Advanced approaches to analyse disability income experience: Using experience from Canada, the United Kingdom, South Africa, Australia and New Zealand

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ABSTRACT

Disability income insurance is sold across multiple markets with different product features. Product design, operational and other environmental factors, can have a significant impact on claims costs. This study was prompted by discussion of the challenges faced by the Australian market. Gen Re has collected disability income experience data from various countries. We compare the product features across Canada, the United Kingdom, South Africa, Australia and New Zealand and use data analytics in an attempt to understand which factors have the greatest impact on claims costs. The main aim of this project is to enable different countries to learn from one another's experience as most other studies focus on single markets. We acknowledge and discuss the complexity of this given the variation in multiple factors across countries. The results in this paper are high level and more detail will be shared with study participants as agreed.

KEYWORDS

Disability income, experience investigations, advanced analytics, machine learning

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1. INTRODUCTION

This paper presents a study conducted on the disability experience in Canada, the United Kingdom, South Africa, Australia and New Zealand to understand differences and similarities between these markets. This paper aims to show how the use of advanced analytical approaches can lead to a better understanding of disability experience across these markets.

We begin with an overview of available literature relating to disability experience investigations. Thereafter, a brief comparison of product features between the different markets is made. The study concludes with a modelling and analytics discussion.

We show crude rates and actual versus expected ratios for both incidence and terminations over a range of rating factors. These results are insightful but it is challenging to draw meaningful conclusions due to both the complexity of the disability income products and because of variations in experience between markets. We therefore employ modelling to generate insights from historic experience. The modelling techniques used are validated by comparing actual experience with the predicted output from the modelling.

The aim of this paper is to provide a broad overview of results and findings, with more detailed results being made available to study participants.

2. BACKGROUND AND LITERATURE REVIEW

2.1 Reasons for this Study

In May 2019 the Australian Prudential Regulatory Authority (APRA) highlighted a number of factors that are "impeding life companies' ability to improve the performance and sustainability of individual DII" in Australia (Summerhayes, 2019). Webersinke (2019) goes on to discuss possible causes of poor experience in the Australian Disability Income market:

— over-insurance,
— insufficient benefit taxation,
— lack of onus placed on the claimant to engage with interventions that would improve prospects of return to work,
— rating/research agency influences in increasing product generosity,
— reinsurance cross-subsidies applied between different product lines,
— product design flaws and complex policy wording,
— relaxed underwriting standards,
— difficulties in interpreting historic experience,
— lack of robust pricing assumptions, and
— lenient claim philosophies in identifying whether a claim is valid.

The above resulted in a series of conversations between individuals that work with disability income products in different jurisdictions. The intention of these conversations was to learn from similarities in product design and to highlight key challenges that have been seen in different disability income markets. A key learning from the ongoing discussions

is that providers of disability income policies, around the world face challenges similar to those faced by Australian insurers (Kerr, 2021).

To continue learning from different markets, Gen Re undertook an individual life disability income survey to compare individual life disability income product experience between Canada, the United Kingdom, South Africa, Australia and New Zealand.

2.2 Available literature

2.2.1 EXISTING IN-COUNTRY DISABILITY INCOME STUDIES

The Society of Actuaries (SOA) analysed individual disability income experience trends over 2011 to 2016 relative to the 2013 Individual Disability Income Base Table (hereafter referred to as 2013 IDI).[1] There were 12 contributors in the United States who provided experience for years 2005 to 2015. The paper found that experience differed by contract type, smoker status, maximum benefit payment period and market segment (individuals, associations or employee sponsored schemes) (Society of Actuaries Individual Disability Experience Committee 2019).

The Institute and Faculty of Actuaries' (IFoA) most recent study looked at "All offices" Individual Income Protection experience for years 2011–2016, using data from eight participants in the United Kingdom. This study includes actual versus expected results over a range of explanatory variables and multiple expected bases. In general, experience showed lighter claims inceptions for male lives and for older ages, when compared to experience from years 2007–2010. For claims in payment, claims experience shows lower recovery rates when compared to experience from years 2007–2010 (The Institute and Faculty of Actuaries Income Protection Committee, 2019).

In New Zealand, Ralph (2023) reviewed the claims incidence and terminations experience of seven insurers over the period 2013 to 2019. Experience was shown relative to the Australian Disability Income industry tables (FSC-KPMG ADI, 2014–2018) that were developed using Australian experience from years 2014 to 2018. The study found an increasing trend in accident claims with sickness claims being stable over the period.

In comparing the experience studies we see a few differences. Studies in North America, Australia and New Zealand look at both inceptions and claims experience by broad cause (accident versus sickness). In some cases, the products have deferred periods and benefit payment periods that differ by broad cause type too. Conversely, a split by accident and sickness is not analysed in the United Kingdom or in South Africa.

The assignment of occupations into occupation classes also differs. This is particularly noticeable for medical occupations. There is a separate category for medical occupations in the USA's 2013 IDI base tables. In Australia, professional and medical occupations are grouped together in the FSC-KPMG 2014–2018 tables, although adjustment factors are proposed in the paper for medical occupations relative to the aggregate occupation class.

1 Industry table used in 'Society of Actuaries Individual Disability Experience Committee 2019'

In the UK and South Africa, individual companies allocate medical professionals to one of the existing occupations classes that include both medical and non-medical occupations. Some companies group doctors along with other professional and administrative occupations while others allocate them to one of the higher risk classes to reflect heavier experience. We would not expect medical professionals to have the lightest experience because, for example, there are some manual components to the job.

2.2.2 MARKET FEATURE COMPARISONS

A 2019 disability income report commissioned by the Actuaries Institute in Australia was completed by KPMG. The paper focuses on a comparison of disability products in Australia, UK, USA and South Africa. The authors use publicly available data sources such as product disclosure documents of the biggest market players in each country. A key finding was that Australia had generous policy terms and conditions for Individual Life Disability Income products, relative to other markets. Factors that may lead to additional claim volumes include higher non-medical underwriting limits and lenient disability definitions. The paper found that a number of factors resulted in high replacement ratios at claim stage, including:

— lenient claims philosophies (for example, paying a full disability claim when the policyholder is able to work in a reduced capacity),
— generous income definitions in determining pre-disability earnings,
— limited financial underwriting at the point of claim, and
— guaranteed insurability options (Bui et al., 2020).

Revisions have been made to enhance the sustainability of the policy features; however, Australian products still appear to offer higher benefits and more generous policy terms than the other regions in this study (Bui et al., 2020).

Wells and Barrett (2013) compared individual and group risk disability income products in South Africa, Australia and North America. The paper mentions that disability income experience is influenced by a range of factors that include economic conditions, changes to claims management practices, a period of strong sales prior to adverse experience as well as product terms, features and conditions.

2.2.3 ENVIRONMENTAL INFLUENCES

Various papers have shown that economic conditions can influence disability experience. However, in different countries and at different times this experience may go in opposite directions. Schriek and Lewis (2010) assessed whether there was a measurable link between claims incidence experience and the state of the economy in South Africa. The paper found that claims incidence increased when certain economic conditions deteriorated. Deng and How Yin Fat (2020) quote a number of studies that also show an increase in disability claim rates with increased levels of unemployment.

COVID-19 is another environmental factor that may have influenced disability income experience. The Society of Actuaries' Individual Disability Experience Committee surveyed eight disability income providers to get a view of the impact of COVID-19 on their business. The results showed that the impact of COVID-19 on individual disability income experience was not as prominent as was seen in mortality-based products (Barriss et al., 2022). Similarly, the IFoA performed a qualitative analysis to assess the impact of COVID-19 on income protection business. In general, the responses suggest that the market expects an increase in claims inceptions due to the removal of financial support from the state that was introduced during the COVID-19 pandemic. The working paper showed mixed responses regarding future claim termination experience because delays in recovery (due to longer National Health Service waiting lists for treatment) may be offset by greater acceptance of work from home (The Institute and Faculty of Actuaries Income Protection Committee, 2021).

3. METHODOLOGY

The approach adopted in this study can be separated into two parts:

— A qualitative product feature comparison, along with a scoring model to suggest the sustainability of each product.
— An experience investigation, looking at claims inceptions and terminations separately.

3.1 Product feature comparisons

We reviewed the study participants' product guides to understand their product features. We then designed a benchmarking tool to give a score to indicate how sustainable each product is from a product design perspective.

The tool considers 75 product features which are grouped into the following seven broad categories:

— disability definition,
— insurable income (such as whether the product pays agreed value or indemnity and also how pre-disability income is calculated),
— income replacement ratios,
— offsets and other deductions (e.g. welfare benefits),
— core benefits (i.e. non-face amount product features typical of disability income),
— increases in benefits (indexation and policy options to increase cover), and
— ancillary benefits (e.g. additional claims triggers).

The benchmarking tool assigns a score of 0 to 5 for each feature considered, where 0 indicates the least robust or most generous and therefore least sustainable feature. A score of five indicates the most sustainable feature. The tool then assigns a weight to each feature's score with those features that are perceived to drive most of the risk inherent in a

product receiving the highest weighting. This allowed us to summarise the wide variation in product features into a single sustainability score in a consistent way. These scores are used to assess whether the results from the experience investigation are intuitive.

Any such tool will be subjective because judgement is required to design a scoring and weighting system. We note that different scores and rankings may have been obtained with different scoring allocations and weights but we would still expect the most generous products to emerge with lower sustainability scores. We found that the sustainability scores within countries were similar. This reflects that competitive pressures influence product design.

3.2 Disability income experience investigation

In this study we show the crude inception and termination rates over a range of variables. The rates are calculated as follows:

$$m_x = \frac{\theta_x^I}{E_x^I}$$

where:

— $m_x =$ central claim incidence rate

— $\theta_x^I =$ number of claim inceptions

— $E_x^I =$ central exposed to risk for incidence (in years).

For terminations:

$$t_x = \frac{\theta_x^T}{E_x^T}$$

where:

— $t_x =$ central claim termination rate

— $\theta_x^T =$ number of terminations

— $E_x^T =$ central exposed to risk in claim (in months).

After this, we perform an actual versus expected analysis using the following formulae:

$$AvE^I = \frac{\theta_x^I}{E_x^I \mu_x^I}$$

where:

— $AvE^I =$ actual versus expected ratio for claim incidence

— $\theta_x^I =$ number of claim inceptions

— $E_x^I =$ central exposed to risk for incidence (in years)

— $\mu_x^I =$ central claim incidence rate from the Society of Actuaries' 2013 individual disability income base tables (2013 IDI).

$$AvE^T = \frac{\theta_x^T}{E_x^T \mu_x^T}$$

where:

— $AvE^T =$ actual versus expected ratio for claim terminations

— $\theta_x^T =$ number of terminations

— $E_x^T =$ central exposed to risk in claim

— $\mu_x^T =$ central claim termination rate from the Society of Actuaries' 2013 individual disability income base tables (2013 IDI).

Lastly, we consider both generalised linear models and LASSO regression (Tibshirani, 1996) to model each of incidence and terminations. Only the model output from the LASSO regressions are shown because there are multi-collinear relationships between the variables that were considered. LASSO regression deals with multi-collinearity by applying cross-validation. Another advantage of LASSO regression is that it produces simpler and more interpretable models by introducing a penalty parameter to shrink the coefficients with minor contribution to be exactly zero.

3.2.1 ALLOWING FOR DELAYS IN THE REPORTING OF CLAIMS

A challenge in this study is that not all participants were able to provide experience over a consistent time period. Some of the data provided was not fully run-off and adjustments are required for incurred but not reported claims.

Rossouw and Richman (2019) discuss how machine learning techniques may be used to allow for delays in claims reporting. Based on this work, we have chosen to use LASSO regression techniques to model potential reporting delays. Adjustments are then made to exposures by following the "exposed but not expected to be reported (EBNER)" approach. Under this approach claims are not adjusted but exposure is reduced. This approach assumes a factor of completeness for each loss period, say R_t which is between 0 and 1. We use the factor of completeness to determine a central claim incidence rate, m'_x, that has been adjusted for delays in the reporting of claims:

$$m'_x = \frac{\theta_x^I}{E_x^I R_x}$$

where:

— $m'_x =$ central claim incidence rate adjusted for reporting delays

— $\theta_x^I =$ number of inceptions

— $E_x^I =$ central exposed to risk for incidence (in years)

— $R_x =$ factor of completeness described above.

The adjusted actual versus expected ratio for claim incidence becomes:

$$AvE^I = \frac{\theta_x^I}{E_x^I R_x \mu_x^I}$$

where:

— $AvE^I =$ actual versus expected ratio for claim incidence

— $\theta_x^I =$ number of claim inceptions

— $E_x^I =$ central exposed to risk for incidence (in years)

— $\mu_x^I =$ central claim incidence rate from the Society of Actuaries' 2013 individual disability income base tables (2013 IDI)

— $R_x =$ factor of completeness described above.

3.2.2 ALLOWING FOR REPEAT CLAIMS

Claims were treated as a single continuous claim where the deferred period was waived in the event of entering disability soon after returning to work. This was done to avoid artificially increasing claim inceptions and terminations. The length of time used to assess whether to waive the deferred period differs by participant and the original deferred period was used where this information was not provided.

3.2.3 MODEL FORMULAE

The following formulae were used to model claims inceptions and terminations. Given that both claim inceptions and terminations are expressed as counts, we assume that the errors follow a Poisson distribution.

For inceptions:

$$log\left(\theta_x^I\right) = \beta_0 + \sum_i \beta_i x_i + log\left(\mu_x^I E_x^I R_x\right)$$

where:

— $\theta_x^I =$ number of claims incepting

— $\beta_0 =$ the intercept parameter

— $\beta_i =$ the coefficient corresponding to covariate x_i

— $\mu^I =$ central claim incidence rate from the Society of Actuaries' 2013 individual disability income base tables (2013 IDI)

— $E_x^I =$ central exposed to risk for incidence (in years)

— $R_x =$ factor of completeness described above.

