024.35	1,024.21	1,023.89	1,023.56	1,023.59	1,023.55	1,023.36	1,023.34
34	1,026.59	1,027.13	1,026.69	1,026.84	1,026.73	1,026.53	1,026.26	1,026.21	1,026.22	1,026.19	1,026.19	1,026.23
35	1,023.56	1,023.33	1,023.31	1,023.24	1,023.10	1,022.94	1,023.07	1,023.05	1,022.99	1,022.81	1,022.79	1,022.81
36	1,039.57	1,039.55	1,039.39	1,039.23	1,039.20	1,039.24	1,039.32	1,039.33	1,039.29	1,039.23	1,039.23	1,039.34
37	967.04	966.83	966.67	966.59	966.59	966.56	966.61	966.57	966.57	966.55	966.60	966.58
38	1,082.52	1,082.37	1,082.34	1,082.31	1,082.18	1,082.30	1,082.19	1,082.11	1,082.27	1,082.25	1,082.28	
39	1,007.19	1,007.06	1,007.07	1,007.62	1,007.68	1,007.52	1,007.45	1,007.45	1,006.44	1,006.35		
40	975.71	975.71	975.71	975.54	975.54	975.46	975.47	975.54	975.51			
41	1,028.06	1,028.05	1,027.58	1,027.59	1,027.61	1,027.61	1,027.59	1,027.54				
42	1,041.95	1,041.38	1,041.19	1,041.08	1,041.07	1,041.14	1,041.02					
43	970.93	970.91	970.83	970.72	970.80	970.60						
44	1,009.40	1,009.31	1,009.36	1,009.31	1,009.22							
45	1,014.11	1,014.07	1,014.06	1,013.85								
46	951.70	951.66	951.52									
47	1,056.62	1,058.23										
48	919.53											

Table 1 (page 4 of 4)

Rows are incurral months, columns are durations. The entry in row k and column n is I_{k+n}^{k}, the insurer's estimate of incurred claims for incurral month k as of the end of month $k+n$. Entries have been normalized so that $I_{k}^{k}=1,000$ (or $I_{k+1}^{k}=1,000$, if I_{k}^{k} was unavailable). Italicized entries are those for which $I_{k+n}^{k}=I_{k+24}^{k}$ by definition (see text).

	36	37	38	39	40	41	42	43	44	45	46	47
1	*1,061.70*	*1,061.70*	*1,061.70*	1,061.70	1,061.55	1,061.55	1,061.54	1,061.55	1,061.54	1,061.55	1,061.54	1,061.73
2	*1,029.58*	*1,029.58*	1,029.57	1,029.58	1,029.58	1,029.50	1,029.51	1,029.52	1,029.52	1,029.51	1,029.47	1,029.46
3	*943.30*	943.30	943.30	943.30	943.29	943.29	943.29	943.29	943.29	943.29	943.29	943.24
4	1,050.73	1,050.73	1,050.73	1,050.73	1,050.68	1,050.22	1,050.22	1,050.23	1,050.28	1,050.29	1,050.28	1,050.27
5	975.57	975.58	975.58	975.69	975.19	975.19	975.20	975.20	975.20	975.20	975.19	975.20
6	930.31	930.31	930.34	929.38	929.36	929.90	930.31	930.31	930.31	930.32	930.32	930.32
7	1,040.70	1,040.67	1,040.34	1,040.33	1,040.33	1,040.42	1,040.37	1,040.37	1,040.36	1,040.24	1,040.24	1,040.15
8	1,033.25	1,032.90	1,032.90	1,032.90	1,032.90	1,032.93	1,032.88	1,032.87	1,032.87	1,032.87	1,032.85	1,032.85
9	961.88	961.88	961.95	961.95	962.01	962.01	961.91	961.93	961.94	961.94	961.96	961.88
10	1,050.08	1,050.02	1,050.03	1,050.01	1,050.09	1,050.08	1,050.28	1,050.28	1,050.33	1,050.33	1,050.33	1,050.08
11	1,053.71	1,053.68	1,053.66	1,053.70	1,053.79	1,053.81	1,053.73	1,053.73	1,053.70	1,053.78	1,053.68	1,053.27
12	1,049.30	1,049.30	1,049.26	1,049.27	1,049.35	1,049.39	1,049.75	1,049.64	1,049.55	1,049.55	1,049.49	1,050.44
13	1,101.15	1,101.12	1,101.12	1,101.16	1,101.35	1,101.37	1,101.22	1,101.21	1,101.47	1,101.47	1,101.45	1,101.07
14	974.36	974.36	974.33	974.50	974.56	974.35	974.22	974.24	974.25	974.20	974.20	974.12
15	984.37	984.36	984.51	984.68	984.51	984.45	984.88	984.86	984.83	984.81	984.81	984.95
16	1,018.28	1,018.44	1,019.60	1,021.86	1,021.80	1,021.99	1,021.86	1,021.93	1,021.90	1,021.89	1,021.89	1,021.82
17	877.81	878.01	878.06	877.73	877.97	877.94	877.93	877.91	877.83	877.82	877.82	877.68
18	1,005.10	1,005.29	1,005.15	1,005.21	1,005.18	1,005.22	1,005.05	1,005.05	1,005.03	1,005.03	1,005.03	1,005.36
19	1,008.72	1,008.68	1,006.97	1,006.62	1,006.71	1,006.67	1,006.53	1,006.53	1,006.49	1,006.45	1,006.53	1,006.49
20	937.43	937.30	937.42	937.26	937.20	937.18	937.06	937.06	937.04	937.08	937.13	936.99
21	940.37	940.47	940.80	940.65	940.60	940.54	940.48	940.48	940.48	940.54	940.45	940.46
22	1,003.84	1,004.15	1,004.19	1,003.79	1,003.72	1,003.73	1,003.41	1,003.41	1,003.47	1,003.38	1,003.39	1,002.89
23	936.36	936.17	935.96	935.55	935.65	935.60	935.54	935.59	935.51	935.53	935.45	935.44
24	1,061.38	1,061.31	1,061.28	1,060.91	1,060.83	1,060.75	1,060.83	1,060.74	1,060.74	1,060.72	1,060.72	1,060.43
25	1,024.18	1,023.90	1,023.84	1,023.73	1,023.71	1,023.76	1,023.69	1,023.70	1,023.68	1,023.68	1,023.68	1,023.67
26	950.72	950.47	950.63	950.48	950.49	950.43	950.44	950.39	950.39	950.39	950.38	
27	1,057.64	1,057.62	1,057.65	1,057.63	1,057.54	1,057.52	1,057.49	1,057.49	1,057.48	1,057.48		
28	911.81	911.86	911.89	911.79	911.76	911.69	911.69	911.69	911.69			
29	1,007.35	1,007.37	1,007.30	1,007.28	1,007.26	1,007.25	1,007.37	1,007.22				
30	1,027.27	1,027.17	1,027.18	1,027.18	1,027.15	1,027.12	1,027.12					
31	982.37	982.37	982.32	982.33	982.27	982.28						
32	924.71	924.68	924.70	924.70	924.65							
33	1,023.33	1,023.33	1,023.74	1,023.41								
34	1,026.21	1,026.27	1,026.16									
35	1,022.95	1,022.97										
36	1,039.35											
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At the start of the 72-month period, the insurer believed that runout for any given incurral month was completed after 25 months; that is, the insurer set $N = 24$ and therefore did not update its incurred claim estimates I_{k+n}^{k} when $n > 24$. However, starting at month $t = 40$, the insurer revised its belief and increased *N* from 24 to 47, recognizing that runout might not be complete until four years are elapsed. Because this change took place in the middle of our study period, in some entries (specifically, those I_{k+n}^{k} where $n > 24$ and $k + n < 40$) the value of I_{k+n}^{k} included in the dataset is actually the frozen value I_{k+24}^{k}, as opposed to an updated value. These frozen entries are shown in italics in Table 1.

