Superimposed inflation – an elusive concept

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Table of Contents

1. Introduction

1.1 Preface

At the 2007 accident compensation seminar, the Superimposed Inflation Working Group for the Institute of Actuaries of Australia ("IAAust") presented the paper *Superimposed Inflation – Australian Accident Compensation Landscape in 2007*. The paper was based on a survey of actuaries and compensation schemes in Australia. The paper presented a fairly comprehensive overview of the issues surrounding the concept of superimposed inflation and its use by members and related stakeholders.

There were three issues highlighted in the paper which we seek to address in our paper:

1. **A lack of understanding for non Actuaries**

   While actuaries generally have some understanding of superimposed inflation, many other stakeholders have little understanding. This includes lawyers, politicians, policyholders, and even insurer or scheme management in some areas. There is a need for a "layman's terms" description of superimposed inflation.

2. **A lack of clarity in the definition and approach used to measure superimposed inflation**

   Even within the actuarial community there are differing views as to what superimposed inflation includes. There is also a lack of consistency in the approaches taken to measure it. This lack of clarity contributes to the difficulty other stakeholders may have understanding the superimposed inflation assumptions used by actuaries.

3. **A lack of consensus on how to allow for future superimposed inflation**

   There are a number of areas where actuaries do not have a clear policy in relation to the use of superimposed inflation assumptions. These include whether to use a flat or variable rate, how long to apply the rate for and whether to base the rate on historical data or judgement.

1.2 Structure of the paper

In section 1, we outline the reasons why we chose to write this paper, the structure of the paper, and provide some background to the issues which will be addressed based on recent papers on the topic.

In sections 2-4 we build up a picture of superimposed inflation from first principles. We look at what it is, what drives it and what methods can be used to examine it.

In section 5 we apply the concepts discussed in the paper to a case study, being the CTP premium setting process in NSW.

In section 6 we conclude with some overall thoughts, based on our investigation into this topic.

Throughout the paper we have included some "tough questions" to challenge new and established actuaries alike. We have also included our thoughts on these. We anticipate that more established actuaries may have differing views to us, and indeed, to each other. There may be legitimate reasons for these differences in opinion, such as differences in the definition of superimposed inflation used. Hence, these questions are simply a platform on which to advance the superimposed inflation debate.

1.3 Literature review

In preparing to write this paper, we reviewed some recent papers on the topic written over the past ten years and presented at IAAust seminars.

Pearson & Beynon (2007) provided an overview of many of the issues with the concept of superimposed inflation. One of the key issues was that there are two commonly used definitions of superimposed inflation – one looking at the overall growth in payments, while the other looks at the gap between what is projected in actuarial models and what happens in practice, which is often higher. We discuss these two definitions, and suggest a reason as to why both may be valid, in section 2.3 of the paper.

De Ravin & Fowlds (2010) indicated that measuring superimposed inflation is notoriously difficult, given random fluctuation in claim payments, particularly for smaller portfolios. As a result, most models allow for superimposed inflation using a simple flat long-term assumption. As Pearson & Beynon noted, this approach does not tend to align well to what happens in practice, with superimposed inflation coming in bursts before being addressed by tort or other reforms.

Tough Question
If superimposed inflation assumptions are set in response to experience (rather than using a long term average level) should the adopted rate be applied to all future years or for a limited number of years?
Our thoughts: In a similar manner to forecasting regular inflation, the ideal approach is probably to adopt short-term tactical estimates while using a more stable long-term rate based on longer-term experience. This minimises excessive volatility in the liability, particularly for long tail liabilities such as those for long term care, and is more reasonable given greater uncertainty over where superimposed inflation will be several years down the track.

Cutter (2009) explored one measurement approach, looking at comparable claims and comparing claim sizes between different time periods. This approach provided an indication of inflation from environmental drivers, and aligns well with the second definition discussed above.

Marshall, Collings, Hudson & O'Dowd (2008) presented a paper outlining a framework for dealing with risk margins – another area which has historically been debated in the actuarial community. We thought it would be useful to reflect on where the industry is headed in terms of risk margins and whether similar lessons could be applied to the estimation of superimposed inflation. The authors present a framework whereby risk drivers are considered separately and then weighted to produce an overall assumption. Both quantitative and qualitative analyses are used to justify the level of risk, with these being documented. A regular review is undertaken, with a full review being done every few years.

Tough Question
Should actuaries apply a similar framework to that proposed by Marshall et all when assessing superimposed inflation, and communicate this to users of the results?
Our thoughts: We consider this to be best practice – particularly for long-tail portfolios. There is value in taking a structured approach to considering the factors which might drive unexpected claim cost increases, documenting any quantitative analyses or qualitative judgments made and communicating this to the users of the model results, including regulators/auditors. For short tail portfolios, superimposed inflation is less material and the Actuary may choose to ignore it (along with regular inflation and investment returns).

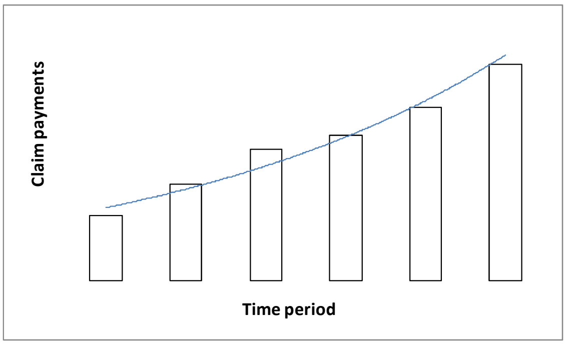
2. Defining superimposed inflation

In this section of the paper, we try to present a working definition of superimposed inflation from first principles. We first present a basic definition, considering both a simple approach and also a more complicated "actuarial" approach. We then discuss some of the factors which complicate this basic definition, particularly the latter approach. We conclude with an overview of the two common definitions that are used in practice and explain why both are relevant.

2.1 The basic definition

Approach 1: Trend lines

At the highest level, superimposed inflation can be considered in terms of growth in payments across time. The figure below shows some arbitrary historical claim payments.

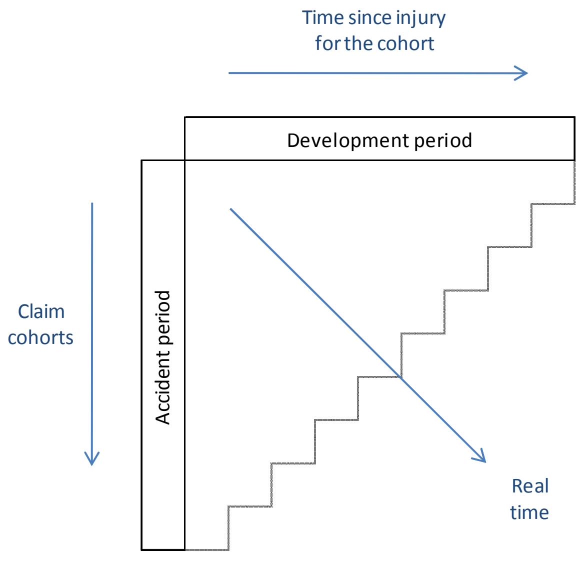


In the absence of changes to the underlying portfolio, we might expect that claim payments would grow roughly in line with a relevant inflation index such as AWE or CPI. Hence, we inflate all payments into "current dollars" using these indices before modeling.

If we fit a trend line to the payments after removing regular inflation, we have a starting point for what we might call superimposed inflation, in the sense that there is inflation superimposed on top of the regular inflation.

Approach 2: Actuarial triangles

We can take this idea further by considering this same data in the form of a typical actuarial model. The triangle in the figure below shows the historical data by claim cohort. We are trying to predict future payments using our knowledge of how the older claim cohorts developed, and applying this to the new claim cohorts.

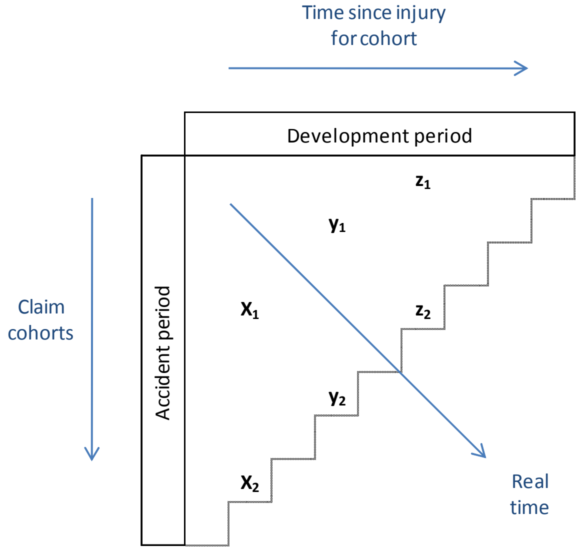


Within this model, we may see inflation in the portfolio of claims across two directions:

- Inflation can be an "accident period" effect, which means it happens for particular cohorts of claims (i.e. arising from the same accident period). An example of this would be legislation for statutory schemes which increases the amount paid to claims relating to accidents after a given date.
- Inflation can be a "payment period" effect, which means it happens in real time, along the diagonal of the triangle. An example of this would be legislation for statutory schemes which increases the cost of all open claims.