For terminations:

$$log\left(\theta_{\mathrm{x}}^{T}\right) = \beta_0 + \sum_i \beta_i x_i + log\left(\mu_{\mathrm{x}}^{T} E_{\mathrm{x}}^{T}\right)$$

where:

— $\theta_{\mathrm{x}}^{T} =$ number of terminations

— $\beta_0 =$ the intercept parameter

— $\beta_i =$ the co-efficient corresponding to covariate x_i

— $\mu_{\mathrm{x}}^{T} =$ central claim termination rate from the Society of Actuaries' 2013 individual disability income base tables (2013 IDI)

— $E_{\mathrm{x}}^{T} =$ central exposed to risk in claim (in months).

Note that no adjustments have been made for potential reporting delays on terminations. The effect of reporting delays is likely to be less significant when compared to claim inceptions.

4. RESULTS

This section provides an overview of the product comparisons and the data used for this study. Then we look at crude inception and termination rates, followed by actual versus expected results. We then assess how well the model performs using actual versus predicted results. The crude rates, actual versus expected and actual versus predicted results are shown by country, deferred period, age and occupation class. Various cuts of the average inception and termination rates on a standard business mix are provided to give a feel for the model output.

The results in this paper are high level. More detailed results will be shared only with study participants as agreed.

4.1 Product comparisons

When comparing disability income offerings between regions, we found variations in product features as well as differences in how certain information is coded. Both underwriting and claims practices differ too. We discuss these separately below.

The product features for the participants varied from simple policies (that only pay for pre-defined expenses) to products with a range of complex riders and guarantees. An interesting feature in some markets is the presence of different deferred periods and benefit payment periods, based on whether the disability event is accident- or sickness-related.

An example of differences in coding of certain information relates to the classification of medical occupations for experience investigations. In some regions, medical professionals are allocated to a specific occupation class that only represents medical professionals. Other regions allocated medical professionals to a broader occupation class, sometimes with an additional explicit rating. In this study we chose not to allocate medical occupations to

their own group because this level of detail is not provided for all regions. The regions that provided a medical occupation indicator also provided a broad occupation class. For these cases, we only used the broad occupation class and not the medical occupation flag.

There are variations in health evidence requirements at underwriting stage. We also find differences in how financial underwriting is applied at claim stage with some regions and insurers only doing financial underwriting for high value claims.

4.2 Data overview

Each participant provided two datasets, one with claim inceptions experience and another with claim terminations experience. Table 1 shows the number of contributors to this study for each region. Note that contributions from participants were not uniform over the period.

Table 1 Number of participants and exposure periods

Country	Participants	Exposure periods by region
Canada	2	2009–2020
United Kingdom	5	2010–2021
South Africa	3	2009–2021
Australia	3	2018–2022
New Zealand	7	2013–2019

4.2.1 INCEPTIONS DATA SUMMARY

The data provided contains exposures for calendar years 2009–2021. Table 2 shows the overall inceptions exposure numbers (in years) and claim numbers. The drop in exposures and claims in year 2020 is a result of New Zealand participants not providing data beyond 2019. Similarly, the data provided by participants in Canada does not go beyond 2020.

Table 2 Exposure (in years) and claims by calendar year

Year	Exposure	Claims
2009	175,807	1,765
2010	182,919	1,791
2011	386,780	3,896
2012	398,612	3,876
2013	574,839	5,174

Year	Exposure	Claims
2014	604,258	5,581
2015	663,481	6,110
2016	694,571	6,524
2017	755,154	7,180
2018	956,275	7,874

Year	Exposure	Claims
2019	1,096,137	9,723
2020	767,571	6,580
2021	256,068	2,415

4.2.2 TERMINATIONS DATA SUMMARY

The data provided contains a claims list for claims in payment between calendar years 2009–2021. Table 3 shows the overall claims exposure numbers (in months) and claim termination numbers. A drop off similar to what was seen with the inceptions data is observed where the exposure periods provided for New Zealand and Canada end prior to 2021.

Table 3 Exposure (in months) and terminations by calendar year

Year	Exposure	Terminations
2009	79,330	1,239
2010	93,833	1,244
2011	107,382	2,963
2012	114,078	2,945
2013	122,408	3,949
2014	128,500	4,248
2015	134,856	4,689
2016	143,196	5,270
2017	153,211	5,585
2018	178,427	6,248
2019	188,157	7,427
2020	176,798	7,098
2021	106,262	7,056

4.2.3 VARIABLES INCLUDED

Table 4 lists the variables that were included in the data. There were some variations in this from product to product as well as differences between insurers.

Table 4 Variables included in this study

Variable	Description
Age	Age last birthday (adjustments were made to the data provided to align the age definitions)
Gender	Gender at birth: Male, Female or Unknown
Smoker Status	Smoker status: only smoker and non-smoker indicators were provided
Policy Duration	Curtate duration in years from policy inception
Underwriting Year	Year in which the policy originated
Calendar Year	Calendar year
Deferred Period	The period of time from when a person has become unable to work until the time that the benefit is eligible to be paid
Benefit Payment Period	The length of time during which an insurance policyholder may file and receive payment for a covered event
Occupation Class	Insurer's allocation of an occupation to one of out of four occupation classes
Cause of Claim	Description of the cause of claim
Benefit Amount	Monthly benefit payment amount
Occupation Definition	Own occupation, any occupation or 'other'

Variable	Description
Accident/Sickness	Whether the policy claims triggers include accidental claims, sickness claims or both
Financial Underwriting	An indicator showing if there is financial underwriting at claim stage
First Day Accident Rider	An indicator for accidental claims where the deferred period has been waived
Indexed	An indicator to show whether the benefit increases during claim
Date of Claim (where applicable)	Date first deemed absent from work
Date of Termination (where applicable)	Date that the relevant claim benefit stopped

4.2.4 KNOWN DATA LIMITATIONS

We are aware of the following data limitations:

— Not all contributing companies provided sufficient detail to remove policies with loadings and/or exclusions.
— Canadian, Australian and New Zealand product specifications define whether claims are a result of an accident or sickness. However, the data provided by participants from the United Kingdom and South Africa did not include this level of detail. As a result, we could not perform a separate study by accident versus sickness for these regions.
— Some regions have different deferred and benefit payment periods for accident and sickness claims where others do not.
— Not all participants could provide experience for the same observation period.
— Each region uses a different approach to map occupations into broad occupation classes. In addition, the same occupation may be in a different occupation class depending on the country, insurer and product.
— Not all providers include the reason for termination.
— Some participants did not provide the date of claim notification and we need to make broad assumptions when modelling potential reporting delays.
— One region adjusted the claim indicator to a value less than 1 for partial disability claims.
— Some participants supplied data with an earlier exposure end date to avoid periods that would include incurred but not reported claims.

To allow for the above, the following adjustments are made:

— We create two categories to model the effect of differing accident and sickness deferred periods – one where the accident and sickness deferred period are the same and another where the deferred period is waived for accident claims.
— For policies in claim we use the actual deferred and benefit payment period in the claims list (regardless of broad claim cause).

— All participants that provided a medical occupation flag also provided a broader occupation class. Medical occupations are not allocated to their own occupation class of medical professionals but rather to the broader occupation groups that were provided.
— To avoid counting false terminations, we do not flag terminations for policies that recover within four months of the end of the benefit payment period.
— All claims, including partial disability claims, were given a claim indicator value of 1 regardless of whether the full monthly benefit amount was paid.
— No EBNER adjustment was applied where the periods with incurred but not reported claims had already been removed.

4.3 Adjustments for delays in the reporting of claims

Figure 1 shows what multiplicative adjustments were applied to incidence exposures, by calendar year, using the EBNER method to allow for delays in claims reporting. Note that no adjustment was applied for participants in the UK because the data provided already has exposure periods truncated to an earlier date to avoid incurred but not reported claims. In this figure we see a larger EBNER adjustment in 2019 for New Zealand compared to other regions, highlighting that New Zealand has had longer reporting delays over the observation period.

To show the magnitude of the overall adjustments applied we compare a factor of completeness over the full observation period in Figure 2.

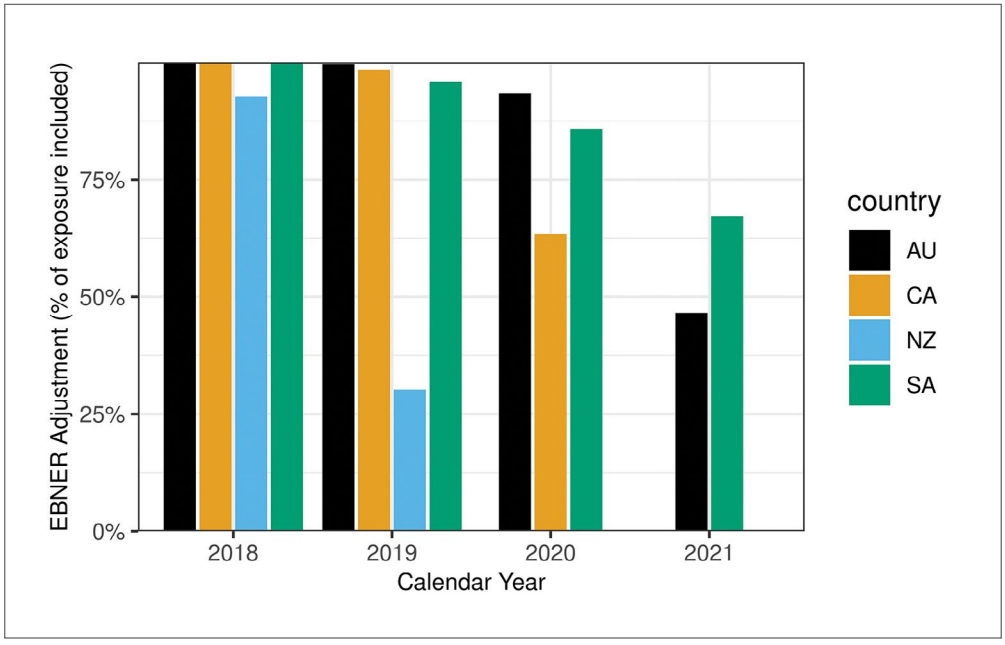

Figure 1 EBNER adjustment by country and calendar year

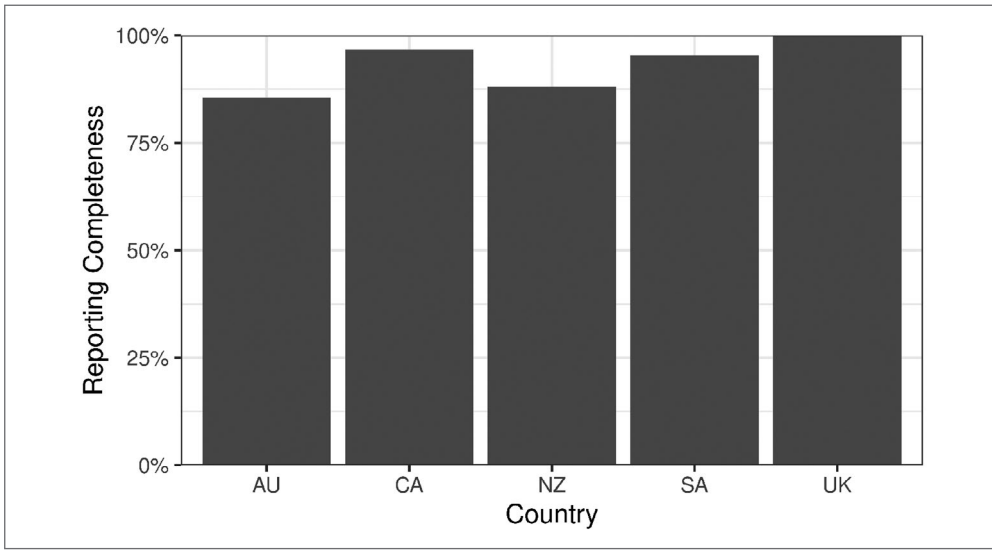

FIGURE 2 Reporting completeness by country

4.4 Crude rates

This section compares the raw claim inception and claim termination rates over a range of variables. An important consideration within this section is that the graphs have not been standardised. As a result, variations in the crude rates may be a function of a different mix of results within the categories plotted and not solely due to the factor. As an example certain deferred periods are more common in certain markets. It is widely accepted that deferred period has an impact on inception and termination rates. More detailed results will be made available to participants.

Some confounding factors to note when reviewing the figures below are:

— Each participant has a different age and gender mix.
— Each region has a different mix of deferred periods with UK generally having policies with longer deferred periods.
— Some participants waive the deferred period if the claim cause is accident.
— The approach used to allocate occupations to broad occupation classes differs by product and each participant has a different business mix by occupation class.
— There are differences in business mix when looking at whether the benefits are indexed (i.e., whether the benefit increases during claim).

4.4.1 INCEPTIONS

This section shows the actual central incidence rates relative to central exposure in years. When showing the rates by country we classify policies into two groups by deferred period, those that have a deferred period less than or equal to 30 days and those with deferred periods greater than 30 days.

Differences in raw claim inception experience by country are illustrated in Figure 3. These differences are likely to be a result of a different mix of lives (or rating factors) within each region. The model output (in Figure 28) compares annual incidence rates between countries after allowing for differences in the mix of lives within each region.

South Africa and the UK show the lowest claims inception rates for deferred periods greater than 30 days. Canada shows the highest claim inception rates for deferred periods less than or equal to 30 days.