To use these data to estimate risk release factors, we need to know the actual ultimate incurred claims I_U^k for each incurral month *k*. In light of the fact that the insurer now believes that $N = 47$ and that the dataset extends for 72 months, we can confidently set $I_U^k = I_{k+47}^k$ for $1 \le k \le 25$. For $25 < k \le 48$, we are assuming that runout is complete at the end of our 72-month data period, and hence we are setting $I_U^k = I_{72}^k$. Although this is slightly inaccurate, it allows us to include a larger set of incurral months in our study period, including months that are more recent and hence likely to be more representative of current conditions.

Recall that in Section 3.2, we defined

$$\varepsilon_n^k = \frac{I_{k+n}^k - I_U^k}{I_U^k},$$

that is, ε_n^k represents the percentage by which the insurer's estimate I_{k+n}^k of incurred claims for month *k* using $n+1$ months of paid claims differs from the ultimate value. Table 2 presents observed values of ε_n^k derived from the data in Table 1. In the interest of conserving space, only selected values of *n* are shown in Table 2, namely, those values representing 1, 2, 3, 6, 9, 12, 18, 24, 30, and 36 months of paid claims data.

Also, recall that in Section 3.2, for $n > 0$ we expressed the risk release factor φ_n as

$$\varphi_n = \varphi_0 \frac{\sigma_n}{\sigma_0},$$

where σ_n is the standard deviation of $\{\varepsilon_n^k\}$ with *n* fixed and *k* varying. Hence, if we select an estimate for φ_0, and obtain estimates of the vector $\{\sigma_n\}$ of standard deviations, then we can derive estimates of the vector $\{\varphi_n\}$ of risk release factors via the above expression.

As discussed earlier, φ_0 represents the amount of risk that exists in the insurer's incurred claim estimates using one month of paid claims, relative to the amount of risk that exists in the insurer's incurred claim estimates before any claims have been paid. In Section 3.1 we put forward a plausibility argument to support the notion that φ_0 may be equal to one, in light of the fact that the insurer's estimate of I_k^k is generally independent of the actual amount of claims paid in month *k* for claims incurred in month *k*. As such, for now we will set $\varphi_0 = 1$, although we will later explore the implications of alternate values of φ_0.

Table 3 shows the sample standard deviations s_n obtained from the observed ε_n^k values derived from Table 1. Each s_n is an unbiased estimator of σ_n. As such, in light of our decision to set $\varphi_0 = 1$, the ratio $s_n \div s_0$ shown in Table 3 is an estimator of the risk release factor φ_n.

Table 2

Rows are incurral months, columns are durations; only selected durations are shown below, to conserve space. The entry in row k and column n is ε_n^k, the percentage difference between I_{k+n}^k (from Table 1) and I_U^k. Italicized entries are those for which $\varepsilon_n^k = \varepsilon_{24}^k$ by definition (see text).

	0	1	2	5	8	11	17	23	29	35
1	−5.814%	−5.259%	0.011%	−0.493%	0.105%	−0.348%	−0.035%	−0.060%	*−0.003%*	*−0.003%*
2	−2.862%	−2.276%	−3.531%	−0.912%	−0.070%	0.536%	N/A	0.512%	*0.011%*	*0.011%*
3	6.017%	3.147%	2.715%	−1.231%	−1.440%	N/A	0.061%	−0.056%	*0.006%*	*0.006%*
4	−4.787%	−2.421%	0.071%	0.927%	0.181%	0.763%	0.536%	0.225%	*0.043%*	*0.043%*
5	2.543%	3.813%	3.828%	0.666%	1.064%	0.718%	0.065%	0.189%	*0.034%*	0.038%
6	7.490%	7.016%	3.064%	1.667%	N/A	1.271%	0.881%	0.551%	*−0.010%*	−0.002%
7	−3.860%	−2.616%	−1.643%	0.231%	0.869%	0.519%	0.143%	0.024%	*0.129%*	0.057%
8	−3.180%	−3.479%	−0.113%	0.821%	0.891%	N/A	0.450%	0.279%	*0.043%*	0.013%
9	3.964%	2.435%	3.442%	N/A	0.445%	0.556%	0.092%	0.021%	*0.079%*	0.062%
10	−4.769%	−5.911%	−1.635%	−1.888%	1.537%	0.732%	0.424%	0.384%	*0.215%*	−0.001%
11	−5.058%	−4.902%	−0.741%	1.892%	N/A	0.868%	0.397%	0.318%	0.156%	0.041%
12	−4.802%	−3.721%	N/A	0.437%	−0.155%	0.253%	−0.162%	−0.267%	−0.037%	−0.109%
13	−9.180%	N/A	−2.890%	0.825%	0.085%	−0.335%	−0.734%	−0.148%	−0.031%	0.003%
14	N/A	2.657%	1.831%	N/A	0.169%	0.168%	−0.432%	−0.094%	0.041%	0.025%
15	1.528%	2.670%	−0.210%	0.520%	0.107%	−0.048%	−0.225%	−0.105%	−0.011%	−0.068%
16	−2.136%	9.360%	−3.506%	0.427%	−0.234%	−0.084%	−0.362%	−0.473%	−0.430%	−0.403%
17	13.936%	0.648%	N/A	0.855%	0.387%	−0.037%	−0.135%	−0.044%	−0.017%	0.001%
18	−0.533%	N/A	0.168%	0.329%	0.034%	−1.204%	−0.069%	0.012%	−0.112%	−0.041%
19	N/A	−0.645%	0.576%	−0.081%	−0.399%	−0.514%	−0.002%	0.093%	0.094%	0.213%
20	6.725%	2.759%	−0.064%	0.499%	0.086%	−0.193%	−0.078%	−0.002%	−0.014%	0.061%
21	6.331%	1.916%	0.181%	0.777%	0.311%	0.154%	−0.017%	−0.048%	−0.058%	0.006%
22	−0.289%	0.026%	−1.006%	−0.602%	−0.098%	−0.284%	0.075%	0.071%	0.028%	0.096%
23	6.902%	1.598%	0.692%	0.462%	0.439%	0.034%	0.309%	0.092%	0.050%	0.096%
24	−5.699%	−3.311%	−2.303%	−0.310%	−0.042%	−0.329%	−0.078%	−0.155%	0.065%	0.096%
25	−2.312%	−1.021%	−1.008%	0.168%	−0.236%	−0.092%	0.133%	0.029%	0.067%	0.061%
26	5.221%	1.622%	−0.993%	0.167%	−0.235%	−0.059%	0.064%	0.039%	0.070%	0.059%
27	−5.436%	0.448%	−2.414%	−0.517%	−0.741%	0.102%	0.034%	0.108%	0.093%	0.035%
28	9.687%	−1.138%	−0.400%	−0.532%	−0.435%	−0.071%	0.125%	0.201%	0.086%	0.020%
29	−0.716%	−0.683%	−0.727%	−0.560%	−0.128%	0.235%	0.051%	0.078%	0.105%	0.008%
30	−2.640%	−0.653%	−1.351%	−0.733%	0.110%	−0.081%	0.097%	0.052%	0.097%	0.013%
31	1.804%	−0.005%	−0.862%	−0.997%	−0.440%	−0.006%	0.124%	0.145%	0.092%	0.019%
32	8.149%	4.484%	1.471%	−0.410%	0.331%	0.214%	0.173%	0.141%	0.074%	0.010%
33	−2.287%	0.446%	0.083%	0.227%	0.391%	0.390%	0.270%	0.135%	0.078%	−0.007%
34	−2.549%	−3.251%	0.843%	−0.479%	0.116%	−0.021%	0.093%	0.035%	0.036%	0.007%
35	−2.246%	1.878%	2.923%	0.270%	0.195%	0.213%	0.172%	0.049%	−0.004%	−0.016%
36	−3.786%	−1.189%	−2.467%	−1.787%	−0.053%	0.091%	0.109%	0.051%	−0.011%	−0.001%
37	3.457%	0.000%	−0.583%	0.073%	−0.096%	−0.103%	−0.050%	0.053%	−0.002%	
38	−7.602%	−4.792%	1.024%	0.493%	−0.153%	−0.145%	−0.034%	0.048%	0.002%	
39	−0.631%	4.961%	1.609%	0.218%	−0.138%	−0.091%	0.210%	0.117%	0.117%	
40	2.511%	1.042%	1.313%	−0.510%	−0.008%	−0.032%	0.042%	0.014%	−0.005%	
41	−2.681%	−0.382%	−2.288%	−2.198%	0.145%	0.058%	0.151%	0.043%	0.007%	
42	−3.940%	−0.917%	−2.794%	1.309%	0.414%	0.352%	0.228%	0.083%	0.012%	
43	3.029%	2.158%	3.870%	0.621%	0.158%	0.288%	0.101%	0.070%		
44	−0.913%	−1.814%	−1.854%	1.021%	0.156%	0.470%	0.165%	0.065%		
45	−1.366%	−1.395%	0.269%	−0.002%	0.389%	0.311%	0.087%	−0.006%		
46	5.095%	6.569%	2.231%	0.642%	0.374%	0.359%	0.072%	0.006%		
47	−5.503%	−5.859%	−3.725%	−0.776%	0.220%	0.121%	−0.159%	−0.139%		
48	8.751%	3.259%	3.971%	0.163%	−0.214%	0.135%	−0.018%	−0.008%		