In general, changes which drive claim frequency (such as legislative changes applying to accidents from a given date) will be accident period effects, while changes which drive average claim size (such as environmental changes) will be payment period effects.[i]

The figure below shows how we measure growth in claims costs in our typical actuarial model:



Payment amounts are often similar at a given development period or "delay" post injury. Hence, whether we are considering inflation from accident or payment period effects, we will generally look at the growth down the columns. In the figure, this would be comparing x_2 to x_1, y_2 to y_1, z_2 to z_1 and so on. The annualised rate of growth implied by comparing these amounts is again a starting point for considering superimposed inflation, given that we converted all payments into "current dollars" before modeling.

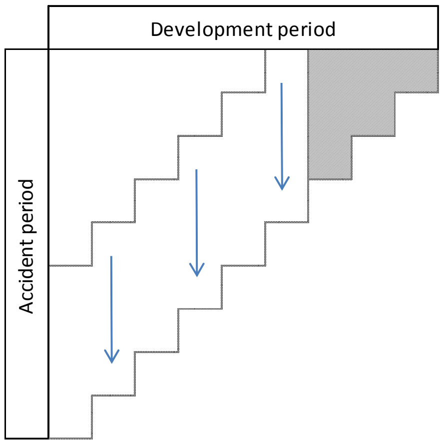
At this point you may be wondering why we would use the complex actuarial model to examine superimposed inflation when we can simply look at trends in total payments. There are two good reasons for this:

- The actuarial model allows us to split payments by cohort and delay. Examining trends in these two dimensions often gives insights into what is driving trends at an overall level.
- Future superimposed inflation assumptions are often applied to actuarial models. Hence it is useful to define and analyse past superimposed inflation in a consistent manner.

2.2 Things which make it complicated

There are a number of things which make the basic definition difficult to apply in practice.

- In calculating superimposed inflation, we need to be mindful of the mix by development delay. If the mix is changing, such as would be the case in a growing portfolio, then there may be growth in payments due to an increase in the volume of data being considered. Similarly, the average cost of claims may vary by delay, so a change in the mix by delay may impact the level of superimposed inflation in average costs. A possible approach to address this is shown in the figure below, where we omit the shaded triangle from our calculations and consider only the growth over the trapezoid figure, which represents the past few years.



- We can also examine superimposed inflation for particular durations post injury. In particular, if superimposed inflation is present in the later durations of a long tail portfolio, and the Actuary models this as continuing, it can have a significant impact on the model results as these assumptions are leveraged by being applied to many future claim cohorts.
- Claims experience is naturally somewhat random. There may be fluctuations in the type of injuries or number of large claims from one cohort to another. A more robust estimate may be obtained by looking at trends over several years. However, this creates a delay in how long it takes for trends to be identified.
- The basic definition presented above considers only one triangle. For most portfolios, actuaries will break experience into many triangles, such as by injury type, head of damage or whether a claim is legally represented. Each triangle will have its own inflation level, with the residual effect being any trend in the mix of claims between categories.
- The triangles may show a range of metrics, including total payments, average payments, numbers of active claims or numbers of finalised claims. Each metric tells a unique story about the drivers of claims inflation at a portfolio level.

While these factors complicate the use of superimposed inflation in practice, they are in essence just questions of what to look at in trying to understand the experience. Starting with the total cost increase we can break the portfolio down and consider the growth in individual segments. These estimates can then be recombined to recreate the superimposed inflation seen at a portfolio level.

This leads us to the two definitions of superimposed inflation which are commonly used in practice.

2.3 A tale of two definitions

In 2007 the SI Working Group offered a small prize for the best definition of superimposed inflation. These were summarised into two main camps:

- Claim cost escalation above "normal" inflation
- Claim cost escalation above that which is allowed for in the actuarial models

These two views can be reconciled by considering the two main purposes for considering trends in superimposed inflation.

Portfolio management, managers and other stakeholders want to understand the *past* level of superimposed inflation, as well as the drivers of the experience. Hence, they are interested in both the superimposed inflation estimate at a portfolio level, as well as changes in the mix between the categories used in the actuarial modeling, and also any trends within these. This will help them understand what *future* superimposed inflation might look like and what they can do to control it.

For pricing and reserving, Actuaries are interested in what allowance for *future* superimposed inflation they should include in their models. This assumption will be applied to the projected payments from the actuarial model to ensure that future payments will be at a sufficient level. The assumption will be based on *past* trends in superimposed inflation as well as judgement as to whether these trends are likely to continue. A common metric examined will be average claim size, as trends in claim frequency are usually allowed for in actuarial modeling.

The two definitions commonly used correspond nicely to the two types of users above. Hence, both definitions can be considered to be "correct" for certain stakeholders and purposes.

Tough Question
…inflation begets further inflationary expectations, which beget further inflation…[ii] In establishing an "expected" level of deterioration in their projections, are Actuaries reducing the incentive for portfolio managers to address increases in cost?
Our thoughts: To the extent that portfolio managers receive feedback based on the Actuarial profit or loss, there may be a lesser focus on addressing increases in claims costs if these are allowed for in the modeling and "actual is in line with expected". This suggests again the importance of the Actuary communicating (wherever possible) the drivers of past superimposed inflation and the anticipated drivers of the future superimposed inflation being allowed for.

3. Drivers of superimposed inflation

Understanding the potential drivers of superimposed inflation gives us ideas on where to look to explain past experience. Once these drivers are identified and examined, portfolio managers may be able to take action to control any adverse trends, and actuaries can form a view as to whether the trends are likely to continue, and make appropriate allowances in their modeling. It is useful to consider which of these can be influenced by the portfolio manager.

In order to understand the drivers of superimposed inflation, we must first agree on which of the two definitions above we are using. A portfolio-level definition will consider a broader range of drivers than the actuarial model-relative definition; the model-relative definition will exclude any factors which are already incorporated in the model.

The table below outlines some potential drivers of increases in claims costs. We have attempted to flag which of these are allowed for explicitly in standard actuarial models and hence might be excluded from the typical use of the term *superimposed inflation* amongst Actuaries. We have also flagged the drivers which are fairly systemic and hence would be difficult for an insurer to influence.

Driver	**Description**	**Modelled**	**Systemic**
Change in exposure	An increase in exposure is likely to give rise to increases in the number of claims and hence overall claim costs.	✓	×
Change in propensity to claim	Propensity to claim may shift with changes in awareness of claimants as to the benefits they are eligible for, and the approval processes in place. Propensity to claim may also be impacted by economic slumps.	✓	×
Increased utilisation of heads of damage	Over time there can be an erosion of the threshold required to access particular heads of damage. Claimants and their advisors may also become more aware of the available options. This particularly impacts benefits which are more subjective in nature, such as pain and suffering or care needs.	?	✓
Access to new heads of damage	Particularly in a common law environment, reinterpretation of legislation may give rise to a new type of claim. This precedent can then give rise to a wave of similar claims.	×	✓
Increased duration on periodic benefits	In a periodic environment, there may be superimposed inflation in total claim costs due to claims receiving benefits for increasingly longer durations. This might be due to trends in the economic or social environment, changes in case management practices, or the use of redemptions which may encourage claimants to "hold out" for a lump sum settlement.	?	✓

Driver	**Description**	**Modelled**	**Systemic**
Fluctuations in finalisation or payment patterns	Changes in the timing of payments may not impact ultimate claim costs, but it will impact the pattern of claim cost increases, and hence measurements of superimposed inflation.	×	×
Increases in average cost of lump sums	Lump sums may increase due to creep in court awards or changes to mortality tables or interest rates used to calculate them.	×	✓
Limited experience for a portfolio or environment	Before a portfolio reaches a "steady state" total claims costs will grow as the accident years accumulate. A similar effect can occur where analysis is undertaken on accident periods following a legislative change.	✓	×
Volume of large claims	Large claims have a disproportionate impact on total costs. As they are few in number their total cost will be quite volatile and this may impact measurements of superimposed inflation. They may also reflect actual trends in the environment, such as wealthier societies having more resources to allocate to the seriously bodily injured.[iii]	✓	✓
Imperfect inflation indices	While CPI or AWE are commonly used to inflate claim payments, these indices track a generic basket of goods or average wages, which will differ from those underlying the claim costs. For example, medical costs may increase at a rate greater than CPI due to advances in medical technology, and care costs may increase at a rate greater than AWE due to shortages in the labour market caused by an ageing carer workforce.	×	✓
Claims management practices	As the main link between the insurer and the insured, claims managers can impact claim costs. Changes in approach may influence the propensity to claim or claim particular heads of damage, the duration on periodic benefits or the stage at which a lump sum claim is settled. It can be difficult to identify changes in practices, although file reviews may be of some use.	×	×
Legal precedents	Judicial decisions on disputes can contribute to superimposed inflation. Once a precedent is set, a similar impact can be expected for similar claims in the future.	×	✓

Driver	Description	Modelled	Systemic
Legal practices	By increasing claimant's awareness of the available benefits, setting expectations in relation to lump sum sizes and representing them in negotiations and in court, lawyers can impact claim costs. Changes in the prevalence of lawyers and their familiarity with the current legislation can drive increases in claims and average claim costs. This is often seen with "honeymoon" periods following legislative change, with strong superimposed inflation once lawyers are more familiar with the legislation and precedents have been set.	×	✓

Tough Question
Should increasing propensity to claim be termed *superimposed inflation in claim reports*, or should *superimposed inflation* only ever refer to increases in payment amounts?
Our thoughts: It is probably more appropriate to talk about increasing propensity to claim being a driver of superimposed inflation in claim payments. While the value of a dollar inflates (and hence there are indices measuring regular inflation) the value of a claim report doesn't "inflate" over time.