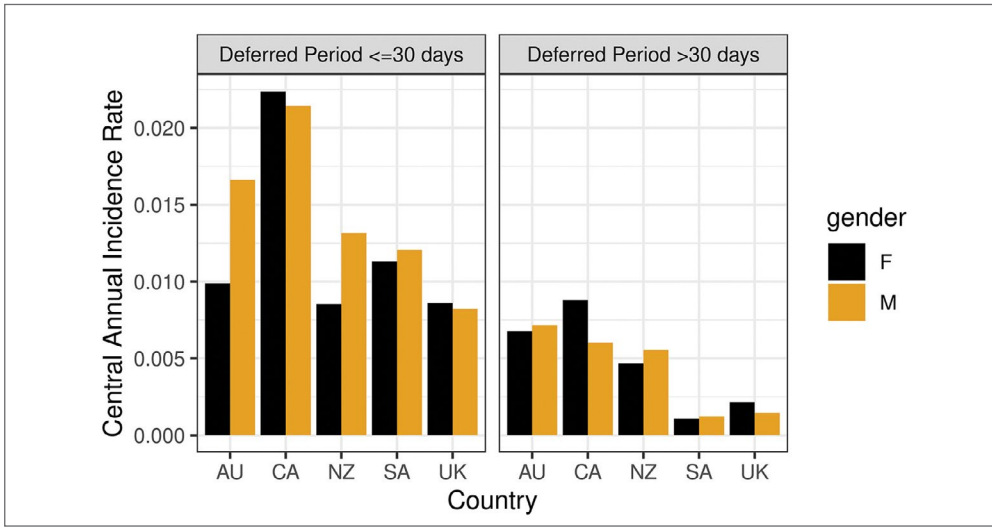

FIGURE 3 Annual crude inception rate by country and deferred period

Figure 4 shows that, in general, policies with longer deferred periods have lower claims incidence rates. In this graph, claims on policies with 0 day deferred periods mostly relate to accident claims.

Figure 5 shows that claim inceptions increase with attained age and that claim inception rates are higher for female lives, compared to males, for ages above 35.

Figure 6 shows that lower risk occupation classes (1 and 2) have lower claims inceptions. Higher inceptions are typically seen for more manual occupation classes which are often driven by shorter claims with higher termination rates.

We see that female lives in occupation class 1 have a similar claims inception rates to female lives within occupation class 2. The populations within these classes have not been standardised so the variation could be a result of different population characteristics within these two groups. In addition, the occupation class definitions vary from region to region and between companies. As a result, similar risks may be grouped into differing occupation classes depending on the region or company.

NOTE: Occupation class 1 represents the lowest risk category with occupation class 4 representing the highest.

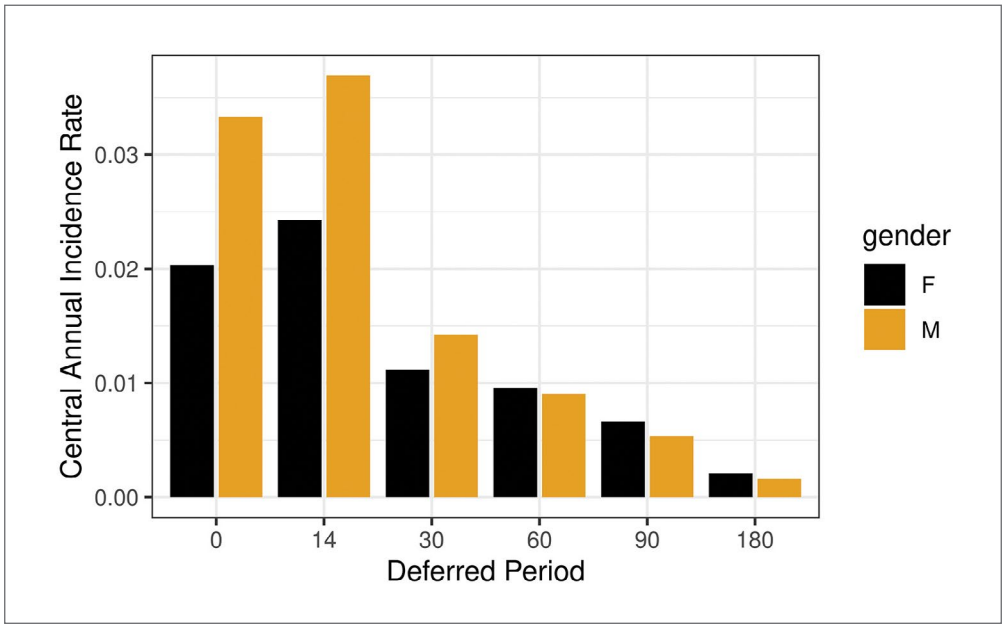

FIGURE 4 Annual crude inception rate by deferred period

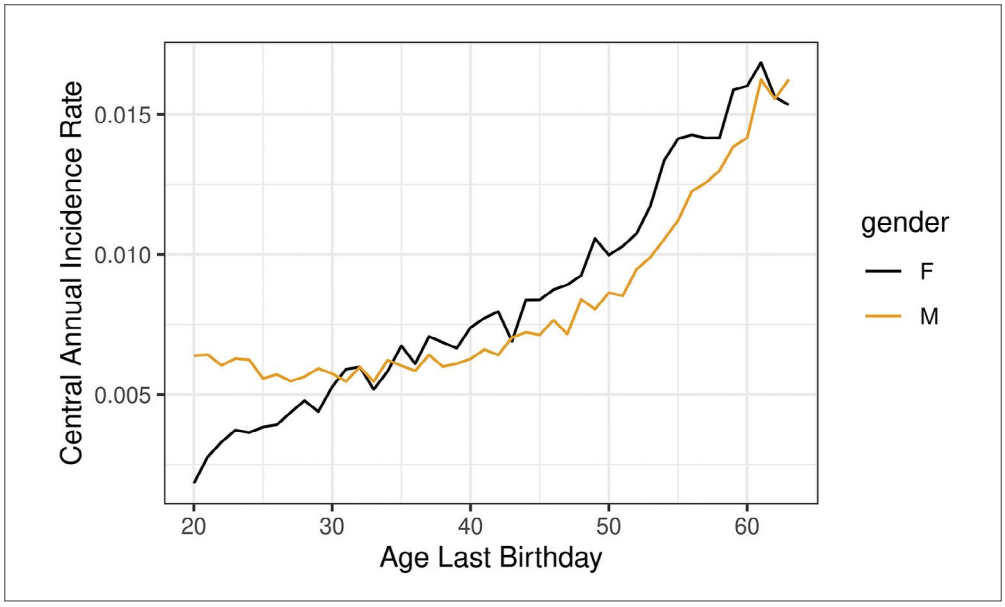

FIGURE 5 Annual crude inception rate by age

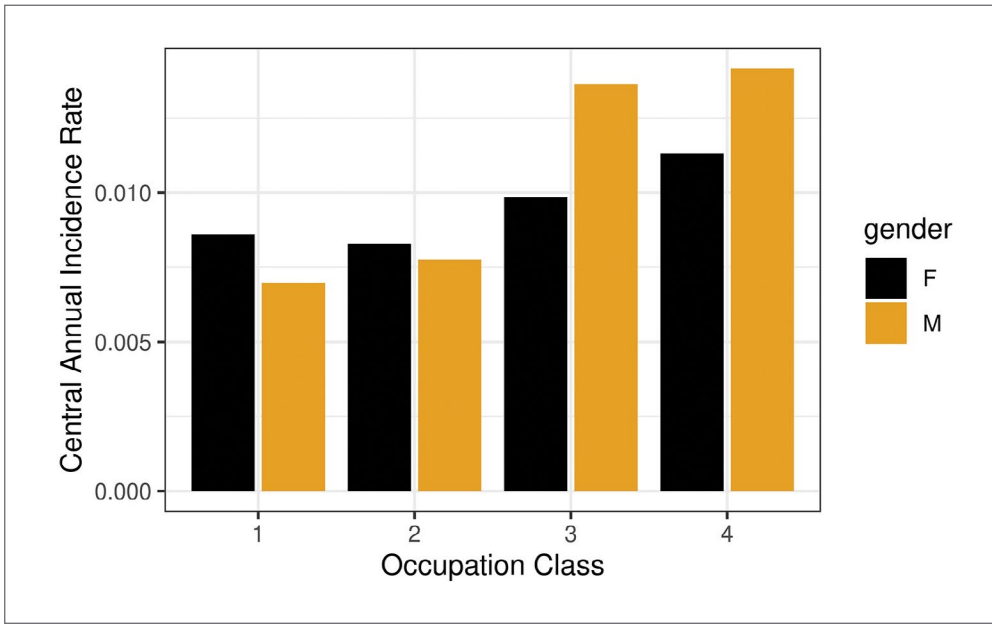

FIGURE 6 Annual crude inception rate by occupation class

4.4.2 TERMINATIONS

This section shows the crude termination rates relative to central exposure in months. When showing the rates by country we classify policies into two groups by deferred period, those that have a deferred period less than or equal to 30 days and those with deferred periods greater than 30 days.

Figure 7 shows crude termination rates by country. Australia has the lowest termination rates for both short and long deferred periods. There is actually little difference between the Australian short and long deferred period rates which is surprising. We found that this was caused by confounding with different occupation class mixes by deferred period.

South Africa and the UK show the biggest differentials between the short and long deferred period rates and have the highest termination rates for these short deferred periods. South Africa and the UK have similar termination rates by gender for the short deferred periods but in Australia, Canada and New Zealand termination rates are higher for males.

For the longer deferred periods Australia and South Africa have the lowest crude termination rates while the UK and New Zealand have the highest rates. The differences by gender are small.

Figure 8 shows crude terminations rates by deferred period. Termination rates are significantly higher for 0 day deferred periods. The rates are lower for longer deferred periods with a slight decrease in the crude termination rate between deferred periods of 30 and 180 days.

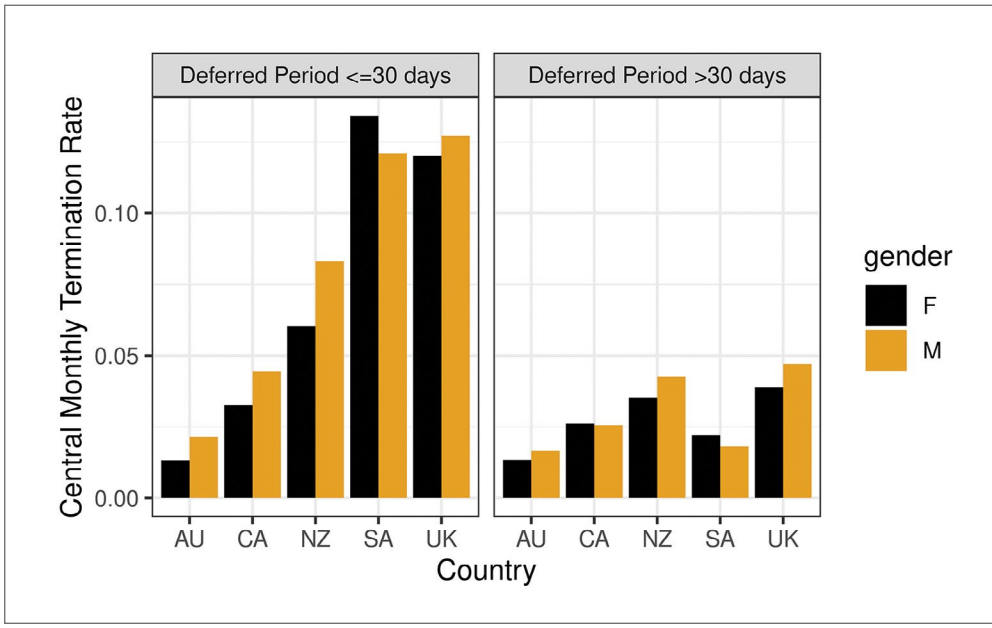

FIGURE 7 Monthly crude termination rate by country and deferred period

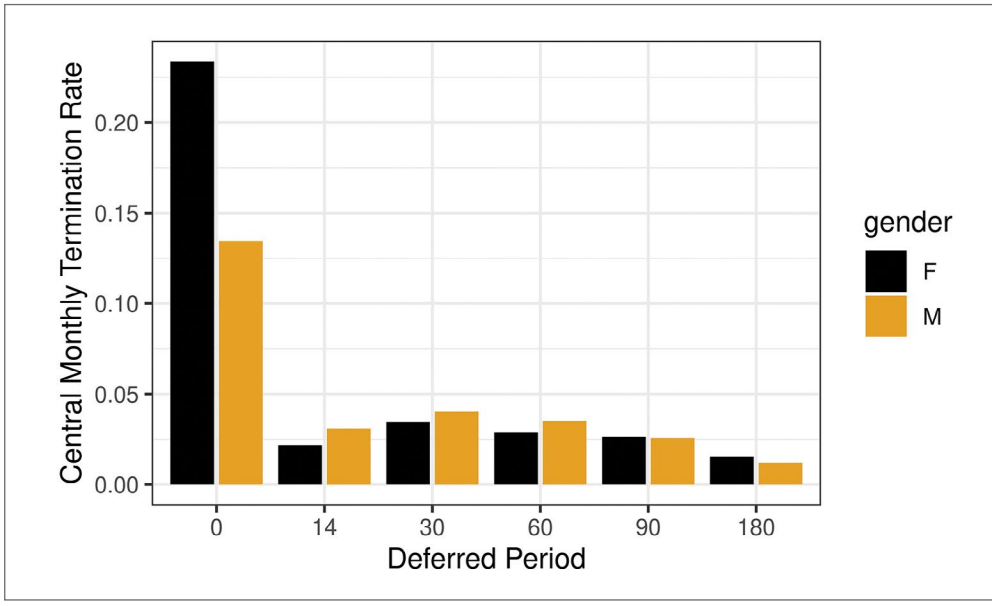

FIGURE 8 Monthly crude termination rate by deferred period

In Figure 9 we see that termination rates generally decrease with increasing age. At the younger ages (below 30) results are somewhat volatile due to lower volumes. Male termination rates are higher than female termination rates at all ages.