Table 3 actually includes two different versions of the $\{s_n\}$. The first set comes from considering all values of *k* in our dataset, namely, $1 \le k \le 48$, in computing the sample standard deviations. (Note that for $25 < k \le 48$, we excluded ε_{72-k}^{k} in calculating s_{72-k}, because we had artificially forced ε_{72-k}^{k} to be zero via our definition of I_U^k.) The second set comes from considering only those values of *k* for which the claims runout is truly complete, namely, $1 \le k \le 25$. As shown in Table 3, the differences between the two sets of sample standard deviation estimates are not highly significant. We prefer to work with the first set, since it reflects a broader and more recent set of incurral months.

Before taking the $s_n \div s_0$ values shown in Table 3 and using them as our estimated risk release factors for this business cell, it is appropriate to make some minor modifications to address two issues. First, we had commented earlier that, in theory, the $\{\varphi_n\}$ should form a nonincreasing sequence. This is not uniformly true in the sample estimates; for example, Table 3 shows that $s_8 \div s_0 = 0.0889 < 0.0918 = s_9 \div s_0$. Therefore, it would be appropriate to smooth the sample estimates to obtain a nonincreasing sequence. Second, the sample estimates shown in Table 3 are essentially flat over the range $25 \le n \le 34$. This may be an artifact of inadequacies in the underlying data, specifically that we have $\varepsilon_n^k = \varepsilon_{24}^k$ by definition in certain situations. It would seem to be appropriate to correct for this by assuming that the φ_n actually diminish over that range of *n* rather than remaining flat.

As such, Table 4 presents a straightforward attempt to round and smooth the $s_n \div s_0$ values shown in Table 3 (for the full table, rather than the subset) to produce an appropriate vector $\{\varphi_n\}$ of risk release factors, addressing the two issues raised above.

Table 4 also includes a vector $\{\gamma_n\}$ of completion factors. These completion factor estimates were based on our analysis of the triangle of incremental paid claims for the business cell under discussion, with some rounding and smoothing. As such, they are representative of the insurer's claims processing speed for this particular business cell but do not represent the actual completion factors employed by the insurer at any point in time for this cell.

In Section 4.2 we will make use of both the risk release factors and the completion factors from Table 4 in a model office projection comparing our proposed claim liability formula relative to the current practice formula. As a prelude, we offer some initial observations.

First, consider the implications of the values shown in Table 4 for $n = 2$. The completion factor indicates that, for this business cell, 92.3 percent of the claims incurred in a given month are expected to be paid within the first three months. Under the current practice liability formula, this implies that the insurer expects to recognize the vast majority of its profits on that month's premiums within the first three months. However, the risk release factor indicates that only 60 percent of the risk associated with the estimation of incurred claims for that month has been released during the first three months. As such, current practice leads to a significantly accelerated recognition of the insurer's expected profits for the month in question, relative to what a release-from-risk approach to claim liability margins would imply.

Table 3

Sample standard deviations s_n computed from the ε_n^k data derived from Table 1. The first set of figures are computed from the full dataset; the second set of figures are computed from the subset where $k \leq 25$.