Many of these drivers are behavioral; they are linked to the self interests of the various stakeholders of the insurance process:

- Claimants and their lawyers will have the most micro-level perspective; they will primarily seek to increase the amount they can claim.
- Claims managers and judges will see more claims and may have some appreciation of cost trends, but as they deal directly with claimants and can empathise with their situation, they may also support them in their desire to increase the amount claimed.
- Claims managers will also seek to meet KPIs which are undoubtedly based on macro-level perspectives taken by portfolio managers, Actuaries or shareholders; this will act to contain growth in claims costs.

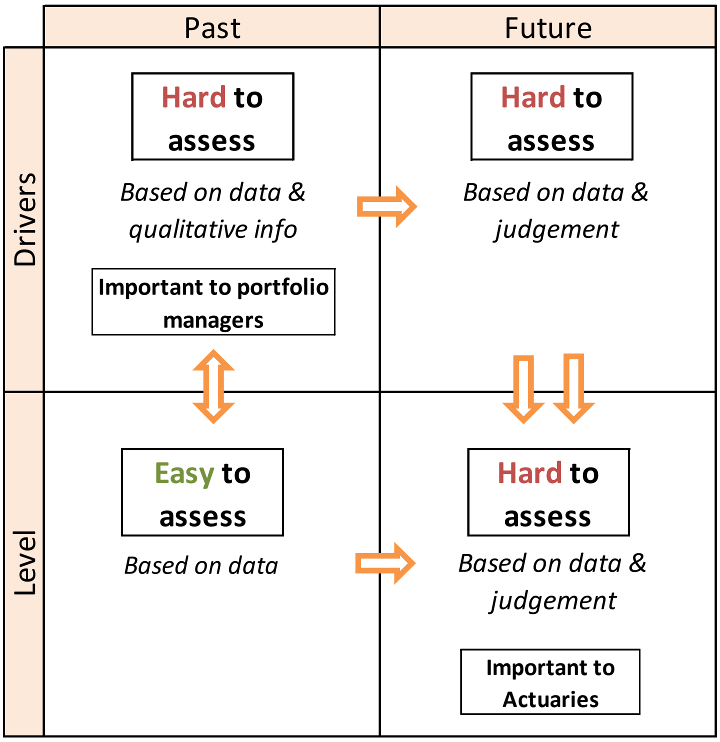
Hence, in order to fully appreciate the historical and likely future superimposed inflation, it is important to consider as much as possible both the micro and macro level perspectives.

4. Methodology for assessing superimposed inflation

In this section we consider ways in which historical superimposed inflation can be examined. We differentiate between the level of superimposed inflation (often expressed as a single per annum growth figure) and the underlying drivers of this growth. The methods of analysis we consider differ in their level of focus on these two factors; hence, it is important to consider the value of each to the various stakeholders, and in particular, Actuaries and portfolio managers.

4.1 The importance of understanding the drivers

The figure below represents the relationship between the level and drivers of superimposed inflation in the past and in the future:



The cell of most importance to Actuaries is the future level in the *bottom right*, as this is incorporated into projections. The cell of most importance to portfolio managers is the past drivers in the *top left*, as understanding these allows them to take actions to mitigate any adverse trends.

The figure highlights that the easiest route for Actuaries to take is to consider the *past level* of superimposed inflation and look at trends or long-term averages to come up with an allowance for the *future level* of superimposed inflation. While easy, this approach is poor in two regards:

- It is of limited use to portfolio managers as it fails to communicate the reasons for past superimposed inflation, which they need to understand in order to take appropriate action.
- There is a stronger relationship between the *future drivers* of superimposed inflation and the *future level* of superimposed inflation than there is between the *past level* and *future level*. That is, past trends may not continue into the future.

Hence while it is harder to do, there is value in investigating the drivers of past superimposed inflation, communicating this to portfolio managers and incorporating their intended actions into an assessment of the drivers and resulting level of future superimposed inflation.

Tough Question
Typically superimposed inflation happens in bouts but actuaries model it as a single average future assumption meaning that over a one year time period the actuary is always likely to be wrong.[iv] *Superimposed inflation…tends to occur in bouts, however for pricing and reserving purposes, a smoothed long-term rate is normally adopted.*[v] Should Actuaries allow for future superimposed inflation at a flat rate, based on long term historical data, or should Actuaries produce estimates of how superimposed inflation is expected to change over the projection period?
Our thoughts: Where superimposed inflation has a material impact on the liability, we believe the Actuary should consider the current level of superimposed inflation and how that level will vary over the projection period in justifying the assumption used. It is unlikely that a benign environment will give rise to superimposed inflation overnight. Similarly, high superimposed inflation is unlikely to be sustained without some legislative intervention. While this is a difficult task, it is the role of the Actuary to form an opinion on such areas of uncertainty.

4.2 Quantitative methods

The table below outlines some of the more common methods for examining superimposed inflation. Some worked examples are presented in the Appendices.

Method	**Description**	**Pros**	**Cons**
Trend lines	Payments are inflated to "current" dollars to remove the impact of normal inflation. Trend lines are fitted by payment period and implied growth rates calculated. This same approach can be applied to segments of the portfolio based on suspected drivers. Trends in the mix by driver should be examined to gain a full understanding of cost drivers.	Simple *(both to undertake the analysis and to understand the results)* May be applied to standard actuarial models *(see section 3.1)*	Limited predictive capability *(assumes past trends will continue in the future)* Need to define the drivers in advance May be misleading if some drivers are correlated
Decision trees	Similar claims are grouped into "buckets" using software such as CART. These buckets are then examined for superimposed inflation.	Helps to identify drivers Deals with correlation of drivers	Have to combine with other methods to actually analyse superimposed inflation *(e.g. trend lines)*
Generalised linear models (GLM)	The relationship between suspected drivers and claim costs is fitted with statistical software such as SAS. A time-dependent parameter may be used to estimate the rate of superimposed inflation after allowing for other factors.	Helps to identify drivers of claim size Deals with correlation of drivers	Complex *(e.g. transforming variables)*

Method	**Description**	**Pros**	**Cons**
Multiple GLMs	A series of GLM are fitted, and drivers are added in sequence. The change in model fit gives an indication of the contribution of the added drivers to historical superimposed inflation.	Helps to identify drivers Helps to quantify the contribution of drivers	Very complex *(e.g. transforming variables, fitting multiple models, ensuring successive models are consistent)*
Comparable claims model	Similar claims from different time periods are compared. An increase in cost may indicate superimposed inflation in average claim size. This can be combined with analysis of claim frequency and claim mix to understand the drivers of overall cost.	Simple to understand Easy to calculate growth rates	Can be difficult to match claims Can be difficult to obtain sufficient sample sizes May only provide some indication of what is driving costs at portfolio level, not the complete picture

Of these, the "best" approach to use will depend on the question being asked, the intended audience, and the size of the portfolio being considered.

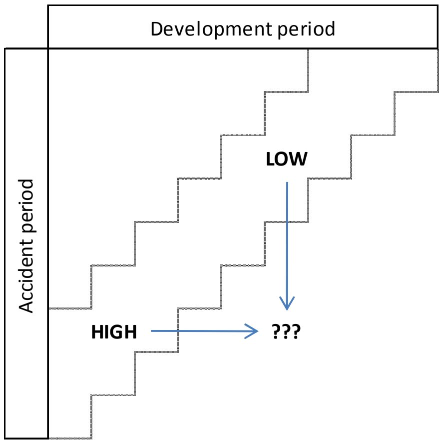
- Simple approaches can help identify significant trends, communicate to broader audiences who are less familiar with actuarial concepts and undertake reasonableness checks on more complex approaches.
- Complex approaches can provide more detailed insights as well as statistical measures of how reliable the trends identified actually are.

A combination of both approaches is probably ideal.

4.3 Qualitative overlay

Having examined the historical data, we still need to consider whether these trends are likely to continue into the future. This view will influence the actions taken by portfolio management as well as the impact on actuarial projections.

The figure below shows the standard actuarial model discussed in section 3, and gives an example of the sort of question that might arise in practice:



In this instance, superimposed inflation has been *moderate* overall in recent years. However, for recent claim cohorts there has been *high* superimposed inflation (in the early delays), while for older claim cohorts there has been *low* superimposed inflation (in the later delays). Will the later delays for the current cohort resemble the later delays for earlier cohorts, the earlier delays for the current cohort, or something else entirely?

Another question which could arise is whether actions taken by portfolio managers or politicians to control recent superimposed inflation are likely to achieve the intended outcomes. Even if the data suggests that costs have been controlled, it may be that there is a "honeymoon period" while claimants and their advisors gain an understanding of the new regime and precedents are set in court. Following this initial period, superimposed inflation might actually be higher than it otherwise would have been, as the hiatus in activity unwinds.