Figure 10 plots crude termination rates by occupation class. Generally lower risk occupation classes have lower termination rates which is expected given the higher

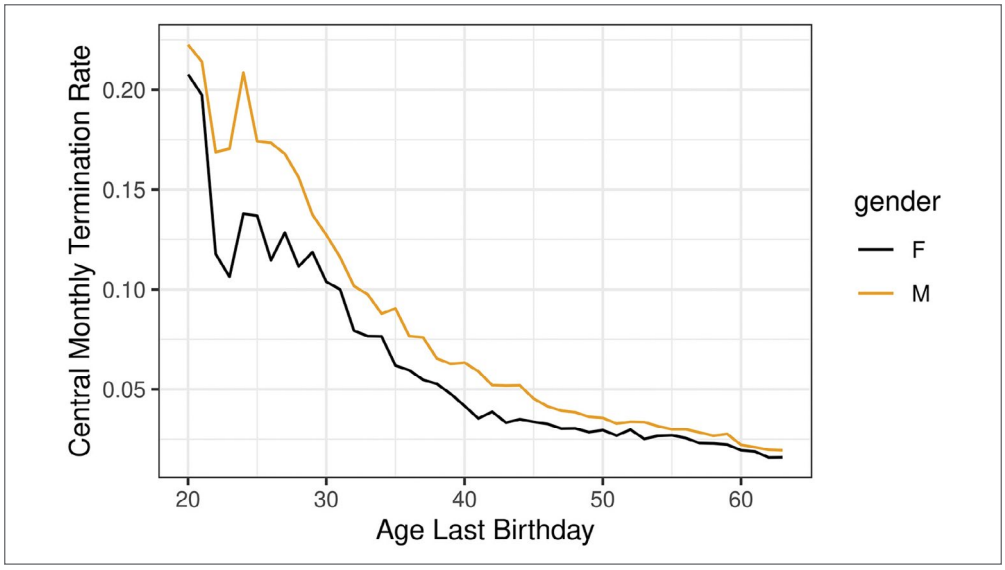

FIGURE 9 Monthly crude termination rate by attained age

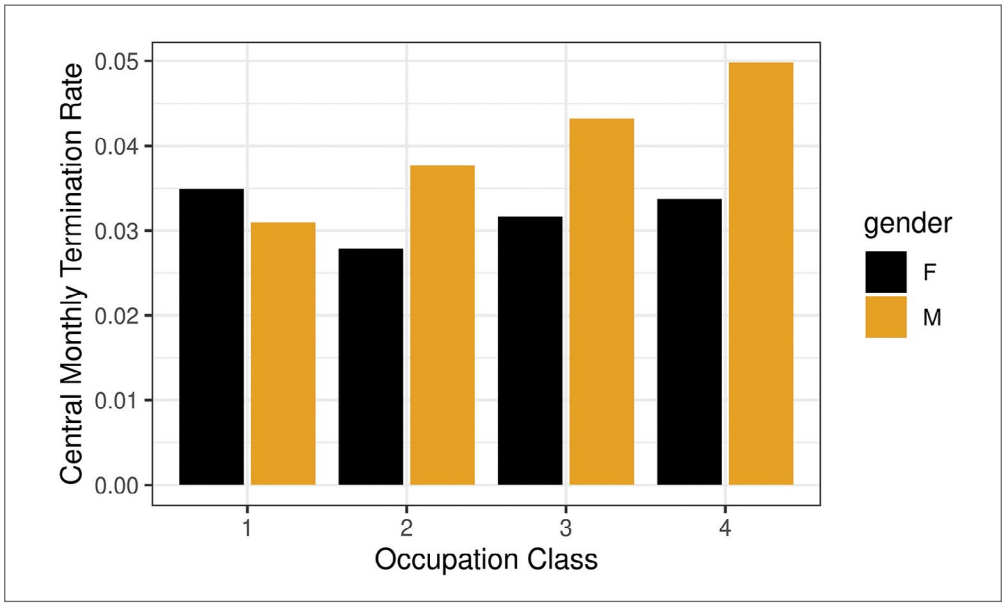

FIGURE 10 Monthly crude termination rate by occupation class

inceptions seen on the higher risk occupation classes above. We see less differentiation for females.

It should be noted that the data does not allow perfect mappings of occupation classes between countries or participants. As a result, the same person may be assigned a different occupation class than the one another participant may have supplied if they insured that person.

Note: Occupation class 1 represents the lowest risk category with occupation class 4 representing the highest.

4.5 Actual versus expected ratio analysis

In this section we compare the actual claim inception and terminations experience to a set of industry tables (the Society of Actuaries' 2013 IDI basis).

The following rating factors are present in the expected basis for inceptions:

— attained age,
— gender,
— deferred period,
— occupation class, and
— cause (accident or sickness).

The following rating factors are present in the expected basis for terminations:

— disability age,
— gender,
— deferred period,
— occupation class,
— duration in claim, and
— cause (accident or sickness).

Overall, we see some clear variations from the Society of Actuaries' 2013 IDI basis.

4.5.1 INCEPTIONS

Differences in actual versus expected ratios by country are shown in Figure 11. The countries included in this analysis have a very different gender shape to the US IDI tables with female experience running significantly lighter relative to the tables than male experience. A possible reason may be differences in coverage during pregnancy.

Inception rates are highest relative to the expected rates for Australia and New Zealand. UK rates are the lightest relative to the IDI tables. Note that output relating to Canada has been removed from this figure to ensure that the participants remain anonymous.

Figure 12 shows differences between the Society of Actuaries' 2013 IDI incidence rates by deferred period with 90-day deferred periods having the highest actual versus expected ratio.

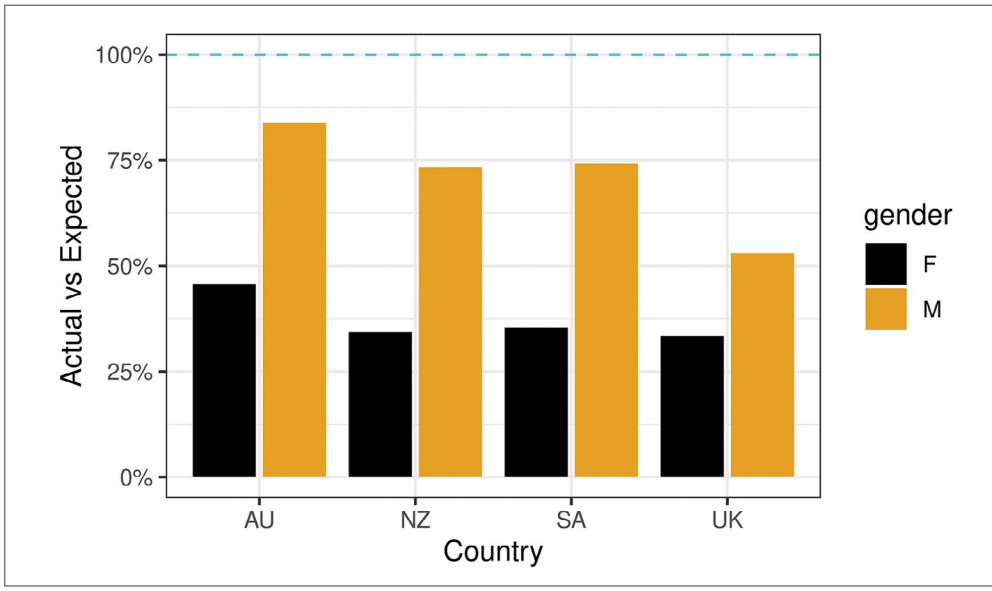

FIGURE 11 Actual versus expected inceptions by country

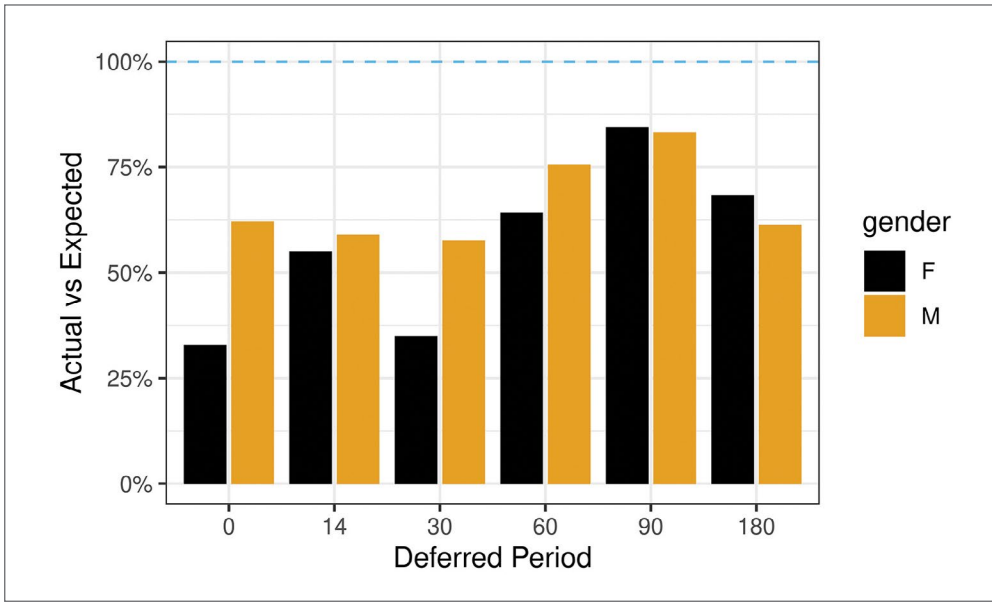

FIGURE 12 Actual versus expected inceptions by deferred period

Figure 13 shows an increasing actual versus expected ratio by age last birthday for female lives. The slope of the ratio for ages below 55 is flatter for male lives relative to female lives.

Figure 14 also shows that experience is lighter than the US IDI basis for all occupation classes. The male experience is closer to the expected basis than female experience. For

females we see that experience gets increasingly lighter than expected for the higher risk occupation classes.

Note: Occupation class 1 represents the lowest risk category with occupation class 4 representing the highest.

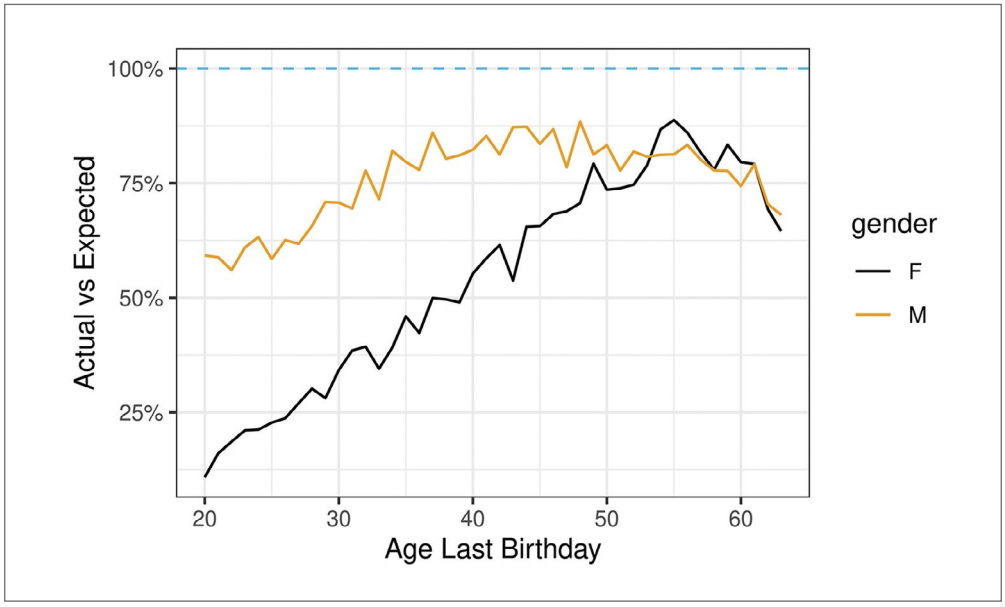

Figure 13 Actual versus expected inceptions by attained age

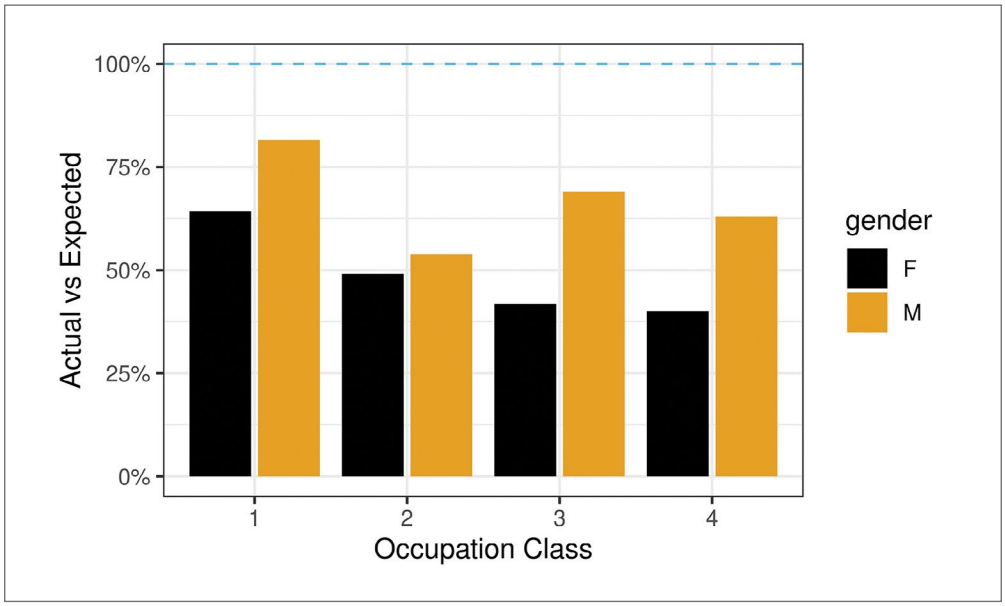

Figure 14 Actual versus expected inceptions by occupation class

4.5.2 TERMINATIONS

In this section actual terminations are plotted against the Society of Actuaries' 2013 IDI claim terminations basis as an expected. High ratios represent terminations that are higher than those expected using the industry table. This implies a lower cost of claim than that implied by the industry table.