n	s_n (Full)	$s_n \div s_0$	s_n (Subset)	$s_n \div s_0$
0	5.2375%	1.0000	5.7695%	1.0000
1	3.4185%	0.6527	3.9212%	0.6796
2	2.0718%	0.3956	2.0641%	0.3578
3	1.2921%	0.2467	1.2656%	0.2194
4	1.0389%	0.1984	1.0889%	0.1887
5	0.8681%	0.1658	0.8716%	0.1511
6	0.5818%	0.1111	0.6503%	0.1127
7	0.5782%	0.1104	0.7091%	0.1229
8	0.4656%	0.0889	0.5822%	0.1009
9	0.4810%	0.0918	0.6424%	0.1113
10	0.4020%	0.0768	0.5341%	0.0926
11	0.4083%	0.0780	0.5543%	0.0961
12	0.3903%	0.0745	0.5269%	0.0913
13	0.3410%	0.0651	0.4522%	0.0784
14	0.3144%	0.0600	0.4159%	0.0721
15	0.2753%	0.0526	0.3707%	0.0643
16	0.2746%	0.0524	0.3746%	0.0649
17	0.2508%	0.0479	0.3404%	0.0590
18	0.2640%	0.0504	0.3620%	0.0628
19	0.2445%	0.0467	0.3275%	0.0568
20	0.2191%	0.0418	0.2895%	0.0502
21	0.2057%	0.0393	0.2702%	0.0468
22	0.1822%	0.0348	0.2451%	0.0425
23	0.1729%	0.0330	0.2330%	0.0404
24	0.1060%	0.0202	0.1250%	0.0217
25	0.0974%	0.0186	0.1222%	0.0212
26	0.0988%	0.0189	0.1233%	0.0214
27	0.1008%	0.0193	0.1235%	0.0214
28	0.0945%	0.0180	0.1149%	0.0199
29	0.0947%	0.0181	0.1155%	0.0200
30	0.0989%	0.0189	0.1216%	0.0211
31	0.1018%	0.0194	0.1243%	0.0215
32	0.1003%	0.0192	0.1236%	0.0214
33	0.1014%	0.0194	0.1235%	0.0214
34	0.0994%	0.0190	0.1203%	0.0209
35	0.0886%	0.0169	0.1061%	0.0184
36	0.0813%	0.0155	0.0965%	0.0167
37	0.0796%	0.0152	0.0932%	0.0162
38	0.0561%	0.0107	0.0645%	0.0112
39	0.0369%	0.0070	0.0419%	0.0073
40	0.0371%	0.0071	0.0415%	0.0072
41	0.0317%	0.0061	0.0348%	0.0060
42	0.0217%	0.0041	0.0233%	0.0040
43	0.0229%	0.0044	0.0242%	0.0042
44	0.0255%	0.0049	0.0265%	0.0046
45	0.0256%	0.0049	0.0261%	0.0045
46	0.0264%	0.0050	0.0264%	0.0046

Table 4

Risk release factors φ_n , and completion factors γ_n , used in Section 4.2.

n	φ_n	γ_n
0	1.000	0.30600
1	0.650	0.81400
2	0.400	0.92300
3	0.250	0.95900
4	0.200	0.97500
5	0.160	0.98300
6	0.130	0.99000
7	0.110	0.99250
8	0.100	0.99400
9	0.090	0.99550
10	0.085	0.99700
11	0.080	0.99750
12	0.075	0.99800
13	0.065	0.99850
14	0.060	0.99900
15	0.056	0.99910
16	0.053	0.99920
17	0.050	0.99930
18	0.048	0.99940
19	0.046	0.99950
20	0.043	0.99955
21	0.040	0.99960
22	0.035	0.99965
23	0.030	0.99970
24	0.025	0.99972
25	0.024	0.99974
26	0.023	0.99976
27	0.022	0.99978
28	0.021	0.99980
29	0.020	0.99982
30	0.019	0.99984
31	0.018	0.99986
32	0.017	0.99988
33	0.016	0.99990
34	0.015	0.99992
35	0.014	0.99994
36	0.013	0.99996
37	0.012	0.99998
38	0.011	1.00000
39	0.010	1.00002
40	0.009	1.00004
41	0.008	1.00006
42	0.007	1.00008
43	0.006	1.00010
44	0.005	1.00008
45	0.004	1.00006
46	0.002	1.00004
47	0.000	1.00000

Similarly, consider the values in Table 4 for $n = 11$. The completion factor of 99.75 percent indicates that the expected value of claims incurred in a given month but paid after the first year is completed is only 1/400th of the ultimate incurred claims for that month. However, the risk release factor indicates that 8 percent of the original claims estimation risk for a given month remains intact after a year. As such, although the base estimate of the durational liability component V_t^{11} will be very small, the risk associated with that component—and hence the risk margin that our proposed liability formula will include in that component—is not insignificant.

Finally, consider the values in Table 4 for $n \geq 38$. In a footnote in Section 2.2, we commented that for U.S. medical insurance, the triangle of incremental claim payments frequently has a large number of negative values, particularly in the later durations. For this business cell, the influence of negative increments is such that the expected value of V_t^n is zero for $n = 38$, and very slightly negative for $38 < n < 47$. However, as the risk release factors for these durations in Table 4 demonstrate, a small amount of risk still is associated with these durational liability components. Under current practice, no margin would be included in V_t^{38}, and negative margin would be included in V_t^n for $38 < n < 47$. Under our proposed liability formula, by contrast, positive risk margin would be included in V_t^n whenever $\varphi_n > 0$.

4.2 Applying the Proposed Liability Formula

In Section 4.1 we derived a vector of risk release factors (shown in Table 4) from actual data for a sizeable block of U.S. medical insurance business. In this subsection we use these risk release factors in demonstrating the impact of the claim liability formula proposed in Section 3.2.

As we had done throughout Section 3, we start by fixing an incurral month *k,* and we contemplate a model office projection showing the expected month-by-month evolution of the insurer's financial statement with respect to that single incurral month. For ease of notation, we will set $k = 0$.

For our projection we will assume that the risk release factors $\{\varphi_n\}$ and completion factors $\{\gamma_n\}$ are as shown in Table 4. We also make a number of other assumptions, as follows:

- Premium earned for incurral month 0: $P_0 = 1{,}000{,}000$
- Expected incurred loss ratio for incurral month 0: $\lambda_0 = 85.0\%$
- Expected profit margin for incurral month 0, as a percentage of premium: $\rho_0 = 5.0\%$
- Decomposition of ρ_0 into risk and non-risk pieces: $\rho_0^R = 3.5\%$, $\rho_0^S = 1.5\%$.

These assumption choices are fairly arbitrary but are intended to be broadly representative of values that may currently exist in the U.S. medical insurance market. (In particular, note that they do not represent the actual profit margin or loss ratio targets for the real-life business cell from which we derived the values shown in Table 4.) Later in this subsection, we will consider the impact of varying these assumptions.

Table 5 shows selected data from a model office projection under these assumptions, using the current practice liability formula. The rows in Table 5 represent months, starting at $t = 0$ and ending once runout for incurral month 0 is complete, at $t = 47$. The first column is $I_t^0 - C_t^0$, the base estimate of the claim liability for incurral month 0 at the end of month *t.* The second column is the amount of explicit margin included in the claim liability under current practice. For purposes of this illustration, we have assumed that same margin factor μ is used at all times, and that the margin factor has been calibrated to premiums to produce no gain or loss at issue; this implies that $\mu = \rho_0 \div \lambda_0 = 5.88\%$. The third column is V_t^t, the claim liability for incurral month 0 as of the end of month *t,* which is simply the sum of the two previous columns. Finally, the last column in Table 5 is the cumulative amount of profit that the insurer expects to have recognized for incurral month 0 through the end of month *t.* Denoting this quantity by Π_t^0, we have

$$\Pi_t^0 = \sum_{n=0}^{t} \pi_n^0 = \gamma_t \rho_0 P_0$$

using formulas developed in Section 3.1.