While the answer to such questions undoubtedly involves professional judgement, we reiterate the question from in section 1.3 – should actuaries be using a more formal approach to applying and documenting their judgement in this area?

We think so, to the extent that superimposed inflation assumptions may have a material impact on results. This will depend on the size and term of the portfolio, as well as the analysis being undertaken. For example:

- The uncertainty in estimates of superimposed inflation will be greater for premium setting than in establishing reserves, given the premiums will cover periods further into the future. Hence there is a greater argument for taking a formal approach when justifying premiums.
- While a long-term superimposed inflation assumption might be appropriate to include in the central estimate, when looking at higher probabilities of adequacy, the potential impact of superimposed inflation may be more extreme. For a risk-averse portfolio manager, there would be an argument for a more formal approach to be taken.

Tough Question

A critical assumption in reserving is the assumed level of superimposed inflation. Superimposed inflation is inflation in excess of economic inflation. HIH almost certainly did not adequately identify, quantify or assess the superimposed inflation in its own long-tail lines of business for many years. Underestimation of superimposed inflation leads to chronic under-reserving, under-pricing and ultimate ruin.[vi]

Clearly superimposed inflation can have a material impact on the solvency of an insurer; but in allowing for a long-term rate of superimposed inflation, are Actuaries simply being conservative / pessimistic in their projections during times where superimposed inflation is low?

Our thoughts: There are certainly incentives for conservatism in actuarial projections. Actuaries want reserves to be sufficient; they don't want to be responsible for insolvency. In an environment where premium increases have to be justified to the regulator, portfolio managers may want to justify higher premiums to realize more profits in the long run. There may also be a desire to smooth profits over the insurance cycle. While it is difficult to prove any of these are occurring in practice, it is important to be mindful of these when considering whether an allowance for future superimposed inflation is well justified.

5. Case study: a regulatory perspective

5.1 Case study

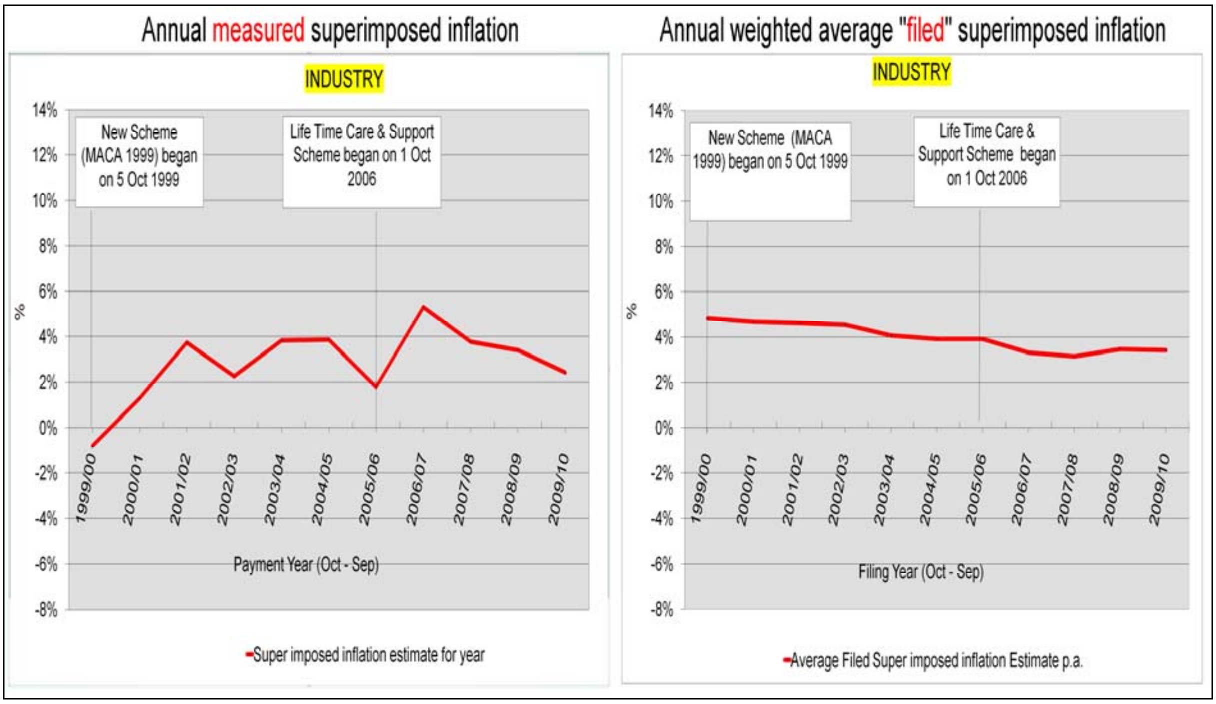
In this section of the paper, we apply the findings of our report to a specific case study. We consider a "regulator's perspective" of the New South Wales (NSW) Compulsory Third Party (CTP) scheme premium rate filing process. In this case study, multiple stakeholders must agree on terminology and the method of measuring past superimposed inflation, since this could impact premium levels.

While we are considering this case study from a regulatory perspective, **we note that the views expressed herein are in fact, the views of the authors** and not the Motor Accidents Authority of NSW ("MAA") or PricewaterhouseCoopers Australia ("PwC"). Further, the modeling is **illustrative in nature** and has not been reviewed to the extent required in order to make commercial decisions.

Given CTP is a compulsory insurance, there is pressure on insurers to justify premium increases to the regulator. The MAA reviews superimposed inflation assumptions used in insurers' rate filings, in consultation with the scheme actuaries. The scheme actuaries and actuaries preparing rate filings for CTP insurers will also be doing detailed modelling of past superimposed inflation, but there may be differences in their approaches used to analyse superimposed inflation.

We have attempted to measure past superimposed inflation rates based on CTP industry claims data held by the MAA and compared these to the rates assumed in insurers' rate filings. We used a trend line approach, which is outlined in Appendix 7.2.

The figure below gives an example of the results of our analysis. Data presented is for the whole industry and not a specific insurer. For confidentiality reasons, insurers have not been named in this paper. The chart compares the measured superimposed inflation rates with insurer weighted projected rates presented in past premium rate filings for the aggregate of licensed CTP insurers in New South Wales.



Note: The *annual measured superimposed inflation* figure above has been revised since it was originally presented, following feedback at the seminar. An additional section 5.2 has also been included below, to explain the methodology used in more detail.

While some insurers had rate filing assumptions which were consistent with their experience, others had measured rates that were either consistently higher or lower than their estimated past superimposed inflation. We recognise that each insurer may take a different approach to calculating past superimposed inflation and may also hold differing views as to how this relates to likely future superimposed inflation; we nonetheless found these results to be interesting.

Also, although superimposed inflation fluctuates over time and the past rates may not provide a good indication of future rates, **knowing the range in which superimposed inflation fluctuates may be quite helpful in projecting future estimates, in particular where the insurer's past estimates have been consistently higher or lower than its experience**. This got us thinking of ways insurers and their actuaries could improve their understanding and methods of monitoring trends in superimposed inflation. For instance an independent, but generally accepted calculation of a standardised portfolio-level estimate of superimposed inflation for each insurer would be useful to compare against their rate filing assumption. Industry rates might even be published to allow insurers to more easily benchmark their experience against the rest of the industry.

We feel a simple approach like this could inform dialogue between the regulator, the scheme actuaries and the insurers, in justifying the assumptions used in rate filings.

Tough Question

If historical rates of Superimposed Inflation (SI) were to be published for the industry and individual insurers, could this result in better future SI estimates for insurers in their rate filings?

Our thoughts: For this case study:

1. ***In projecting future levels of superimposed inflation*** - *As noted above, we think that undertaking comparative analyses would be a useful starting point in better understanding the level, drivers and variability of superimposed inflation, and hence justifying appropriate assumptions to incorporate into premiums. We also note that the superimposed inflation assumptions used in rate filings are arrived at differently by different actuaries, but each percentage point reduction in estimated superimposed inflation, can have a material impact on the premium level.*
2. ***In reviewing past levels of superimposed inflation*** - *We think it may be beneficial to adopt one objective method of measuring past superimposed inflation, with the view that, the different superimposed inflation projection methods can be evaluated on how well they estimate past levels of super imposed inflation.*

Although we think publishing past rates of SI can help refine future projections of SI, we also recognise there is a risk that insurers would simply converge to the industry average experience and this would be expected to reduce the fit of assumptions to individual insurer portfolios.

5.2 Implications of the Case Study methodology

The case study above presents superimposed inflation estimates. However, there are various ways of examining the data which may produce materially different superimposed inflation estimates. In this section we provide more discussion on the methodology used and alternative estimates that might come from using other methodologies.

Over the course of the 2000s, the Motor Accidents Scheme of NSW ("the Scheme") experienced a sustained reduction in the number of claims receiving payments. Between 2000 and 2004, this was matched by reductions in claim payments. However, from 2004 to 2008, claim payments increased despite continued reductions in the number of claims receiving payments. Hence, there were increases in the average cost per claim during this period.