Figure 15 shows that termination experience differs from the Society of Actuaries' 2013 IDI claim termination basis. All regions, except Australia, show actual versus expected ratios above 100%. The gender shape of the experience also differs from that inherent in the IDI basis with male termination rates running relatively higher.

Note that output relating to Canada has been removed from this figure to ensure that the participants remain anonymous.

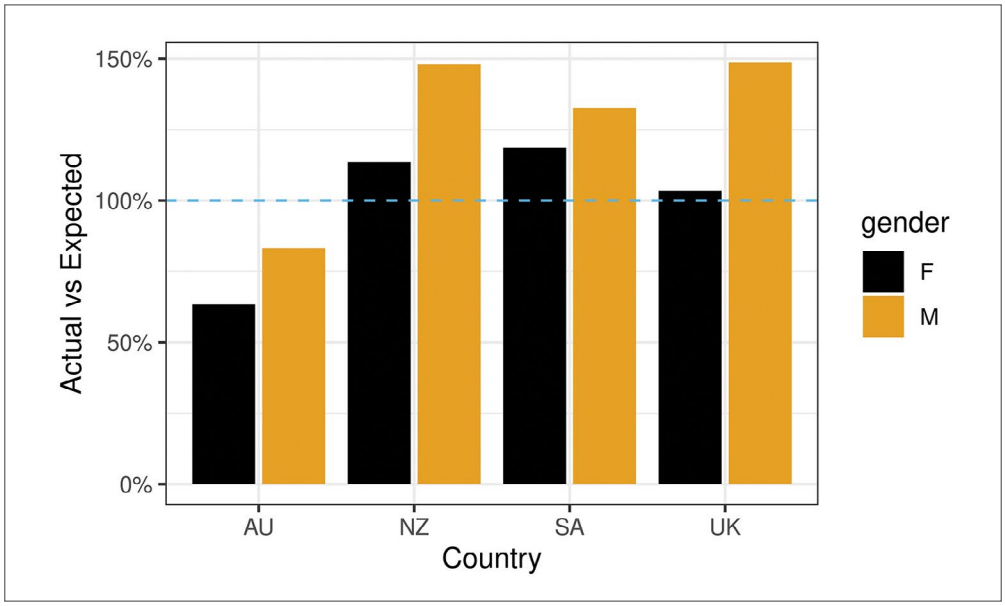

FIGURE 15 Actual versus expected terminations by country

Figure 16 shows that termination rates in the study data are higher than termination rates in the IDI basis for deferred periods of 0 days and 60 days or longer. For 14 and 30 day deferred periods, termination rates are lower than those in the expected table for females and somewhat higher than rates in the expected table for males.

Figure 17 shows some volatility in the actual versus expected ratios by age last birthday. Termination rates are higher than rates in the expected table at all ages for males and at most ages for females. Males show higher actual versus expected ratios for ages below 50.

Figure 18 shows termination rates by occupation class. For occupation classes 1 and 2 termination rates are significantly higher than the expected rates for both males and females.

For occupation classes 3 and 4, termination rates for females are lower than expected. For males, the termination rates are slightly higher than expected.

Note: Occupation class 1 represents the lowest risk category with occupation class 4 representing the highest.

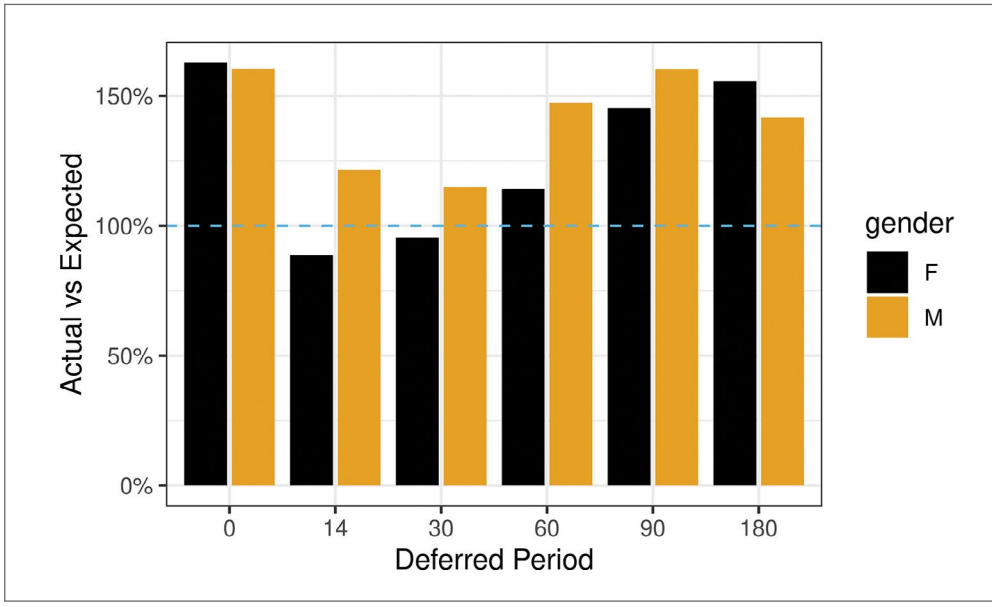

Figure 16 Actual versus expected terminations by deferred period

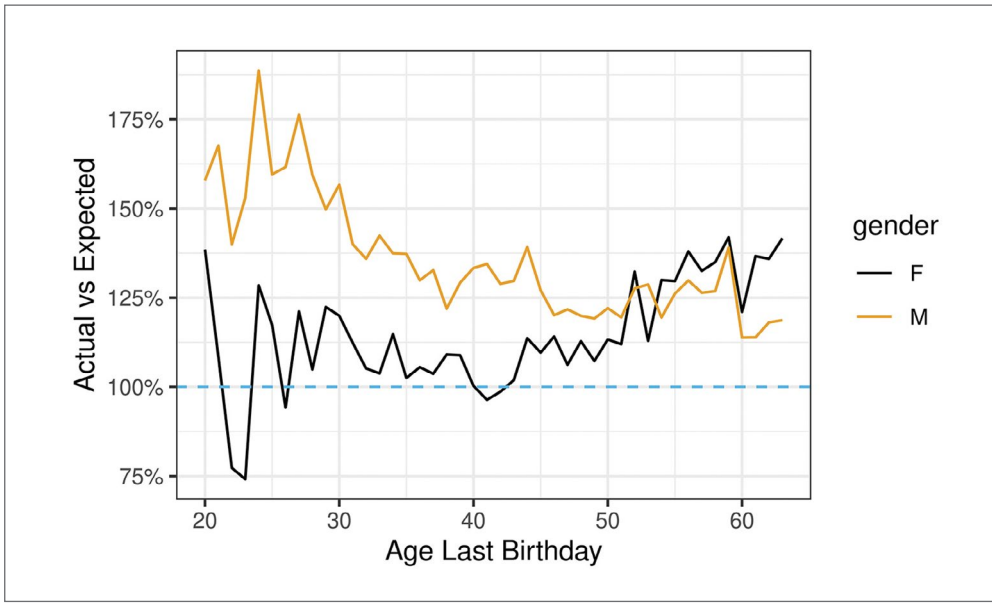

Figure 17 Actual versus expected terminations by attained age

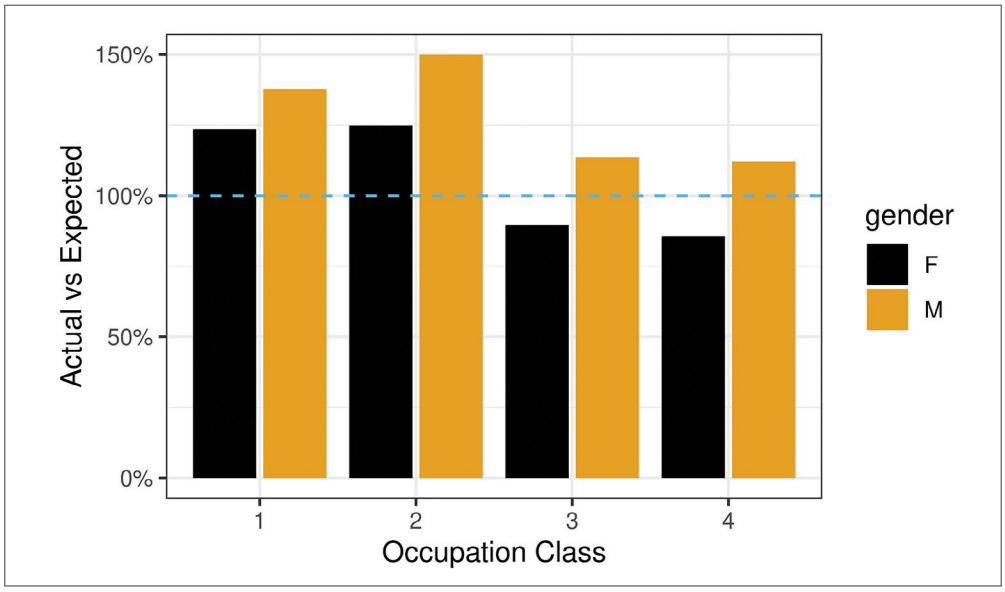

FIGURE 18 Actual versus expected terminations by occupation class

4.6 Actual versus predicted ratio analysis

Crude rates and actual versus expected analyses provide limited insights due to a range of factors that may influence claims costs. To help improve our understanding of historic experience, we use LASSO regression. This section summarises the actual versus predicted results after modelling for both claims inceptions and claim terminations experience. This gives an indication of how well the model performs.

4.6.1 INCEPTIONS

Figure 19 shows that actual experience is similar to the LASSO regression predicted inception rates by region.

Figure 20 shows actual versus predicted results close to 100% indicating that the model is a good fit to the experience by deferred period.

Figure 21 shows actual versus predicted experience near 100% with some volatility over individual ages. Most of the claim inception exposures lie between attained ages 30 and 50 where the model performs better.

Figure 22 shows a good fit by occupation class.

NOTE: Occupation class 1 represents the lowest risk category with occupation class 4 representing the highest.