Table 6 shows comparable data from a model office projection under these same assumptions, but now using our proposed liability formula. The first column is the same as in Table 5. The second column is the service margin included in the claim liability, which is the base liability multiplied by a service margin factor $\mu^S = \rho_0^S \div \lambda_0 = 1.76\%$. The third column is the risk margin included in the claim liability, which is the current estimate of incurred claims, multiplied by a risk release factor, then multiplied by a risk margin factor $\mu^R = \rho_0^R \div \lambda_0 = 4.12\%$. Because the incurred claims estimate is always just $\lambda_0 P_0$ in a model office projection, note that the formula for the risk margin in the model office projection at month *t* simplifies to $\varphi_t \rho_0^R P_0$. The next column is the claim liability V_t^t, which is the sum of the previous three columns. Finally, the last column in Table 6 is Π_t^0, the cumulative gain that the insurer expects to have recognized for incurral month 0 through the end of month *t,* which is

$$\Pi_t^0 = \sum_{n=0}^{t} \pi_n^0 = \left[\gamma_t \rho_0^S + (1 - \varphi_t)\rho_0^R\right] P_0$$

using formulas developed in Section 3.2.

Comparing the rightmost columns of Tables 5 and 6, we see that our proposed claim liability formula is significantly more conservative than the current practice formula with respect to the timing of the insurer's recognition of expected profits. This reflects the fact that, in Table 4, the risk release factors grade to zero more slowly than the completion factors grade to one.

The flip side of this observation is that our proposed claim liability formula includes significantly more margin in the liability than does the calibrated version of the current practice formula, because the margin is the vehicle by which expected profits are appropriately deferred to future periods. Indeed, in this example the durational claim liability component V_t^t is, for every value of *t,* higher under our proposed formula (Table 6) than under the calibrated current formula (Table 5). Interestingly, once we get to $t = 10$ and beyond, the explicit margin included under our proposed formula is actually larger than the base estimate of the liability. This unexpected result reflects the fact that, for these values of *t,* γ_t is very close to 1, yet φ_t is not correspondingly close to 0.

Table 5

Model office projection using the current practice liability formula. Completion factors are as in Table 4. Explicit margin factor has been calibrated to expected profit margin in premiums, so $\mu = 5\% \div 85\% = 5.88\%$.

t	Base Liability $I_t^0 - C_t^0$	Margin $\mu(I_t^0 - C_t^0)$	Recorded Liability V_t^t	Cumulative Profit Π_t^0
0	589,900	34,700	624,600	15,300
1	158,100	9,300	167,400	40,700
2	65,450	3,850	69,300	46,150
3	34,850	2,050	36,900	47,950
4	21,250	1,250	22,500	48,750
5	14,450	850	15,300	49,150
6	8,500	500	9,000	49,500
7	6,375	375	6,750	49,625
8	5,100	300	5,400	49,700
9	3,825	225	4,050	49,775
10	2,550	150	2,700	49,850
11	2,125	125	2,250	49,875
12	1,700	100	1,800	49,900
13	1,275	75	1,350	49,925
14	850	50	900	49,950
15	765	45	810	49,955
16	680	40	720	49,960
17	595	35	630	49,965
18	510	30	540	49,970
19	425	25	450	49,975
20	383	23	405	49,978
21	340	20	360	49,980
22	298	18	315	49,983
23	255	15	270	49,985
24	238	14	252	49,986
25	221	13	234	49,987
26	204	12	216	49,988
27	187	11	198	49,989
28	170	10	180	49,990
29	153	9	162	49,991
30	136	8	144	49,992
31	119	7	126	49,993
32	102	6	108	49,994
33	85	5	90	49,995
34	68	4	72	49,996
35	51	3	54	49,997
36	34	2	36	49,998
37	17	1	18	49,999
38	0	0	0	50,000
39	−17	−1	−18	50,001
40	−34	−2	−36	50,002
41	−51	−3	−54	50,003
42	−68	−4	−72	50,004
43	−85	−5	−90	50,005
44	−68	−4	−72	50,004
45	−51	−3	−54	50,003
46	−34	−2	−36	50,002
47	0	0	0	50,000

Table 6

Model office projection using our proposed liability formula. Completion factors and risk release factors are as in Table 4. Explicit risk margin and service margin factors have been calibrated to expected profit margin in premiums, so $\mu^R = 3.5\% \div 85\% = 4.12\%$ and $\mu^S = 1.5\% \div 85\% = 1.76\%$.

t	Base Liability $I_t^0 - C_t^0$	Service Margin $\mu^S(I_t^0 - C_t^0)$	Risk Margin $\mu^R \varphi_t I_t^0$	Recorded Liability V_t^t	Cumulative Profit Π_t^0
0	589,900	10,410	35,000	635,310	4,590
1	158,100	2,790	22,750	183,640	24,460
2	65,450	1,155	14,000	80,605	34,845
3	34,850	615	8,750	44,215	40,635
4	21,250	375	7,000	28,625	42,625
5	14,450	255	5,600	20,305	44,145
6	8,500	150	4,550	13,200	45,300
7	6,375	113	3,850	10,338	46,038
8	5,100	90	3,500	8,690	46,410
9	3,825	68	3,150	7,043	46,783
10	2,550	45	2,975	5,570	46,980
11	2,125	38	2,800	4,963	47,163
12	1,700	30	2,625	4,355	47,345
13	1,275	23	2,275	3,573	47,703
14	850	15	2,100	2,965	47,885
15	765	14	1,960	2,739	48,027
16	680	12	1,855	2,547	48,133
17	595	11	1,750	2,356	48,240
18	510	9	1,680	2,199	48,311
19	425	8	1,610	2,043	48,383
20	383	7	1,505	1,894	48,488
21	340	6	1,400	1,746	48,594
22	298	5	1,225	1,528	48,770
23	255	5	1,050	1,310	48,946
24	238	4	875	1,117	49,121
25	221	4	840	1,065	49,156
26	204	4	805	1,013	49,191
27	187	3	770	960	49,227
28	170	3	735	908	49,262
29	153	3	700	856	49,297
30	136	2	665	803	49,333
31	119	2	630	751	49,368
32	102	2	595	699	49,403
33	85	2	560	647	49,439
34	68	1	525	594	49,474
35	51	1	490	542	49,509
36	34	1	455	490	49,544
37	17	0	420	437	49,580
38	0	0	385	385	49,615
39	−17	0	350	333	49,650
40	−34	−1	315	280	49,686
41	−51	−1	280	228	49,721
42	−68	−1	245	176	49,756
43	−85	−2	210	124	49,792
44	−68	−1	175	106	49,826
45	−51	−1	140	88	49,861
46	−34	−1	70	35	49,931
47	0	0	0	0	50,000

To meaningfully discuss the amount of margin that our proposed formula includes in the claim liability, it is useful to consider a model office projection for an insurer's business cell viewed at a single point of time, as opposed to the model office projection above for a single incurral month within that cell viewed as it progresses through time.

As such, we now fix a valuation month *t,* and we assume that the insurer has been writing premiums in all incurral months *k* for which $t - N \le k \le t$. For the sake of simplicity, we also assume that the insurer's target pricing has not changed over this period, meaning that the target loss ratio λ, target risk profit ρ^R, and target service profit ρ^S are independent of the incurral month *k.*[20] Finally, we also assume for the sake of simplicity that there is a constant premium growth rate, meaning that there is a parameter *g* such that $P_{k+1} = (1+g)P_k$ for all *k.*

With these assumptions, the durational component V_t^n in the model office projection using our proposed liability formula can be written as

$$V_t^n = [(\lambda + \rho^S)(1-\gamma_n) + \rho^R \varphi_n] P_{t-n},$$

which implies that

$$V_t = P_t \sum_{n=0}^{N} [(\lambda + \rho^S)(1-\gamma_n) + \rho^R \varphi_n](1+g)^{-n}.$$

We are interested in the margin percentage implicit in the recorded claim liability, by which we mean the level of explicit margin that V_t contains in the model office projection, expressed as a percentage of the base estimate of the claim liability. Denoting this margin percentage by *M,* the above equation implies that

$$M = \frac{\sum_{n=0}^{N} [\mu^S (1-\gamma_n) + \mu^R \varphi_n](1+g)^{-n}}{\sum_{n=0}^{N} (1-\gamma_n)(1+g)^{-n}},$$

where, as before, $\mu^R = \rho^R \div \lambda$ and $\mu^S = \rho^S \div \lambda$.