The increase in average cost was as high as 15-20% in a few of these years. In the surrounding years, changes in average costs were actually negative. This highlights the volatility seen in claims data, which the actuary must contend with in determining what superimposed inflation has been and considering what it is likely to be in the future.

These large fluctuations compare with a more stable 0-6% range shown in the case study. The main reason for this is that a trend-line approach was used, and this creates a smoother and longer-term estimate of superimposed inflation.

Using a trend-line approach to estimate superimposed inflation is particularly important for smaller portfolios, or splits by severity or payment type, where the experience is quite volatile. It allows the actuary to produce a stable estimate over time. However, it also means there is a delay between seeing the experience and it being fully reflected in the estimates.

For the case study, the trend lines were fit to the entire history of the claims data. This makes them very slow to react to the emerging experience and produces long-term average estimates. At the opposite end of the spectrum, the volatile figures discussed above are calculated directly from the claims experience. The most appropriate approach is probably somewhere in between these two extremes.

The estimates shown in the case study were also derived for each payment year using separate models, with payments inflated to the year in question, producing "point in time" estimates of superimposed inflation similar to what might have been done at the point the rate filings were made. This contrasts with a pure hindsight approach, in which data is inflated to current dollars. While the latter is useful in assessing whether our estimates were correct, the former is useful in understanding why estimates were made as they were made at the time.

Finally, both the case study and the analysis above were undertaken on all claims receiving payments by payment year. A common alternative is to wrap all of the payments on a claim up and recognise these upon finalisation of the claim. This approach is used in Appendix 7.3. At an overall level, the trends in annual growth rates are fairly similar between the two approaches. The average cost is clearly much higher for the finalised claims approach, as claims may receive payments over several years, where they will only be finalised in one.

While the specific methodology used may be debated, the purpose of our case study was really to suggest the value of comparing historical forward estimates of superimposed inflation to historical actual data, such that any tendency to consistently over- or under-estimate superimposed inflation could be identified. To facilitate this comparison, the methodology used will need to be agreed so it is consistent and benchmarking can occur. At present this is impossible from the perspective of an individual insurer; different approaches may be used which can produce very different estimates of superimposed inflation.

Tough Question
If reductions in claim frequency are expected to continue, is it be more appropriate to consider trends in total payments rather than average payments in determining the future superimposed inflation estimate?
Our thoughts: In general, the number of claims is known much sooner than the quantum of claim payments. Hence, actuarial models tend to quickly reflect any trend in claim frequency, so actuaries are more concerned with inflation in average costs. We think this is a reasonable approach to take, so long as the estimate of claim frequency used in rate filings allows for expected trends in claim frequency, and the timing of claim reports is considered.

6. Conclusion

6.1 Final thoughts

In this paper we have attempted to pin down the elusive concept of superimposed inflation through a "first principles" approach to defining it with some simple examples. We hope that this will be a useful tool for the broader stakeholders of Actuarial analyses.

We considered two main definitions used in the industry and reconciled these by considering the perspectives of two of the main users of superimposed inflation analyses – portfolio managers and Actuaries. We discussed the importance of understanding the drivers of superimposed inflation, and explained why Actuaries may be tempted to avoid undertaking this analysis – but also why they should be encouraged to do so.

We briefly outlined some methods that can be used to understand claims inflation, provided some worked examples in the Appendices and also outlined a case study to encourage further discussion on the topic. We hope that these will provide a starting point for increased consistency in the approach used to measure superimposed inflation throughout the industry.

The importance of supporting any quantitative analysis with an appropriate qualitative overlay was raised with a few examples. We suggested that where superimposed inflation has a material impact on model results, best practice is to take a formal approach to documenting and regularly reviewing any analyses undertaken and judgement made.

Throughout this paper we came across a number of *tough questions* which we found stimulating and we hope that these have entertained the more experienced Actuaries reading the paper who may have a deeper understanding of the concept. While our views may certainly be debated, this process can only help to create a clear policy in relation to the use of these assumptions.

6.2 Acknowledgements

We would like to thank the following people for their help and support:

- Management of the Motor Accidents Authority of NSW for the use of CTP industry data.
- Michael Playford – for providing input into the initial direction and focus of the paper as well as his peer review of our completed paper.
- Rosi Winn – for her feedback on an initial draft of our paper.
- Adrian Gould – for his feedback on our initial definition of superimposed inflation as well as some aspects of the analysis behind the regulatory perspective case study.

7. Appendices

7.1 Literature review

In this appendix we include some of the key quotes from the papers we examined as background to writing our paper.

7.1.1 Superimposed Inflation – Australian Accident Compensation Landscape in 2007 (Pearson & Beynon, 2007)

This paper was written by the SI Working Group of the IAAust, and was presented at the XIth Accident Compensation Seminar in April 2007.

- *Superimposed inflation is often the "balancing item" between what can be explained by the model and what cannot…different models provide different measures of superimposed inflation…and potentially different rates of future superimposed inflation.*
- *Where there is a trend…the Actuary still needs to make a judgement about the extent and duration of the trend into the future… even accurate measurement of past superimposed inflation can be of little help or relevance as to what level of superimposed inflation will be in the future.*
- *More thought is needed on how actuaries allow for future Superimposed Inflation…we typically model future superimposed inflation as an expected average long term rate. Our models are destined to project too high amounts of superimposed inflation in most years and woefully inadequate levels in a few.*
- *Most actuaries had not been changing their superimposed inflation allowances in the last couple of years despite observation of low superimposed inflation in the recent claims experience.*

Tough Question

"Chain ladder reserving techniques in the US and Europe…do not differentiate between normal and superimposed inflation….average payment reserving techniques…more explicitly identify payment period trends and enable explicit future allowance for superimposed inflation than chain ladder methods"

Do average payment reserving techniques really differentiate between normal and superimposed inflation, or is this just a feature which has become associated with them? Is there any reason we can't measure and allow for superimposed inflation when using a chain ladder approach?

Our thoughts: There is nothing in a PPCI or PPAC model which inherently allows for superimposed inflation, and the separate analysis done on average payments could just as easily be done on the total payments in a chain ladder. The only edge offered by an average payment model is that we're already looking at average payments and superimposed inflation is often defined in terms of increases in the average cost of similar claims.

7.1.2 Inflation Risk in General Insurance (De Ravin & Fowlds, 2010)

This paper was presented at the 17th General Insurance Seminar in November 2010.

- *Estimating year-on-year superimposed inflation from past data is notoriously difficult (or even estimating the average superimposed inflation over a few years), due to the 'noise' of random fluctuation in claims experience.*

- *Most insurers do not model the cycle of strong and benign superimposed inflation in a sophisticated way, but rather they assume a constant level of superimposed inflation in pricing and reserving.*
- *After 5 or 6 years of record breaking court awards for bodily injury claims there is often a public and judicial 'backlash', with the resulting tort reform reducing claim levels.*

Tough Question
"The risk margin should arguably also increase after a year of unexpected inflation, to reflect uncertainty on how long the additional inflation will persist for." *"The cost of capital calculation can make allowance for the unexpected, unanticipated level of claims inflation, modeling a peak risk scenario of an inflation spike that occurs over a year or two before reverting to the long term inflation mean."* Should superimposed inflation be allowed for in the central estimate, or would it be better to allow for it elsewhere, such as in the risk margin or cost of capital?
Our thoughts: We allow for our best estimate of the level of superimposed inflation in the central estimate. The risk margin and cost of capital should also include an allowance, but this is for the uncertainty in that estimated level.

Tough Question
"The selection will not be as heavy as it needs to be, however, since the actuary will take an average development ratio over the past few years, for example the weighted average over the previous five years." Where a future superimposed inflation assumption is used, should this also be applied to any payment assumptions which are based on averages of historical data, from the mid-point of the averaging period to the end of the period?
Our thoughts: In selecting assumptions, some Actuaries may already allow for trends in the experience and use an assumption which reflects the end point of this trend. For those who are taking an average of past experience but are allowing for future superimposed inflation, they should probably apply a past superimposed inflation allowance to the selected average. This is often not done, most likely due to the additional complexity it adds to the modeling and the volatility of payments underlying the selected average.

7.1.3 Measuring and Understanding Superimposed Inflation in CTP Schemes (Cutter, 2009)

This paper was presented at the 12th Accident Compensation Seminar in November 2009.

- The author examines superimposed inflation in the average size of similar claims using a "comparable claims" methodology applied to CTP data for NSW and QLD.
- Claims with similar injury characteristics from two periods of time are compared, and this produces an inflation estimate after standardising for factors such as claim frequency and injury mix.
- Hence, this approach focuses on inflation driven by environmental drivers, which are generally not modeled explicitly by actuaries (unlike claim frequency, for example).

7.1.4 A framework for assessing risk margins (Marshall, Collings, Hodson & O'Dowd, 2008)

This paper was written by the IAAust Risk Margins Taskforce and presented at the 16th General Insurance Seminar in 2008. The paper presents a framework for assessing risk margins. It draws on an earlier PwC paper, "A framework for estimating uncertainty in insurance claim costs".

It is useful to reflect on where the industry is headed with respect to risk margins, and whether similar lessons can be applied to the estimation of superimposed inflation.