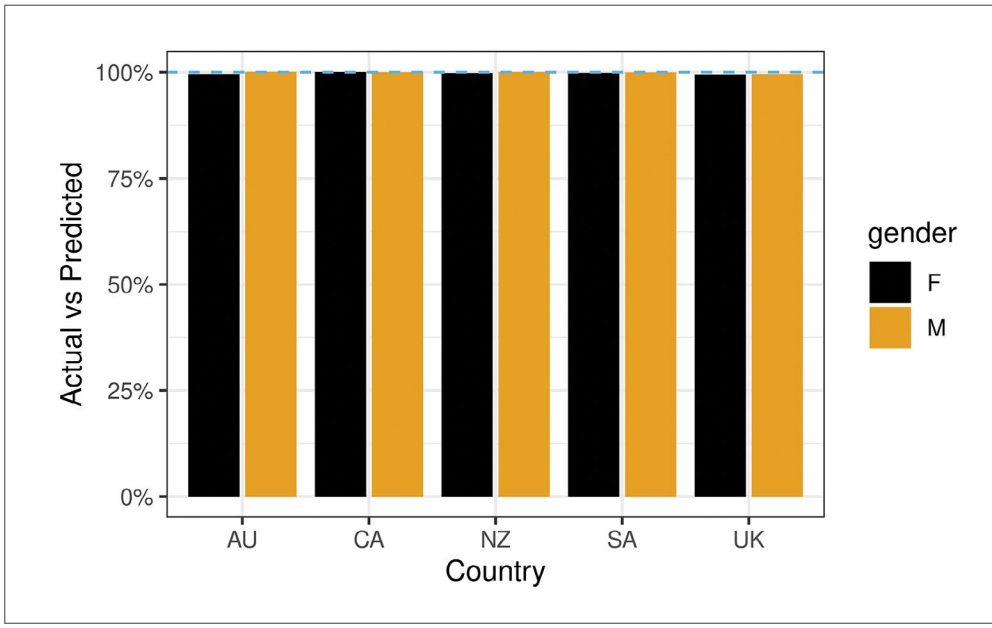

FIGURE 19 Actual versus predicted inceptions by country

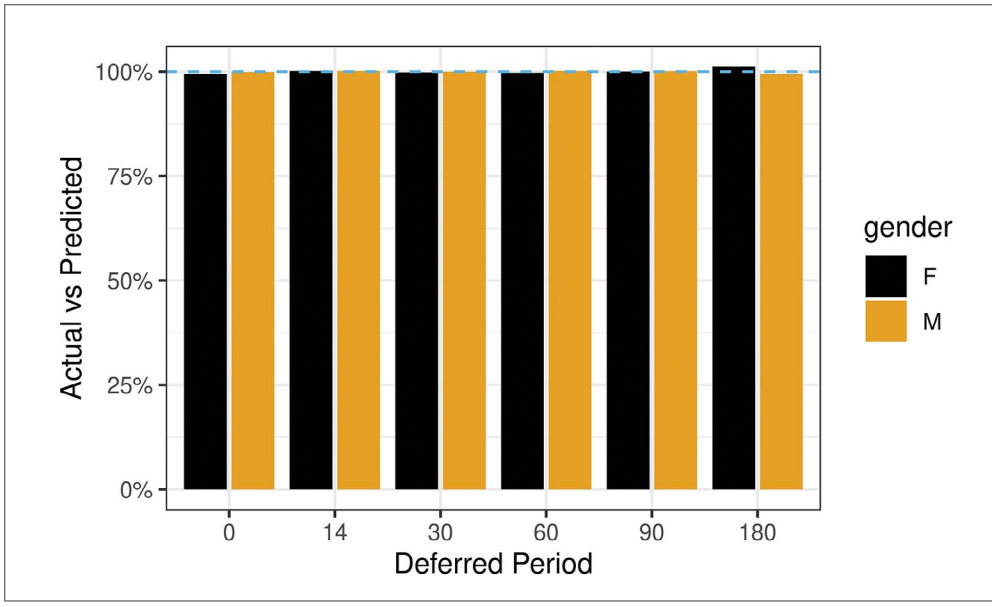

FIGURE 20 Actual versus predicted inceptions by deferred period

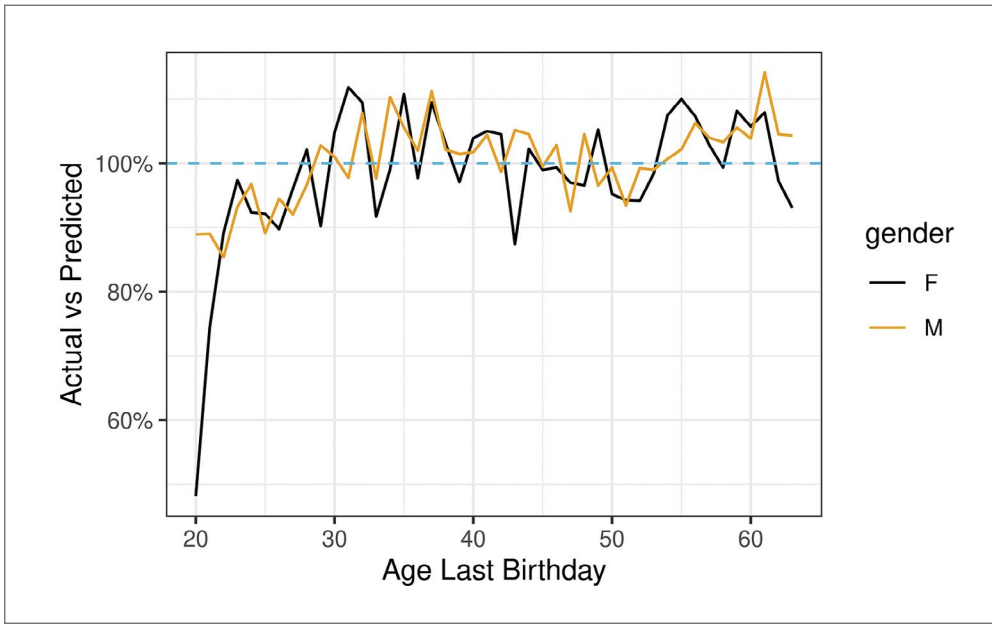

FIGURE 21 Actual versus predicted inceptions by attained age

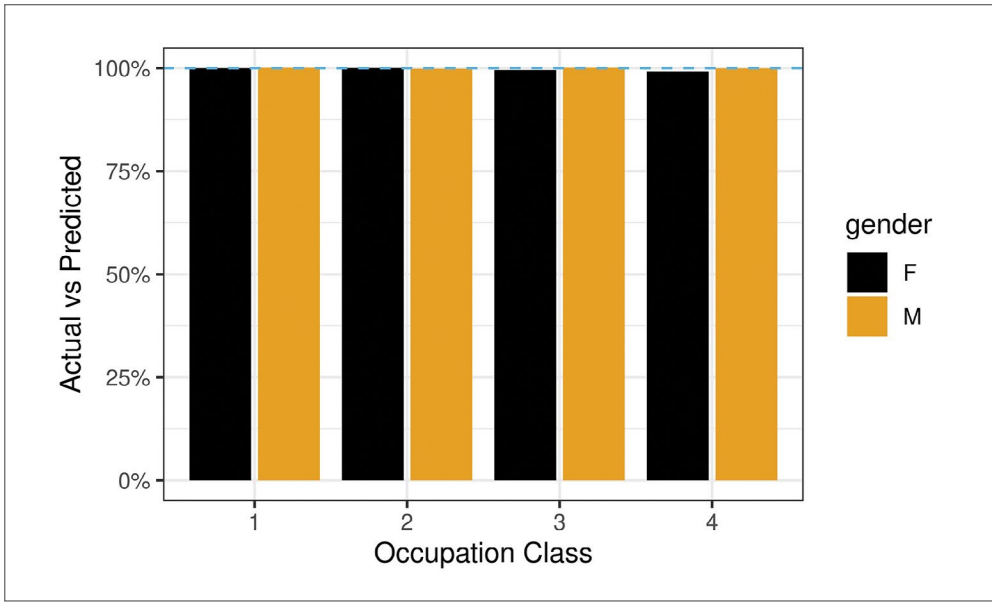

FIGURE 22 Actual versus predicted inceptions by occupation class

4.6.2 TERMINATIONS

Figure 23 shows that actual experience is similar to the LASSO regression predicted termination rates by region.

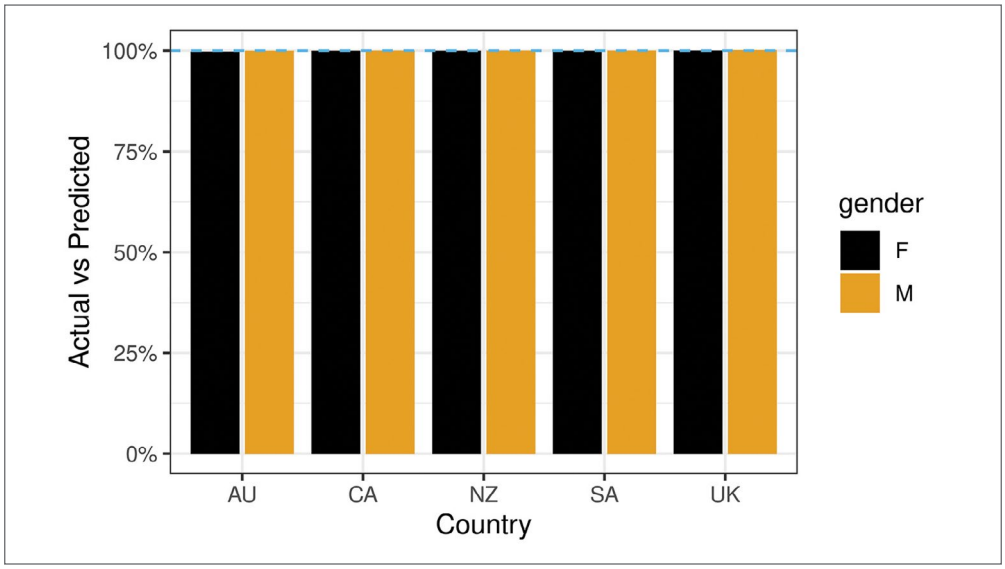

FIGURE 23 Actual versus predicted terminations by country

Figure 24 shows that actual experience is similar to the predicted termination rates by deferred period indicating that the model is a good fit to the data.

Figure 25 shows actual versus predicted results near 100% with some volatility over individual ages, ages below 30 in particular (where there are low claims volumes). Most claim volumes lie between attained ages 30 and 55 where the actual versus predicted results are closer to 100%.

Figure 26 shows that actual experience is similar to the termination rates predicted by the LASSO regression by occupation class.

NOTE: Occupation class 1 represents the lowest risk category with occupation class 4 representing the highest.

We have shown that the model fits the data well. Now we can compare the outputs of different parts of the model.

4.7 Model output rate comparisons

This section provides an overview of the model output on a standard portfolio of lives. We assume a standard mix of lives by gender, smoker status, age last birthday, deferred period, occupation class, occupation definition, whether the benefits in claim are indexed or not and duration in claim (for terminations). Thereafter, a weighted average of the predicted output from the LASSO regression models is derived.

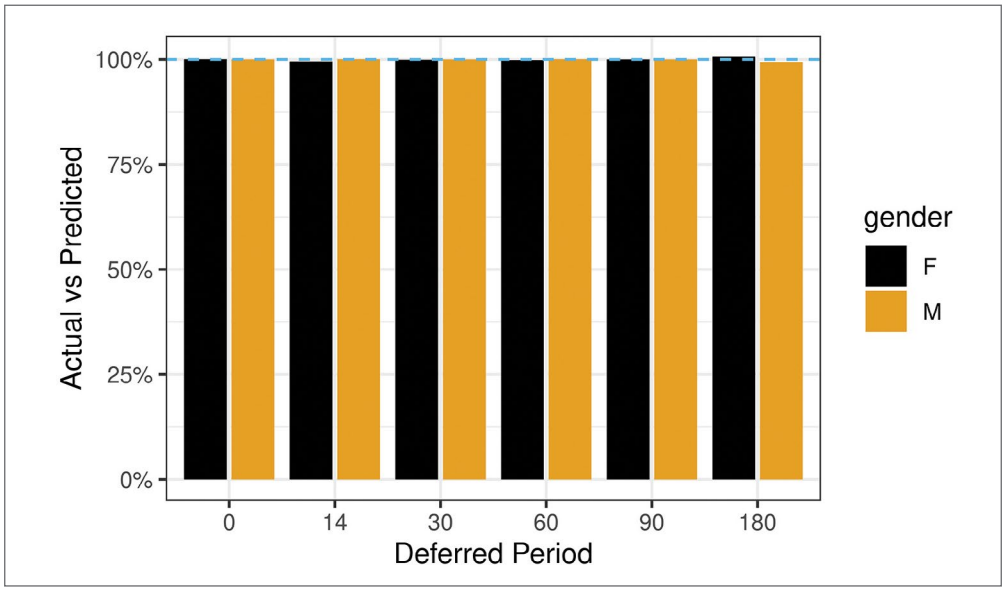

FIGURE 24 Actual versus predicted terminations by deferred period

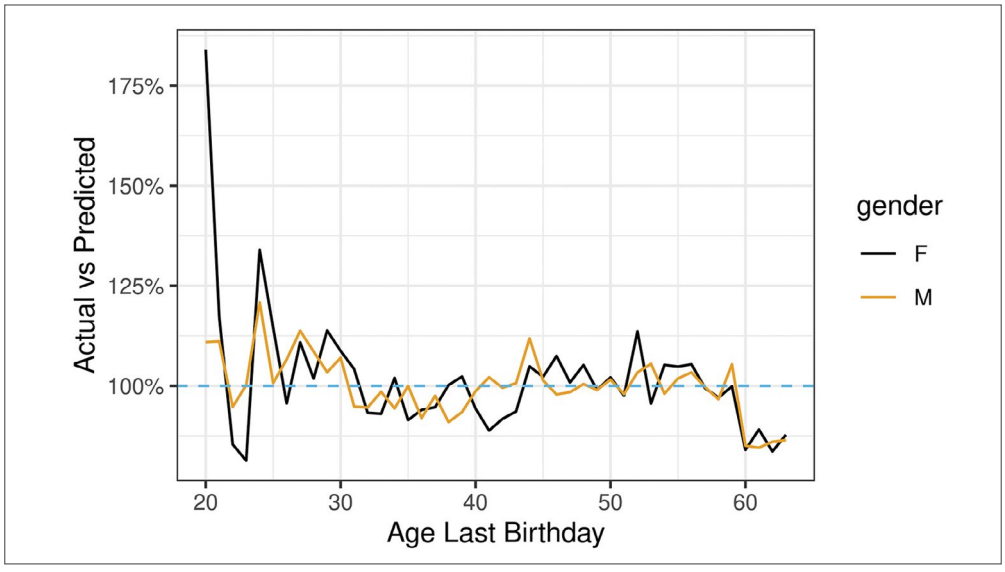

FIGURE 25 Actual versus predicted terminations by attained age

The output is shown by the sustainability score groups that were derived using the product feature comparison approach discussed above. This is done to assess whether the model output is reasonable.

For terminations, we show the model output by attained age for a few sample lines of sickness duration.

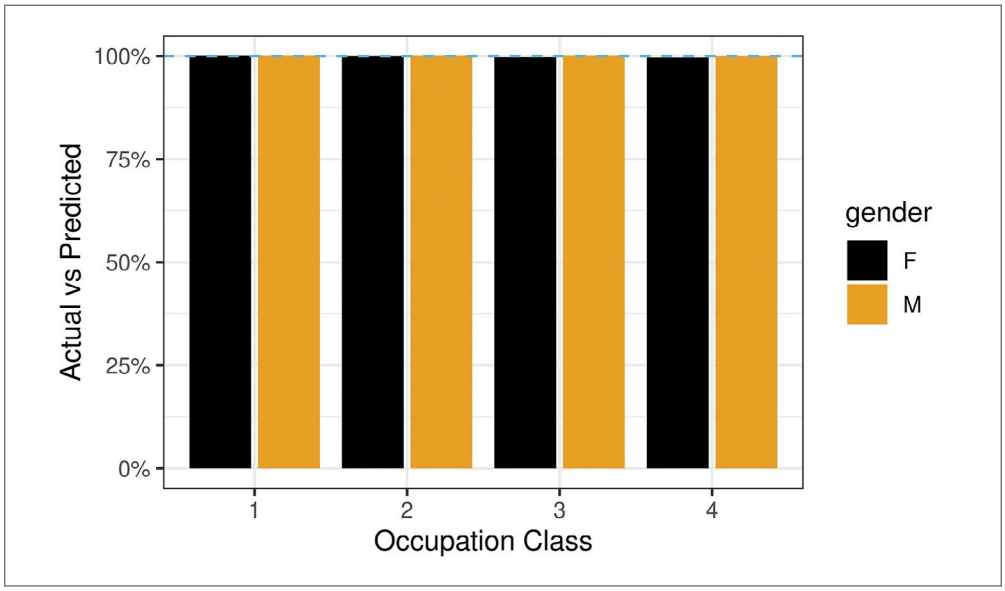

FIGURE 26 Actual versus predicted terminations by deferred period

We conclude this section with a table that compares the overall claims cost for a few model points, by sustainability score.