We can rewrite this as

$$M = \mu^S + \frac{\sum_{n=0}^{N} \varphi_n (1+g)^{-n}}{\sum_{n=0}^{N} (1-\gamma_n)(1+g)^{-n}} \mu^R.$$

Contrast this with the analogous situation under the calibrated version of the current practice formula, where tautologically we have $M = \mu = \mu^S + \mu^R$.[21]

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[20] Here we intentionally ignore the fact that, in reality, the insurer's expected loss ratio (and hence its target profit margins) will actually vary by calendar month, for a variety of reasons. As noted in Bell (2007), under CXV the insurer may be able, via the pre-claims liability, to achieve something close to a level pattern of expected profits by calendar month. Further discussion of that issue lies outside the intended scope of this paper.

[21] As these formulas suggest, to a certain extent we can view the current practice liability formula as being a special case of our proposed liability formula; namely, it is the case where $\varphi_n = 1 - \gamma_n$ for every *n* and where the margin factors have been calibrated to achieve no gain or loss at issue.

Table 7 shows the margin percentage *M* in the model office projection under our proposed liability formula for different values of the monthly premium growth rate *g*, using the completion factors and risk release factors from Table 4, and using the baseline assumptions stated earlier, namely, $\rho^R = 3.5\%$, $\rho^S = 1.5\%$, and $\lambda = 85\%$.

Table 7

Entries in the table represent the margin percentage *M* as a function of the growth rate *g*, assuming that $\rho^R = 3.5\%$, $\rho^S = 1.5\%$, $\lambda = 85\%$, and completion factors and risk release factors are as in Table 4.

g	−1.0%	−0.5%	0.0%	0.5%	1.0%	1.5%	2.0%
M	18.67%	18.12%	17.62%	17.18%	16.77%	16.41%	16.07%

In particular, for the steady state case where $g = 0\%$, the explicit margin contained in V_t under our proposed liability formula is almost exactly three times the explicit margin contained in V_t under the calibrated version of the current practice formula: 17.62 percent of the base liability estimate, versus 5.88 percent.[22]

Going forward, we shall view the case in which $g = 1\%$ as our baseline, with a corresponding margin percentage under our proposed formula of 16.77 percent, and we perform sensitivity analysis around this baseline case. Our reason for focusing on a case with premium growth over time, rather than the steady state case $g = 0\%$, is that medical insurance is intrinsically an inflationary coverage. All else being equal, per-member premiums will rise over time because of increases in the cost of health care services. As such, an assumption that premiums are steadily rising at a rate of 1 percent per month is more representative of reality for most medical insurers than an assumption that premiums remain flat over time, taking into account both per-member premium trend and membership growth.

Table 8 shows how the margin percentage in the model office projection changes as we vary the target profit margins ρ^R and ρ^S from the values used in our baseline case, keeping the loss ratio λ fixed at 85 percent. In Table 8 each row represents a fixed value of the total target profit margin $\rho = \rho^R + \rho^S$, while each column represents a fixed value of the service portion of that profit margin, ρ^S. The italicized entry in the table, corresponding to $\rho = 5.0\%$ and $\rho^S = 1.5\%$, represents our baseline case. Our formula above for *M* implies that, for fixed ρ, the amount of explicit margin included in our proposed liability formula decreases as ρ^S, the portion of ρ deemed to constitute the insurer's required compensation for non-risk services, increases.

[22] Note that this particular conclusion could have been derived directly from Tables 5 and 6, using the following observation: If the insurer writes the same premium in each incurral month, then in the model office projection, the claim liability under our proposed formula (respectively, under the calibrated current practice formula) at the end of any particular month is simply the sum across all rows of the V_t^t column in Table 6 (respectively, Table 5), because for any $n < t$ we have $V_t = V_n$ and, in particular, $V_t^n = V_n^n$.

Table 8

Rows represent total profit margin targets, $\rho = \rho^R + \rho^S$; columns represent the profit margin target for non-risk services, ρ^S. Entries in the table represent the margin percentage M as a function of ρ and ρ^S, assuming that $\lambda = 85\%$, $g = 1\%$, and completion factors and risk release factors are as in Table 4.

	0.5%	1.0%	1.5%	2.0%	2.5%	3.0%
2.0%	7.02%	5.46%	3.91%			
2.5%	9.16%	7.61%	6.05%	4.50%		
3.0%	11.31%	9.75%	8.20%	6.64%	5.09%	
3.5%	13.45%	11.90%	10.34%	8.78%	7.23%	5.67%
4.0%	15.60%	14.04%	12.48%	10.93%	9.37%	7.82%
4.5%	17.74%	16.18%	14.63%	13.07%	11.52%	9.96%
5.0%	19.88%	18.33%	*16.77%*	15.22%	13.66%	12.11%
5.5%	22.03%	20.47%	18.92%	17.36%	15.81%	14.25%
6.0%	24.17%	22.62%	21.06%	19.51%	17.95%	16.39%
6.5%	26.32%	24.76%	23.20%	21.65%	20.09%	18.54%
7.0%	28.46%	26.90%	25.35%	23.79%	22.24%	20.68%

Table 8 demonstrates that the margin percentage M is quite sensitive to the manner in which ρ is decomposed into ρ^R versus ρ^S. This is particularly noteworthy since the decomposition of ρ may not be explicit in the insurer's pricing formula.

Table 8 also demonstrates that the margin percentage is quite sensitive to the total level of profit margin ρ contemplated in the insurer's pricing. This observation may be obvious in context, for if the claim liability margin is the vehicle regulating the emergence of expected profits, it stands to reason that the margin needs to be higher for more profitable products. However, it represents a marked difference from current practice, where as noted earlier the expected profitability of products does not influence the insurer's choice of margin factor.

Table 9 shows how the margin percentage in the model office projection changes as we vary the target loss ratio λ from the value used in our baseline case, keeping the target profit margins fixed at $\rho^R = 3.5\%$ and $\rho^S = 1.5\%$.

Table 9

Entries in the table represent the margin percentage M as a function of the loss ratio λ, assuming that $\rho^R = 3.5\%$, $\rho^S = 1.5\%$, $g = 1\%$, and completion factors and risk release factors are as in Table 4.

λ	75.0%	77.5%	80.0%	82.5%	85.0%	87.5%	90.0%
M	19.01%	18.40%	17.82%	17.28%	*16.77%*	16.29%	15.84%

Table 9 illustrates that the margin percentage included in the liability is sensitive, albeit not particularly so, to the insurer's target administrative expense ratio (namely, $1-\lambda-\rho$). All else being equal, a company with higher administrative expenses would have a higher margin percentage in its claim liability under our proposed formula.