The authors present a framework whereby risk margin drivers are considered separately, including internal systemic risk, external systemic risk and independent risk. Qualitative assessment is emphasized in addition to quantitative analysis – particularly for systemic risks which are difficult to predict.

- *It is common practice for Australian actuaries to adjust the results obtained using quantitative techniques to allow for their known weaknesses. However, this is not always done in a rigorous manner, nor is there much consistency across the profession.*
- *A step-by-step process that requires them to ask a number of questions in the context of these portfolios. This will enable judgmental aspects of the process to be better reasoned, justified and documented and ultimately provide more structure in the application and combination of both quantitative and qualitative processes.*
- *Different groups of claims…should be treated separately…a pragmatic view should be taken when considering whether groups of claims are homogeneous, a view that balances the benefits against the practicalities and cost.*
- *Benchmarking will be of some benefit where there is little information available for analyses purposes…more generally, the use of benchmarking should be as a sanity check rather than as the entire basis"*
- *A full application should be applied every three years… significant interaction with business unit management…at more regular intervals…key assumptions should be examined in the context of any emerging trends, emerging systemic risks and changes to valuation methodologies.*
- *For long tail classes, the risks in [the legislative, political and claims inflation risk] category are normally aggregated and referred to as superimposed inflation for insurance liability valuation purposes.*

7.1.5 Comments in the media and other sources

The term superimposed inflation is used not just by actuaries, but by regulators, judges and other stakeholders in actuarial work:

> "*Superimposed inflation is inflation above the underlying rate of inflation and is sometimes called judicial inflation. In this sense, it reflects that the rate of increase in court awards can increase at a higher rate than underlying inflation."* –James Hardy media release[vii]
>
> *"…the impact of social, economic, environmental, legislative and court precedent factors; often referred to as superimposed inflation"* –APRA guidance note (2002)
>
> *"Superimposed inflation (increasing cost of court awards above CPI)"* –Insurance Council of Australia (2002)

7.2 Case study methodology

The steps taken to derive the results of the case study shown in section 5 are detailed below. Data manipulation, including claims capping, inflation adjustment and calculation of key statistics were done using The SAS computing package. Data presentation including trendline graphs and final measurement of superimposed inflation was done in Microsoft Excel spreadsheets.

In SAS

1. Summarise data from claims datasets (*generally static information*). For this exercise, mainly full claims are considered, since, although ANFs make up about 20% of notifications, they account for less than 1% of costs, hence including ANFs in this analysis will tend to unreasonably reduce the mean claims cost. In instances where the ANFs threshold is increased to $5,000, ANF's with incurred costs between $500 and $5,000 claims are included in the analysis.

2. Summarise claims payment data by claim identification, payment type and payment date. To minimize distortions caused by extreme values used to derive growth rates in payments, total claim amounts for individual claims are capped at an arbitrary threshold of $5M, and the effects of the cap are spread proportionately across all heads of damage for the capped claims. While different caps of $0.75m, $1.5m, $3m and $5m did produce different estimates of past rates of SI, the differences weren't large and the overall pattern of changes over time in estimated rates of SI was similar at the different capping levels.

3. Assume that claims payment each quarter, occur in the middle of the quarter, then summarise claims payment amounts by payment type and payment quarter.

4. Use a suitable index e.g. ABS quarterly Average Weekly Earnings (AWE) series "*Persons full-time adult ordinary time earnings*" for New South Wales, to inflate past claims payments <u>each quarter</u>, to values as at the <u>end of each</u> payment year of the analysis. We use AWE (instead of CPI) for the inflation adjustment, since CTP benefits have an element of wage replacement. Also for each payment year, we use the AWE data as at the end of the particular year to estimate the level of superimposed inflation (SI). This ensures that the past estimates of super imposed inflation do not change as the report is updated with new data.

5. Calculate key payment statistics, means, median and maximum costs. Observing the relationship between these statistics gives an insight into the distribution of costs which is skewed for CTP. This also comes in handy when modeling the drivers of superimposed inflation.

6. Summarise and merge records by payment year and payment type

7. Export data to Excel

In Microsoft Excel

8. Organise data using pivot tables

9. Graph historic and inflated mean payments by payment type and payment year, to check the effect of inflation adjustment.

10. Fit trend lines to inflated mean payments for each payment type over the period of analysis and obtain the trend line equations. This is used to derive the fitted mean cost values for estimating the year-on-year- growth rates for each payment type. For this exercise we use linear and polynomial functions to achieve reasonable smoothing whiles adhering to data. Using INDEX and

LINEST functions in Microsoft Excel, the coefficients of the trend line equations can be extracted to compute the fitted values used to compute year on year growth rates in payments.

11. Derive weights using the $ proportion (%) each payment type contributes to total payments.

12. The year-on-year growth rates for each payment type are weighted by the weights derived.

13. For each payment year, weighted year-on-year growth rates for each payment type are aggregated to obtain an overall estimate of superimposed inflation for the year.

Readers are cautioned that, although this case study is really aimed at measuring past super imposed inflation, the changing mix of claims governed by either the Motor Accidents Act (1988) and Motor Accidents Compensation Act (1999) complicates the interpretation of the measured rates of super imposed inflation in the first five years of the analysis (1999/00 to 2003/04). It must be emphasized that, the trend line method outlined above is concerned solely with measuring the level of past superimposed inflation during each payment year, irrespective of the drivers of this experience.

At this stage we have limited the analysis to examining trends for each payment type. In the next phase of this project, the analyses will be expanded to allow for more scheme features and drivers such as injury severity etc to produce weighted and more representative results.

7.3 Spreadsheet examples

In this section, we provide an example of how basic growth rates can be calculated both at a portfolio level and for segments of the portfolio, using data for the NSW Motor Accidents Scheme.

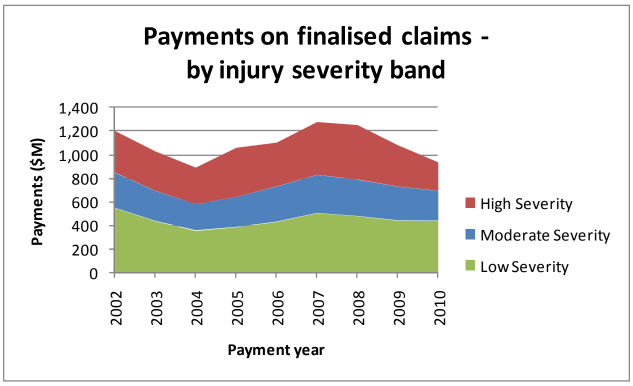
7.3.1 Total payments

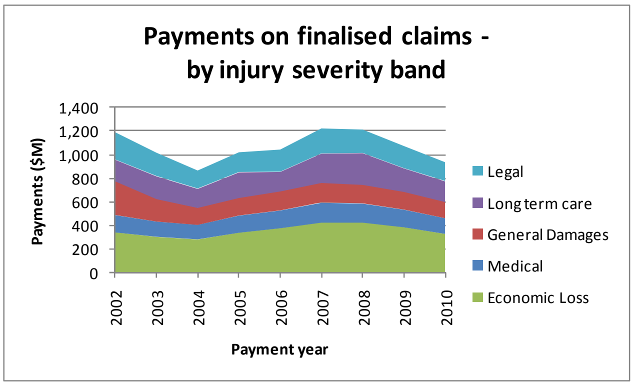
The figure below shows total payments on finalised claims by year of finalization. These have been broken down by broad injury severity band as well as payment type. We've included a few key legislative changes on the right side as well, with the impacted payment types shaded in yellow.

Growth rates in payments on finalised claims ($M, inflated to current $)

	Total		Low Severity		Moderate Severity		High Severity		
Payment Year	Payments ($M)	Growth rate	Payments ($M)	Growth rate	Payments ($M)	Growth rate	Payments ($M)	Growth rate	
2002	1,258		549		299		351		*Civil Liability Act*
2003	1,096	-13%	436	-20%	256	-14%	333	-5%	
2004	928	-15%	357	-18%	224	-13%	309	-7%	
2005	1,102	19%	386	8%	255	14%	416	35%	
2006	1,140	3%	432	12%	299	17%	369	-11%	*Introduction of LTC for Children*
2007	1,318	16%	505	17%	324	8%	446	21%	*Introduction of LTC for Adults*
2008	1,291	-2%	479	-5%	309	-5%	461	3%	*Increase of limit on ANF from $500 to $5,000*
2009	1,124	-13%	442	-8%	287	-7%	349	-24%	
2010	973	-13%	440	0%	253	-12%	240	-31%	*Increase of availability of ANF to at-fault drivers*
Total	10,230		4,026		2,507		3,274		

	Total		Economic Loss		Medical		General Damages		Long term care		Legal	
Payment Year	Payments ($M)	Growth rate	Payments ($M)	Growth rate	Payments ($M)	Growth rate	Payments ($M)	Growth rate	Payments ($M)	Growth rate	Payments ($M)	Growth rate
2002	1,258		340		148		288	0	184		233	
2003	1,096	-13%	302	-11%	131	-11%	191	-34%	194	6%	199	-15%
2004	928	-15%	281	-7%	124	-5%	145	-24%	163	-16%	153	-23%
2005	1,102	19%	337	20%	147	18%	151	4%	218	34%	168	10%
2006	1,140	3%	375	11%	152	4%	163	8%	167	-24%	188	12%
2007	1,318	16%	423	13%	171	12%	170	4%	249	50%	214	14%
2008	1,291	-2%	424	0%	163	-5%	160	-5%	270	8%	200	-6%
2009	1,124	-13%	383	-10%	151	-7%	153	-5%	200	-26%	188	-6%
2010	973	-13%	327	-15%	135	-11%	140	-9%	176	-12%	160	-15%
Total	10,230		3,193		1,320		1,561		1,821		1,704	