4.7.1 INCEPTIONS

Figure 27 shows higher predicted claim inceptions for products with less sustainable scores. As mentioned above, the sustainability score groups were similar within countries.

Figure 28 shows that the region with the highest overall claims inception rate for both males and females is Australia. Note that output relating to Canada has been removed from this figure to ensure that the participants remain anonymous.

Figure 29 shows lower rates of claim incidence for longer deferred periods. Female lives also show higher claim incidence rates for longer deferred periods when compared to males.

Figure 30 shows increasing claim incidence rates by age for female lives. Male predicted inception rates are flat prior to age 32 and increase thereafter. Female lives also have higher claim incidence rates relative to males for ages above 27.

Figure 31 shows similar claim inception rates for occupation classes 1 and 2 and higher inception rates for the more manual occupations (classes 3 and 4). Female claim inception rates are higher than male rates for occupation classes 1 and 2. For occupation classes 3 and 4, females show slightly lower claim inception rates than males.

NOTE: Occupation class 1 represents the lowest risk category with occupation class 4 representing the highest.

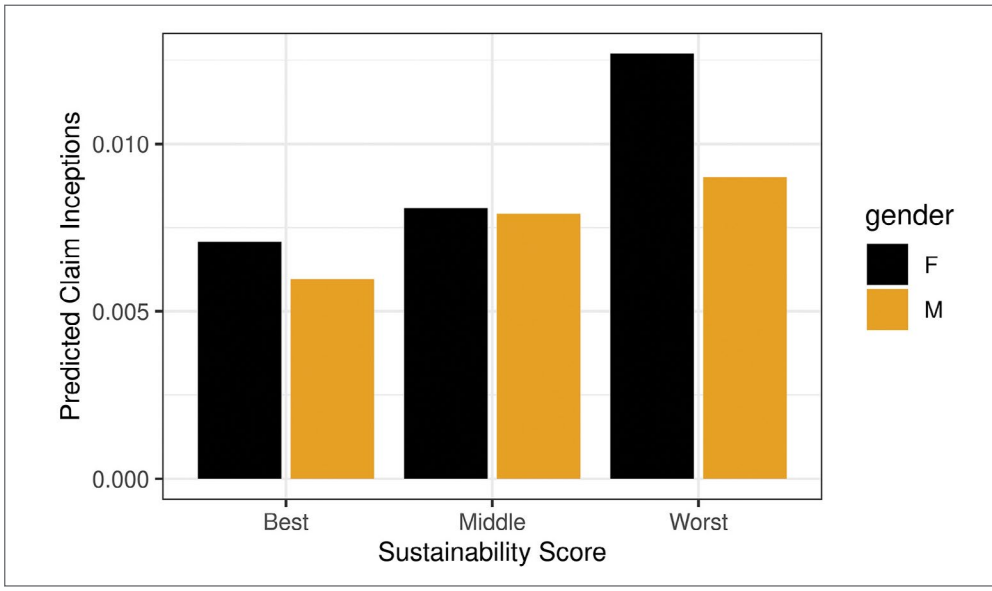

FIGURE 27 Predicted claim inceptions by sustainability score

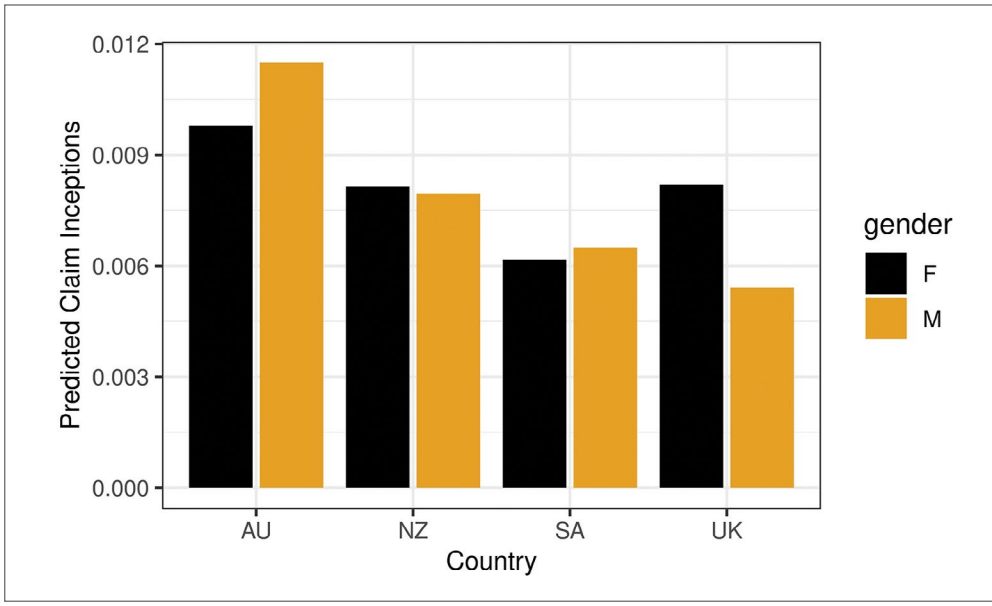

FIGURE 28 Predicted claim inceptions by country

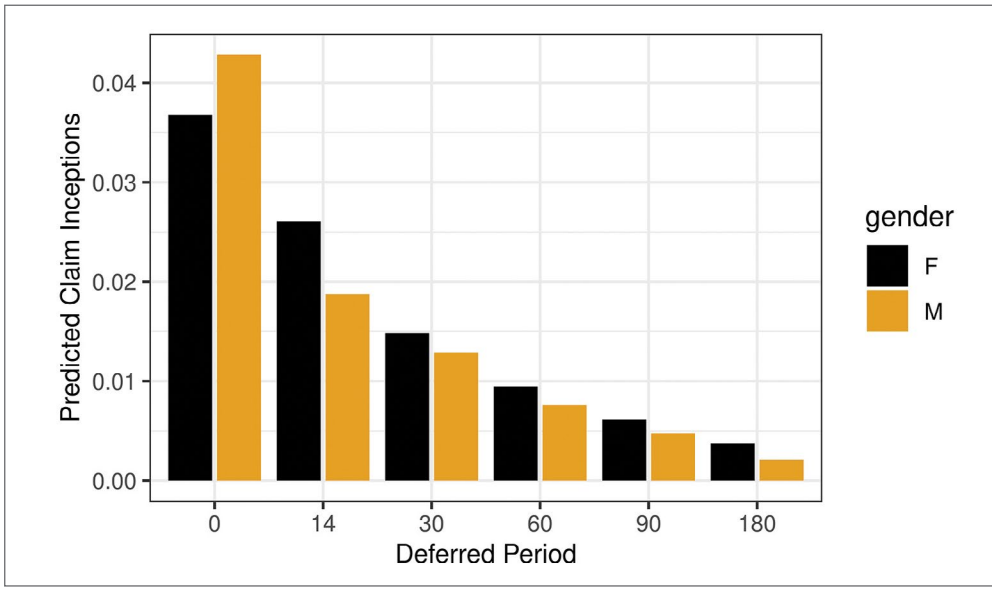

FIGURE 29 Predicted claim inceptions by deferred period

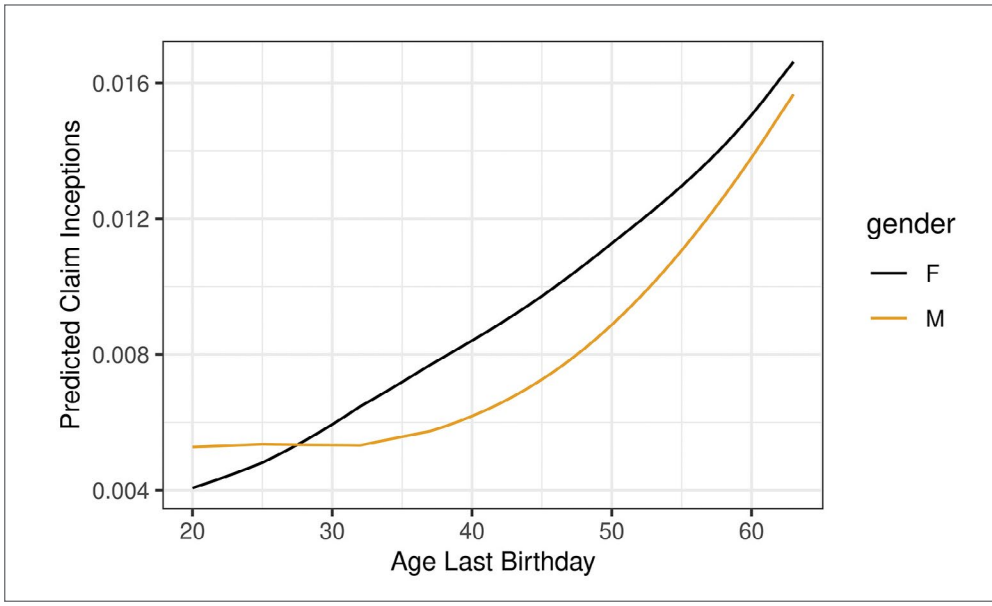

FIGURE 30 Predicted claim inceptions by attained age

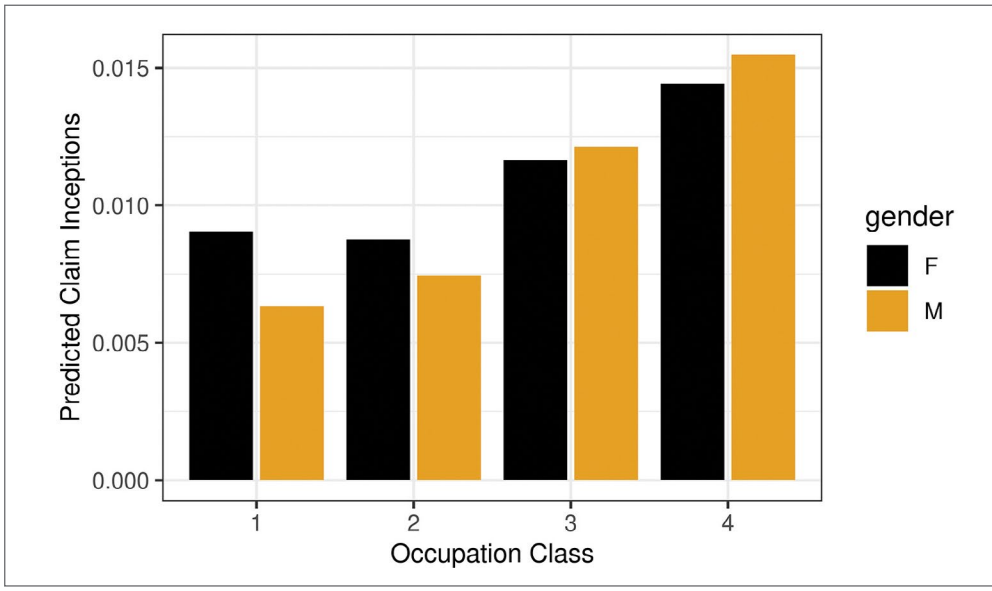

FIGURE 31 Predicted claim inceptions by occupation class

4.7.2 TERMINATIONS

In Figure 32 we see higher terminations on shorter deferred periods for the 'Best' sustainable product group. Less differentiation is seen for longer deferred periods. As mentioned above, the sustainability score groups were similar within countries.

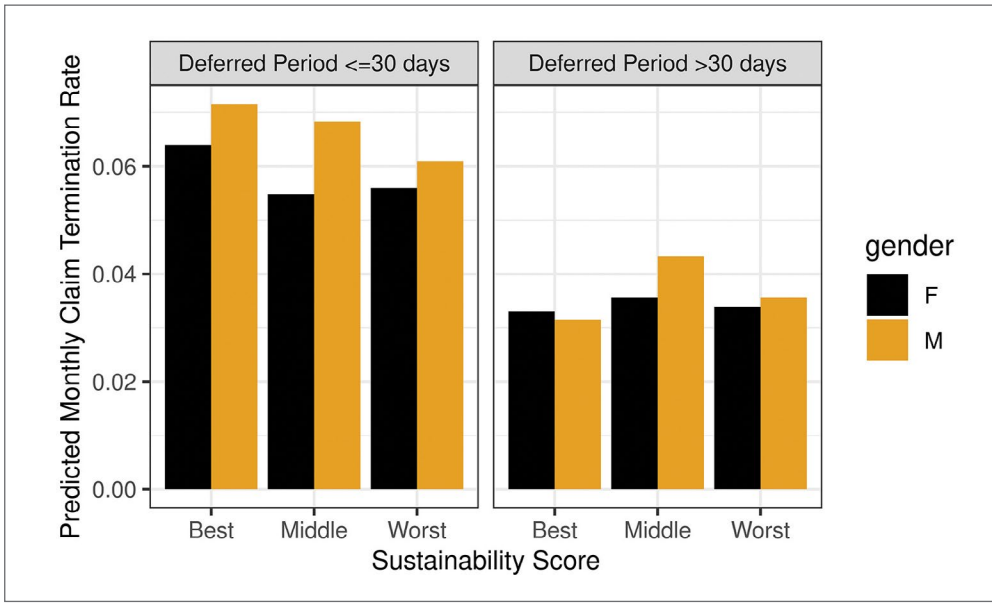

FIGURE 32 Predicted claim terminations by sustainability score and deferred period

Figure 33 shows that the region with the highest average claim termination rate is South Africa. UK and Australia have the lowest predicted termination rates when compared to other regions. The UK, however, shows the lowest claim incidence rate relative to other regions. Figure 34 shows lower claim termination rates for longer deferred periods.