One might wonder why the claim liability margin percentage would bear any relationship to the insurer's administrative expense structure. The answer lies in the concept that the claim liability margin is the vehicle ensuring that the insurer has no gain or loss at issue. To achieve this, the identity $(\mu^R + \mu^S)\lambda = \rho$ needs to be satisfied, so that the margin established in the claim liability for a particular incurral month at the time when no claims for that month have yet been paid is equal to the expected profit for that month. Thus, if we keep the target profit margin constant but increase the target expense ratio, the target loss ratio declines, and hence the identity above forces an increase in the margin as a percentage of the base estimate liability.

The last sensitivity that we consider involves our selection of the risk release factor φ_0. In Section 3.2, when we built the vector of risk release factors shown in Table 4, we decided to set $\varphi_0 = 1$ for reasons discussed at the time. However, one may be able to justify the position that the insurer does experience a modest amount of release from risk during the first month of coverage, and hence $\varphi_0 < 1$.

Note that our estimates of φ_n for $n > 0$ in Table 4 were predicated on the assumption that $\varphi_0 = 1$. So, if we change our estimate of φ_0, we need to make corresponding adjustments to the entire vector of risk release factors. For example, if we set $\varphi_0 = 0.9$, then we would now have $\varphi_1 = \varphi_0(0.650) = 0.585$, $\varphi_2 = \varphi_0(0.400) = 0.360$, etc.

Observe that our earlier formula for the margin percentage M in the model office projection can be rewritten as

$$M = \mu^S + \left(\frac{\sum_{n=0}^{N} \frac{\sigma_n}{\sigma_0}(1+g)^{-n}}{\sum_{n=0}^{N}(1-\gamma_n)(1+g)^{-n}} \mu^R \right) \varphi_0 ,$$

which shows that there is a linear relationship between M and our estimate of φ_0. Table 10 illustrates the magnitude of that linear relationship.

Table 10

Entries in the table represent the margin percentage M as a function of the risk release factor φ_0, assuming that $\rho^R = 3.5\%$, $\rho^S = 1.5\%$, $\lambda = 85\%$, $g = 1\%$, completion factors are as in Table 4, and risk release factors are as in Table 4 but multiplied by the revised value of φ_0.

φ_0	1.00	0.95	0.90	0.85	0.80
M	*16.77%*	16.02%	15.27%	14.52%	13.77%

5 Discussion and Conclusion

This paper has had three major themes:

1. We reviewed (in Sections 2.2 and 3.1) current practice regarding the inclusion of explicit margins in U.S. medical insurance claim liabilities and concluded that current practice

was not sufficiently well aligned with the role articulated in the IASB discussion paper for explicit margins under the CXV accounting model.

2. We developed (in Section 3.2) a new formula for including explicit risk and service margins in medical insurance claim liabilities, in such a manner that the emergence over time of the insurer's expected profit is compatible with the IASB discussion paper guidance on the intended role of explicit margins.
3. We explored (in Sections 4.1 and 4.2) the implications of our proposed liability formula via an extended example, demonstrating how real-life data could be used to estimate a key set of parameters in our new formula, namely, the vector of risk release factors.

Several implementation issues would need to be addressed in practice were one to adopt the formula that we proposed in Section 3.2. However, rather than start a discussion of those issues here, it seems more important to address a more fundamental question: Does our proposed claim liability formula actually produce reasonable results?

The reason this question arises is that the implications of Table 8 are quite striking. We analyzed a sizeable block of medical insurance business and, after assuming that the block was priced to achieve an 85 percent loss ratio and a 5 percent profit margin and that premiums were growing at a rate of 1 percent per month, concluded that the application of our proposed claim liability formula to this block would lead to an expected level of explicit margin in the CXV claim liability of somewhere between 12 and 20 percent of the base claim liability estimate, depending on what assumption we make as to how the 5 percent profit margin decomposes into compensation for bearing risk versus compensation for providing non-risk services. This range of claim liability margin levels appears to be significantly higher than the margin levels that most practitioners would currently use.

We commented in Section 2.2 that current margin levels were often based on retrospective claim liability adequacy testing, in order to specify a margin level that, if applied retrospectively, would have produced an adequate liability some specified proportion of the time. Given this, if we believe that the theory in Section 3 is sound and that the example in Section 4 is representative, it seems that the levels of margin included in the CXV claim liability could lead to a claim liability that would almost never turn out to be inadequate.

Is such a result consistent with the notion that the CXV claim liability is supposed to represent the amount at which a hypothetical party would be willing to assume the liability? Or, alternatively, is there some flaw in either the theory underlying our proposed claim liability formula or the extent to which the example presented in Section 4 is representative?

Although we look forward to hearing the perspectives of readers, we wish to explore three trains of thought here with respect to these questions.

First, transfers of medical insurance claim liabilities from one insurer to another appear to be exceptionally rare in real life. Even in situations in which a block of business is transferred from one insurer to another, it appears to be quite common for the risk and reward associated with the runout of the existing claim liability to remain with the original insurer. The scarcity of such transactions is consistent with the hypothesis that the CXV of a medical insurance claim liability is generally higher than the liability currently recorded by insurers. That is, perhaps one of the reasons why an insurer retains rather than transfers the claim liability is that the insurer has already prematurely recognized some of the expected profit associated with the future runout of the claim liability, and it would need to strengthen the liability and record a loss for another party to be willing to accept the liability. Of course, alternate and equally compelling explanations may exist for the scarcity of liability transfers.

Second, retrospective liability adequacy studies generally focus on the volatility of the insurer's total liability estimate, V_t. In assessing the adequacy of the total liability, offsets exist between durational components; some durational components of a liability estimate may turn out to be inadequate, whereas others may turn out to be adequate. It follows from this that if one selects a claim liability margin factor based on studying the volatility of V_t, then one is implicitly giving the insurer the benefit of having assembled a portfolio $\{V_t^n\}$ of durational liability components.

By contrast, in developing our proposed claim liability formula, we started by thinking about what explicit margin needed to be included in each durational component V_t^n to produce an appropriate pattern of the expected emergence of profits over time for a single month's premiums. The explicit margin included in our total liability V_t is then simply the sum of the explicit margins in the durational components. As such, the amount of margin included in our claim liability may be more akin to what would be produced if one were to separately study the volatility of each V_t^n and establish an explicit margin so that each V_t^n would be adequate under moderately adverse conditions, without any reduction in the overall explicit margin due to a portfolio effect across multiple durational components of V_t.

Some readers may view this as being a logical flaw in the development of our proposed claim liability formula. However, if one believes that our formula produces an excessive level of margin, then effectively one is arguing that the insurer is entitled to accelerate the emergence of the expected profit associated with each month's premiums, solely because of the fact that the insurer has written multiple months of premiums as opposed to a single month. Is that a reasonable argument?

Third, it is possible that the high margin percentage levels shown in Section 4.2 are a consequence of the fact that the risk release factor estimates made in Section 4.1 were calculated at too fine a level of granularity, namely, the reserve cell. We noted in Section 2.2 that, under current practice, insurers typically do not calculate separate margin factors for each reserve cell, but instead combine reserve cells into one or more portfolios (e.g., one portfolio per legal entity) and calculate margin factors at the portfolio level. The IASB discussion paper indicates that the insurer should calculate risk margins at the level of a portfolio of contracts that are subject to broadly similar risks and are managed together.