Notes:

1. Source data – NSW CTP Claims as at 31 March 2011. Claims payment data used in the tables and graphs has been purposely adjusted for this paper and so may not be directly comparable to other reports produced from the MAA.
2. The Total column does not add to the sum of other columns as some claims are missing Severity information and some of the smaller payment types are not split out as a separate column

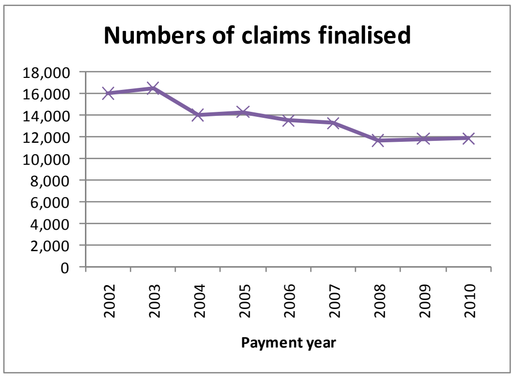
At an overall level, costs have been relatively stable. There was a period of reduction following the Civil Liability Act which particularly impacted General Damages but also Economic Loss, Medical and Legal payments. Between 2005 and 2007 payments were generally on the rise. In 2008 Accident Notification Forms were introduced – and this may have contributed to the fall off in payments in the last few years.

7.3.2 Number of finalised claims

The next figure shows the trend in numbers of finalized claims.

Growth rates in numbers of finalised claims

	Total		Low Severity		Moderate Severity		High Severity	
Payment Year	Number of claims	Growth rate	Number of claims	Growth rate	Number of claims	Growth rate	Number of claims	Growth rate
2002	16,030		11,223		1,211		345	
2003	16,516	3%	11,381	1%	1,420	17%	426	23%
2004	14,028	-15%	9,559	-16%	1,319	-7%	487	14%
2005	14,329	2%	9,807	3%	1,403	6%	485	0%
2006	13,514	-6%	9,288	-5%	1,410	0%	505	4%
2007	13,279	-2%	9,589	3%	1,480	5%	532	5%
2008	11,669	-12%	8,339	-13%	1,374	-7%	505	-5%
2009	11,827	1%	8,474	2%	1,275	-7%	491	-3%
2010	11,861	0%	8,707	3%	1,160	-9%	389	-21%
Total	123,053		86,367		12,052		4,165	



From this we can see that the number of finalised claims has generally fallen between 2002 and 2010, with particular step downs in 2004 and 2008. Hence, while at a portfolio level payments have been volatile but overall fairly trendless, under an actuarial model-relative definition we would expect there to be *high* superimposed inflation in the average payment level.

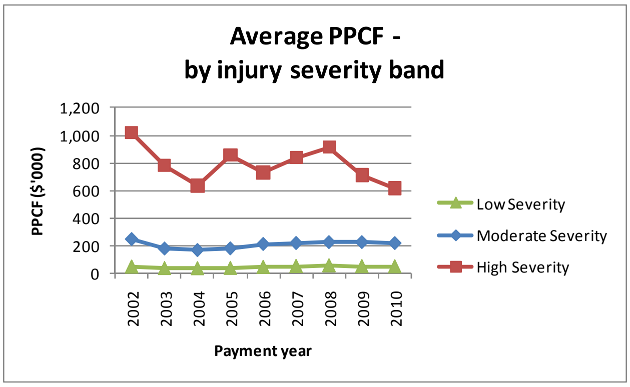
7.3.3 Average size of finalised claims

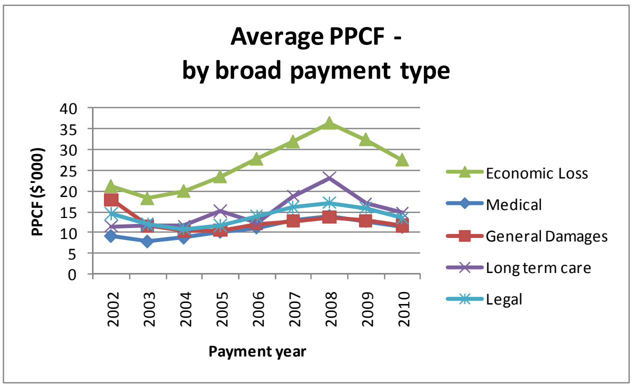
The high superimposed inflation in average claim sizes which we expect based on the results of our analysis of total payments and number of finalised claims is evident in the figure below:

Growth rates in average payment per finalised claims ($'000, inflated to current $)

	Total		Low Severity		Moderate Severity		High Severity	
Payment Year	Payments ($'000)	Growth rate	Payments ($'000)	Growth rate	Payments ($'000)	Growth rate	Payments ($'000)	Growth rate
2002	78		49		247		1,018	
2003	66	-15%	38	-22%	180	-27%	781	-23%
2004	66	0%	37	-3%	169	-6%	635	-19%
2005	77	16%	39	6%	182	7%	858	35%
2006	84	10%	46	18%	212	17%	730	-15%
2007	99	18%	53	13%	219	3%	838	15%
2008	111	11%	57	9%	225	3%	913	9%
2009	95	-14%	52	-9%	225	0%	711	-22%
2010	82	-14%	51	-3%	218	-3%	617	-13%
Total	83		47		208		786	

	Total		Economic Loss		Medical		General Damages		Long term care		Legal	
Payment Year	Payments ($M)	Growth rate	Payments ($M)	Growth rate	Payments ($M)	Growth rate	Payments ($M)	Growth rate	Payments ($M)	Growth rate	Payments ($M)	Growth rate
2002	78		21		9		18		11		15	
2003	66	-15%	18	-14%	8	-14%	12	-36%	12	2%	12	-17%
2004	66	0%	20	10%	9	11%	10	-11%	12	-1%	11	-10%
2005	77	16%	24	17%	10	16%	11	2%	15	31%	12	8%
2006	84	10%	28	18%	11	10%	12	15%	12	-19%	14	18%
2007	99	18%	32	15%	13	14%	13	6%	19	52%	16	16%
2008	111	11%	36	14%	14	8%	14	8%	23	23%	17	7%
2009	95	-14%	32	-11%	13	-8%	13	-6%	17	-27%	16	-7%
2010	82	-14%	28	-15%	11	-11%	12	-9%	15	-13%	14	-15%
Total	83		26		11		13		15		14	





Notes:

1. Source data – NSW CTP Claims as at 31 March 2011. Claims payment data used in the tables and graphs has been purposely adjusted for this paper and so may not be directly comparable to other reports produced from the MAA.
2. The Total column does not add to the sum of other columns as some claims are missing Severity information and some of the smaller payment types are not split out as a separate column

We can see the increase in average payment levels, particularly in economic loss payments and for the moderate severity claims.

In this example we've taken a very simple approach in calculating annual growth rates and then using the average over a number of years as our "total" growth rate. However, this analysis should highlight the volatility that can be seen even within a very large portfolio, and the value in looking at how growth rates vary across time and understanding the legislative drivers.

7.4 GLM examples

In this section, we present some simple GLMs using the SAS programming language. Note that the purpose of this section is not to provide detailed instruction on how to fit GLMs, but rather to provide the interested reader with a starting point from which to begin a journey into understanding GLMs and using them to estimate superimposed inflation rates.