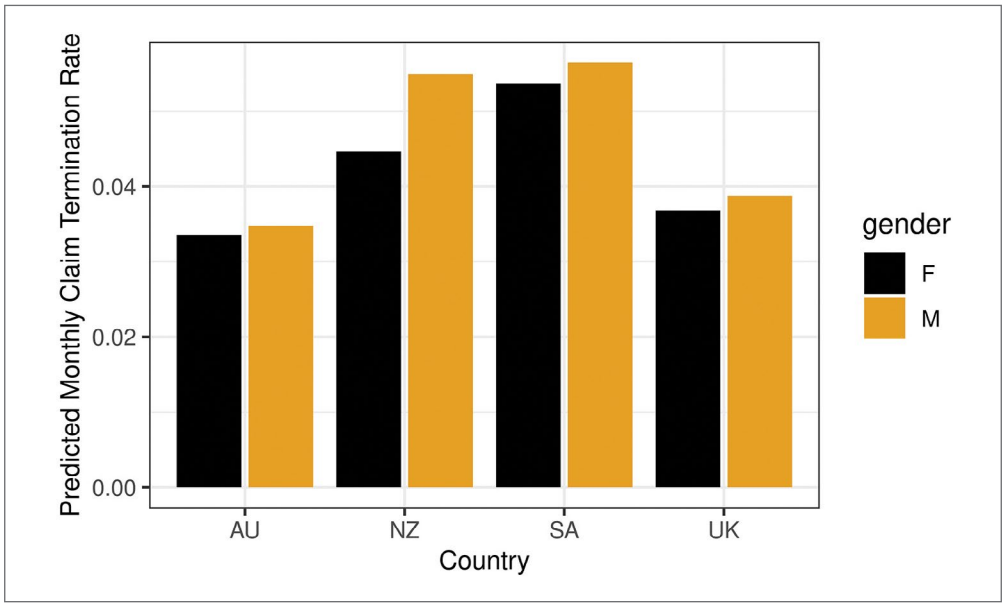

Figure 33 Predicted claim terminations by country

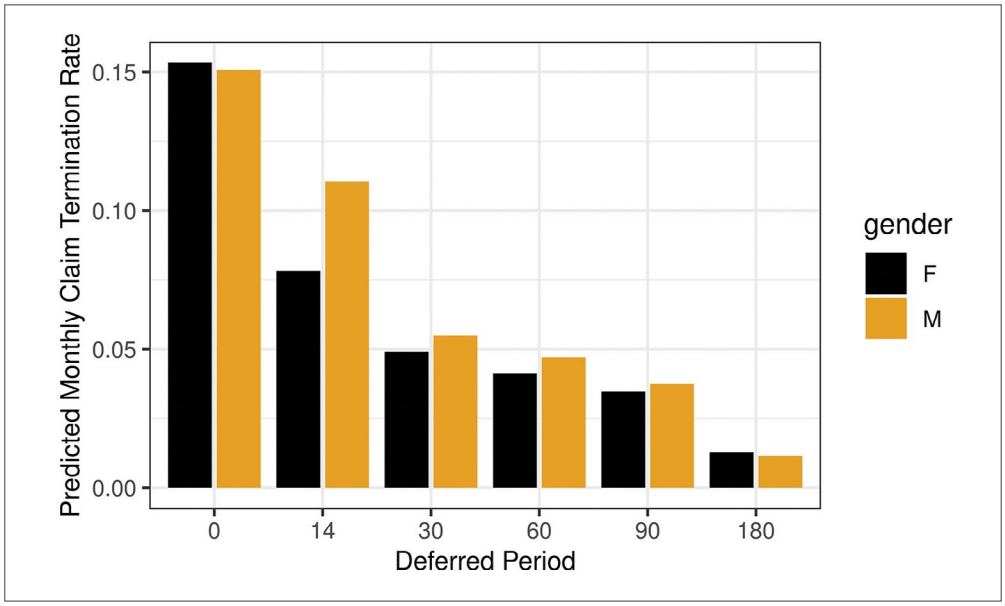

Figure 34 Predicted claim termination by deferred period

Figure 35 shows lower termination rates for longer durations in claim and for higher attained ages. However, the LASSO model suggests termination rates that have an upward slope for ages below 30 for shorter claim durations. The size of the suggested slope reduces with increasing claim duration.

In Figure 36 we see the lowest termination rates for occupation class 1 for males with similar termination rates for occupation classes 2, 3 and 4.

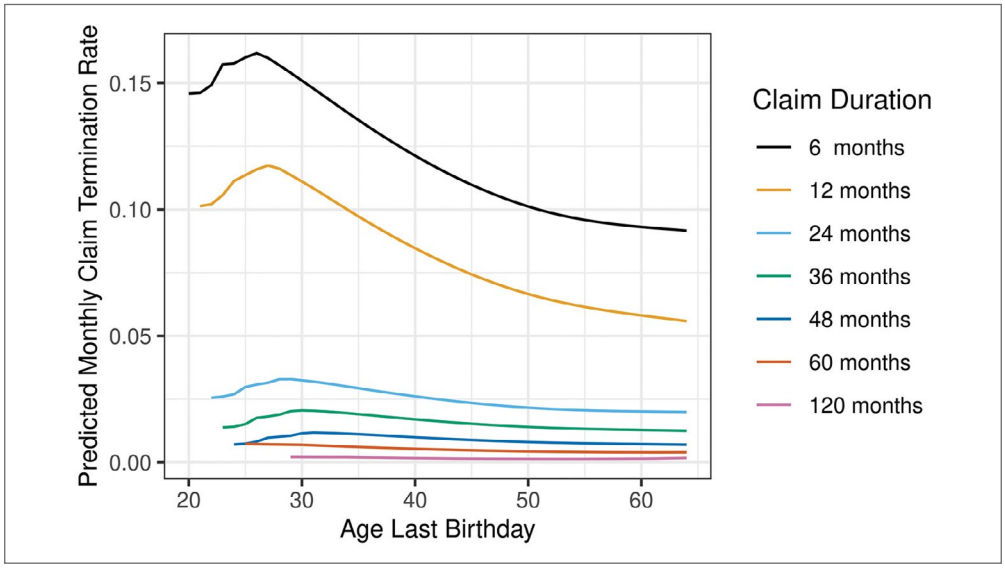

Figure 35 Predicted claim terminations terminations by attained age

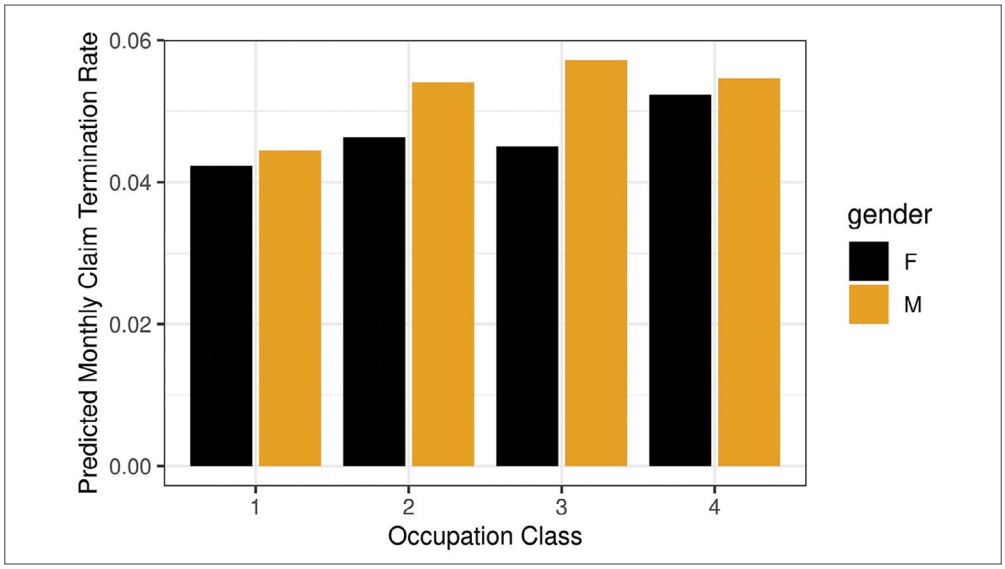

Figure 36 Predicted claim termination by occupation class

Female termination rates are similar for occupation classes 1, 2 and 3 and are highest for occupation class 4. Occupation class 4 has the highest inception rates which are tempered by the associated higher termination rates.

Note: Occupation class 1 represents the lowest risk category with occupation class 4 representing the highest.

4.7.3 PREDICTED CLAIM COST BY SUSTAINABILITY SCORE

Table 5 Predicted claim cost (per annum per 1,000 monthly income) by sustainability score

Disability age	Best	Middle	Worst
20	489.2	716.8	1261.1
30	561.6	752.8	1193.9
40	674.5	835.9	1206.3
50	907.9	1108.0	1503.6

Table 5 shows the predicted annual risk cost per 1,000 monthly income. The figures are based on the assumptions of an interest rate of 1% per annum and a level monthly benefit while disabled. These results are calculated using the claim inception and termination rates for males in occupation class 1 with a deferred period of 30 days. From this we see that products with the "Best" sustainability score have the lowest predicted claims costs and those with the "Worst" scores have the highest predicted claims costs.

5. DISCUSSION

This paper covers new ground in various areas. We discuss the following below:

— cross-country comparisons, and
— the use of advanced analytics techniques to understand disability income experience.

5.1 Cross-country comparisons

This study expands on previous product comparisons by considering both product features and the associated experience. The appropriateness of the model output is assessed using a subjective product feature sustainability score to understand key drivers of experience within each region. Thereafter, cross-country comparisons assist in improving our understanding of disability income products by:

— identifying which regions have similar experience that could be combined,
— assessing the impact of new product features being implemented in one region (where this feature exists in another market),
— highlighting key risk areas within disability income product design,

— discussing what impact the actions of different stakeholders may have on disability income experience in a given market, and
— boosting data credibility where appropriate (for example, data for long duration claims may show similar experience and may be combined).

When considering benefits, it is also useful to highlight potential limitations. Core product features can be compared but there are a range of other factors that affect disability income experience. As such, it is important to consider views and opinions of subject matter experts within each market. These experts may be aware of product design changes, changes in the taxation of benefits, differences relating to how state benefits are treated and any other market-specific events. The model results will not often be interpretable without adjusting for known market changes over time.

In comparing the experience between countries, we need to make simplifying assumptions when aggregating the data. An example of this is applying broad occupation mappings. With this in mind, it is often useful to ensure that the data is aggregated in a consistent way so that each group remains as homogeneous as possible.

5.2 Use of advanced analytics techniques to understand disability income experience

LASSO regression deals with multi-collinearity by applying cross-validation. The implementation of a penalty parameter also produces a simpler model with output that looks similar to that of a generalised linear model. Another benefit of the LASSO technique is that the penalty parameter, with cross-validation, helps ensure that the algorithm does not over-fit where data is not credible.

The crude rate and actual versus expected analyses indicate that there are variations in both claim inceptions and terminations experience between countries. LASSO regression helps identify potential drivers of these variations. We can get summarised comparisons by using a standardised portfolio. This helps us to understand the model and develop insights into reasons for variations in claims costs.

5.3 Advantages of using machine learning techniques for delays in claims reporting

Using a LASSO regression to model potential reporting delays can ensure that many variables are considered when adjusting for claims that have not yet been reported. For example, we saw differences in claim delay patterns by region in Figure 1. This approach incorporates the advantages of the EBNER approach in that it does not inflate credibility for periods that are not fully run off.

6. CONCLUSION

Understanding disability experience is complex. Product features and market conditions can vary considerably between markets, within markets and over time. A number of variables drive the experience.

In this paper we showed how LASSO regression, which is an example of an advanced analytics method, can help to model experience and produce a good fit to a complex data set.

Some of the insights that we gained from the modelling were that experience was indeed lighter for products judged to be more sustainable as indicated by a higher sustainability score on the scoring tool we developed.

Experience in Australia was the heaviest among the markets considered, even after adjusting for product sustainability scores and other factors. This suggests that either the scoring tool didn't amplify some of the Australian product features sufficiently or that wider market conditions in Australia also contributed to the pressures that led to the review of disability products there.

Experience for females is heavier than for males, except at ages under 27.

Inceptions experience by occupation class is heavier for classes 3 and 4. We also find that heavier inceptions experience by occupation is somewhat offset by lighter terminations experience.

We found that experience for most other factors behaved as expected with higher claims costs for shorter deferred periods and older ages.

ACKNOWLEDGEMENTS

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This study would not have been possible without the data from our participants. We thank them for their contribution to enhancing our understanding of disability experience.

DISCLAIMER

The material contained in this paper has been prepared solely for informational purposes. The material is based on sources believed to be reliable and/or from data developed and analysed by Gen Re, but we do not make any representations as to its accuracy or completeness.

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