Consequently, instead of estimating risk release factors for each block of business in the manner demonstrated in Section 4.1, an insurer might instead group multiple business cells together into a portfolio and estimate risk release factors for the portfolio as a whole. Conceivably, the risk release factors calculated at the portfolio level may grade to zero more rapidly than those calculated at the business cell level, as the risk inherent in the insurer's portfolio is reduced because of diversification across different business cells.

Table 11 is an extension of Table 10 that is intended to provide perspective on how the margin percentage *M* from the model office projection in Section 4.2 would vary if we modify the vector of risk release factors from Table 4. Here we introduce a scaling factor, β. For given values of φ_0 and β, the revised *n*th risk release factor for $n > 0$ is equal to $\varphi_0 \beta \varphi_n$, where φ_n is the *n*th risk release factor from Table 4. Note that the row $\beta = 1$ reproduces Table 10. Table 11 illustrates that if the vector of risk release factors grades to zero more rapidly than does the vector shown in Table 4, then the amount of the margin in the claim liability under our proposed formula decreases appreciably.

Table 11

Rows represent the scaling factor β, columns represent the risk release factor φ_0. Entries in the table represent the margin percentage *M* as a function of β and φ_0, assuming that $\rho^R = 3.5\%$, $\rho^S = 1.5\%$, $\lambda = 85\%$, $g = 1\%$, completion factors are as in Table 4, and for $n > 0$ the risk release factor φ_n from Table 4 is multiplied by $\varphi_0 \beta$.

	1.00	0.95	0.90	0.85	0.80
1.0	16.77%	16.02%	15.27%	14.52%	13.77%
0.9	15.66%	14.96%	14.27%	13.57%	12.88%
0.8	14.54%	13.90%	13.26%	12.62%	11.98%
0.7	13.42%	12.84%	12.25%	11.67%	11.09%
0.6	12.30%	11.78%	11.25%	10.72%	10.20%
0.5	11.19%	10.71%	10.24%	9.77%	9.30%

Additional attempts to use real-life data to estimate risk release factors, along the lines of what was done in Section 4.1, would be most helpful to provide further perspective as to whether or not the vector in Table 4 is representative.

In conclusion, we leave the reader with the following thought. Much of the historical activity within the U.S. health actuarial community regarding claim liability margins has focused on calibrating the margin in some manner to the variability in the insurer's liability estimates. This point of view is a natural outgrowth of the manner in which claim liability margins historically arose within U.S. health insurance, namely, as a means by which the opining actuary can gain comfort that the claim liability will be adequate under moderately adverse conditions. In light of the IASB discussion paper, however, the context of the discussion around claim liability margins has evolved. As we hope this paper has demonstrated, when we discuss claim liability margins in the context of future accounting models such as CXV, not only is it appropriate to focus on the variability of the insurer's incurred claim estimates rather than the variability of its liability estimates per se, but it is also appropriate to draw a connection for the first time between the insurer's claim liability margins and its pricing profitability targets.

References

Actuarial Standards Board (ASB). 1997. Actuarial Standard of Practice No. 28, Compliance with Statutory Statement of Actuarial Opinion Requirements for Hospital, Medical, and Dental Service or Indemnity Corporations, and for Health Maintenance Organizations. Online at www.actuarialstandardsboard.org/pdf/asops/asop028_054.pdf.

———. 2000a. Actuarial Standard of Practice No. 36, Statements of Actuarial Opinion Regarding Property/Casualty Loss and Loss Adjustment Expense Reserves. Online at www.actuarialstandardsboard.org/pdf/asops/asop036_069.pdf.

———. 2000b. Actuarial Standard of Practice No. 5, Incurred Health and Disability Claims, Revised Edition. Online at www.actuarialstandardsboard.org/pdf/asops/asop005_076.pdf.

American Academy of Actuaries (AAA). 2007. Comments on Preliminary Views on Insurance Contracts (Discussion Paper). Online at www.actuary.org/pdf/finreport/iasb_nov07.pdf.

Bell, Rowen B. 2007. IASB Phase II Insurance Contracts Project: Implications for U.S. Health Insurers. *Health Watch* 56: 1, 28–35. Online at www.soa.org/library/newsletters/health-watch-newsletter/2007/september/hsn-0708.pdf.

Bell, Rowen B., and Robert Cumming. 2007. Risk-Based Capital Formulas. In *Group Insurance,* 5th edition. Winsted, CT: ACTEX Publications.

Coventry Health Care Inc. (CVH). 2007. Form 10-K for the Annual Period Ending December 31, 2006. Online at http://ccbn.10kwizard.com/xml/download.php?repo=tenk&ipage=4709358&format=PDF.

England, P. D., and R. J. Verrall. 2002. Stochastic Claims Reserving in General Insurance. *British Actuarial Journal* 8(3): 443–516. Online at www.actuaries.org.uk/files/pdf/sessional/sm0201.pdf.

Ernst & Young (EY). 2007. Market Value Margins for Insurance Liabilities in Financial Reporting and Solvency Applications. Online at www.gnaie.net/images/Market%20Value%20Margin10CA985.pdf.

Gamage, Jinamasa, Jed Linfield, Krzysztof Ostaszewski, and Steven Siegel. 2007. Statistical Methods for Health Actuaries IBNR Estimates: An Introduction. Online at www.soa.org/files/pdf/research-stats-hlth-act-ibnr.pdf.

International Accounting Standards Board (IASB). 2007. *Preliminary Views on Insurance Contracts.* London: International Accounting Standards Committee Foundation.

International Actuarial Association (IAA). 2007a. Exposure Draft Measurement of Liabilities for Insurance Contracts: Current Estimates and Risk Margins. Online at www.actuaries.org/CTTEES_RISKMARGIN/Documents/RMWG_Exposure_Draft.pdf.

———. 2007b. IAA Response to the IASB Discussion Paper on Preliminary Views on Insurance Contracts. Online at www.actuaries.org/LIBRARY/Submissions/IASB_Preliminary_Views_Insurance_Contracts.pdf.

Kan, Kenny W., Jin-Dih Shih, and Martin E. Staehlin. 2003. Session 102PD: Health Valuation Issues: Traditional Products. *Record of the Society of Actuaries* 29(2). Online at www.soa.org/library/proceedings/record-of-the-society-of-actuaries/2000-09/2003/june/rsa03v29n2102pd.pdf.

Litow, Mark. 1989. A Modified Development Method For Deriving Health Claim Reserves. *Transactions of the Society of Actuaries* 41: 89–146. Online at www.soa.org/library/research/transactions-of-society-of-actuaries/1989/january/tsa89v417.pdf.

Litow, Mark, and Doug Fearrington. 2007. Short-Term Reserves. In *Group Insurance,* 5th edition. Winsted, CT: ACTEX Publications.

WellPoint, Inc. (WLP). 2007. Form 10-Q for the Quarterly Period Ending September 30, 2007. Online at http://ccbn.10kwizard.com/xml/download.php?repo=tenk&ipage=5229959&format=PDF.