In the first data step we generate some hypothetical claims data to run our GLMs on. The data is representative of CTP claims data in that payments are in the form of lump sums, with the more complex claims finalising later. The sample data has the following features:

- Claims are for accident years 2004 to 2010
- A single lump sum amount is paid for each claim
- Claims which finalise later in general receive larger payments
- All claims are finalised by delay year 4
- The five data fields created are the claim number, accident year, finalisation delay (in years), lump sum amount received and claim severity.

```
* claims data - accident year, finalisation year, finalised payments and severity;
data claims;
    input claim $ accyr findel amount severity @@;
    payyr = accyr + findel;

    * demonstrate different estimates for early vs late finalisation delays;
    if findel gt 1 then tail = 1;
    else tail = 0;

    * demonstrate change in claim numbers;
    count = 1;

    cards;
A1  2004  0  190  1    A2  2004  1  240  1    A3  2004  2  340  1    A4  2004  3  330  2
A5  2004  3  350  1    A6  2004  4  410  2    A7  2004  4  450  3    B1  2005  0  190  1
B2  2005  1  260  1    B3  2005  2  350  1    B4  2005  3  430  2    B5  2005  4  420  2
C1  2006  0  200  1    C2  2006  1  240  1    C3  2006  2  340  1    C4  2006  3  400  2
C5  2006  3  450  1    C6  2006  4  560  2    C7  2006  4  520  3    D1  2007  0  210  1
D2  2007  1  240  1    D3  2007  2  360  1    D4  2007  3  520  2    D5  2007  3  480  2
E1  2008  0  210  1    E2  2008  1  250  2    E3  2008  1  270  2    E4  2008  2  360  2
E5  2008  2  370  3    F1  2009  0  220  1    F2  2009  1  260  1    F3  2009  1  240  1
G1  2010  0  210  1    G2  2010  0  190  1
;
run;
proc sort data=claims;
    by tail;
run;

* highlight there are no payments past finalisation year 4 in this example;
data zero;
    do accyr = 2004 to 2010;
        do findel = 0 to 5;
            payyr = accyr + findel;
            count = 0;
            output;
        end;
    end;
run;
data claims_zero;
    set claims zero;
run;
```

We can look at this data in the format of actuarial triangles like those discussed in section 3.1. The code below does the trick, producing triangles of total payments, average payments and claim counts from the data above.

```
* triangle of total payments;
ods html path="&out" body="1 Total payments triangle.html" style=sasweb;
proc tabulate data=claims_zero format=comma15. missing;
    title 'Triangle of total and average claim payments - all payment years';
    class accyr findel;
    var amount;
    table accyr, findel*amount=''*sum='' / indent=1 misstext='0' box='Accident Year';
    table accyr, findel*amount=''*mean='' / indent=1 misstext='0' box='Accident Year';
run;
proc tabulate data=claims_zero format=comma15. missing;
    title 'Triangle of total claim payments - recent payment years';
    where payyr ge 2008;
    class accyr findel;
    var amount;
    table accyr, findel*amount=''*sum='' / indent=1 misstext='0' box='Accident Year';
    table accyr, findel*amount=''*mean='' / indent=1 misstext='0' box='Accident Year';
run;
proc tabulate data=claims_zero format=comma15. missing;
    title 'Number of claims';
    class accyr findel;
    var count;
    table accyr, findel*count=''*sum='' / indent=1 misstext='0' box='Accident Year';
run;
ods html close;
```

Total claim payments - all payment years

Accident Year	Finalisation Delay 0	1	2	3	4	5
2004	190	240	340	680	860	0
2005	190	260	350	430	420	0
2006	200	240	340	850	1080	0
2007	210	240	360	1000	0	0
2008	210	520	730	0	0	0
2009	220	500	0	0	0	0
2010	400	0	0	0	0	0

Average claim payments - all payment years

Accident Year	Finalisation Delay 0	1	2	3	4	5
2004	190	240	340	340	430	0
2005	190	260	350	430	420	0
2006	200	240	340	425	540	0
2007	210	240	360	500	0	0
2008	210	260	365	0	0	0
2009	220	250	0	0	0	0
2010	200	0	0	0	0	0

Number of claims - all payment years

Accident Year	Finalisation Delay 0	1	2	3	4	5
2004	1	1	1	2	2	0
2005	1	1	1	1	1	0
2006	1	1	1	2	2	0
2007	1	1	1	2	0	0
2008	1	2	2	0	0	0
2009	1	2	0	0	0	0
2010	2	0	0	0	0	0

As noted in section 3.2, estimates of superimposed inflation will be artificially high in the earlier payment years, since the portfolio experience only begins in 2004 and it takes time for the mix of claims by finalisation delay to become stable. That is, for the early payment years, the claims are mostly in the early finalisation delays where the average claim amount is lower. As the mix becomes more stable, the average amount received will be greater.

To mitigate this effect, we can just look at the most recent payment years, as the mix of claims is more stable. Hence we will be looking at the following segment of the triangles above:

Total claim payments - recent payment years

Accident Year	Finalisation Delay 0	1	2	3	4	5
2004	0	0	0	0	860	0
2005	0	0	0	430	420	0
2006	0	0	340	850	1080	0
2007	0	240	360	1000	0	0
2008	210	520	730	0	0	0
2009	220	500	0	0	0	0
2010	400	0	0	0	0	0

Average claim payments - recent payment years

Accident Year	Finalisation Delay 0	1	2	3	4	5
2004	0	0	0	0	430	0
2005	0	0	0	430	420	0
2006	0	0	340	425	540	0
2007	0	240	360	500	0	0
2008	210	260	365	0	0	0
2009	220	250	0	0	0	0
2010	200	0	0	0	0	0

Number of claims - recent payment years

Accident Year	Finalisation Delay 0	1	2	3	4	5
2004	0	0	0	0	2	0
2005	0	0	0	1	1	0
2006	0	0	1	2	2	0
2007	0	1	1	2	0	0
2008	1	2	2	0	0	0
2009	1	2	0	0	0	0
2010	2	0	0	0	0	0

We can now run some GLMs, estimating *individual* claim amounts as a function of payment year (i.e. superimposed inflation):

- For all payment years
- For recent payment years
- For recent payment years with separate estimates for the early and late finalisation delays

Because we are estimating individual claim amounts, the triangle of average claim payments is the most useful reference point when considering the following results.

```
* GLMs on individual data;
ods html path="&out" body="2 Individual GLMs.html" style=sasweb;
proc genmod data=claims;
    title "All payment years";
    model amount = payyr / dist=gamma link=log;
    output out=individual_all p=predicted_amount;
run;
proc genmod data=claims;
    title "Recent payment years";
    where payyr ge 2008;
    model amount = payyr / dist=gamma link=log;
    output out=individual_recent p=predicted_amount;
run;
proc genmod data=claims;
    title "Recent payment years - with tail split";
    where payyr ge 2008;
    by tail;
    model amount = payyr / dist=gamma link=log;
    output out=individual_tail p=predicted_amount;
run;
ods html close;
```

These GLMs produce the parameter estimates shown in the table below. The annualised superimposed inflation rate is based on the payyr parameter, and is calculated as EXP(Estimate) - 1as we are using a log link function.

Analysis Of Maximum Likelihood Parameter Estimates			
	Parameter	Estimate	Rate
Model 1	payyr	0.0952	10.0%
Model 2	payyr	0.0384	3.9%
Model 3, tail = 0	payyr	-0.0115	-1.1%
Model 3, tail = 1	payyr	0.0735	7.6%

From this we can observe:

- The superimposed inflation rate is much higher if we look at all payment years (10.0%) than just the last three (3.9%). It may be the case that superimposed inflation has been lower in recent years, but the more likely explanation is simply that in the earlier payment years the portfolio was skewed towards the earlier finalisation delays where claim sizes are smaller.
- In recent years, superimposed inflation was much higher in the tail (7.6%) than it was in the first two delays, where it was slightly negative.

If we add additional variables into our GLM, such as severity, the model will provide an estimate for the effect of these, and the parameter estimate for the payyr variable will give an estimate of the residual superimposed inflation after taking these effects into account. Hence, by constructing a GLM which is consistent with the actuarial models being used, we can derive a "model relative" measure of superimposed inflation, which we can add to our actuarial model.

If instead we were more interested in a "portfolio level" measure, we could apply a similar approach to the aggregated payments:

```
* Aggregate data;
ods html path="&out" body="3 Aggregate GLMs.html" style=sasweb;
proc genmod data=claims_sum;
    title "All payment years";
    model amount = payyr / dist=gamma link=log;
    output out=aggregate_all p=predicted_amount;
run;
proc genmod data=claims_sum;
    title "Recent payment years";
    where payyr ge 2008;
    model amount = payyr / dist=gamma link=log;
    output out=aggregate_recent p=predicted_amount;
run;
proc genmod data=claims_sum;
    title "Recent payment years - with tail split";
    where payyr ge 2008;
    by tail;
    model amount = payyr / dist=gamma link=log;
    output out=aggregate_split p=predicted_amount;
run;

ods html close;
```

This produces the following estimates:

Analysis Of Maximum Likelihood Parameter Estimates			
	Parameter	Estimate	Rate
Model 1	payyr	0.2338	26.3%
Model 2	payyr	0.1894	20.9%
Model 3, tail = 0	payyr	0.3466	41.4%
Model 3, tail = 1	payyr	0.0735	7.6%

These estimates are much higher – why is this? Looking at the claims triangle we can see that the number of claims finalised has increased significantly between the 2008 to 2010 payment years (from 1 to 2 at most delays, a huge 100% increase!). This is picked up in our aggregated dataset, and hence is fit by the GLM.

8. References

[i] De Ravin, J., Fowlds, M., 2010, Inflation Risk in General Insurance. 17th General Insurance Seminar.
[ii] http://en.wikipedia.org/wiki/Inflation
[iii] De Ravin, J., Fowlds, M., 2010, Inflation Risk in General Insurance. 17th General Insurance Seminar.
[iv] Pearson, E., Beynon, C., 2007, Superimposed Inflation – Australian Accident Compensation Landscape in 2007. XIth Accident Compensation Seminar.
[v] Cutter, C., 2009, *Measuring* and Understanding Superimposed Inflation in CTP Schemes – What's in our Toolkit?. 12th Accident Compensation Seminar.
[vi] Zehnwirth, B., 2002, *FAI* a red herring, not Trojan horse, in HIH disaster. Australian Financial Review 10th May 2002.
[vii] http://www.secinfo.com/dR7Km.1wj.d.htm