Property and Casualty Insurance

FINANCIALEDGE

The Law of Large Numbers

Your friend asks you

If I pay you $1,000 will you pay for the rebuilding of my house if it burns down?

So you either get a few fine dinners, or you go to the poor house

Individually we would not be willing to take on this level of risk

But insurance companies can exploit the law of large numbers – and statistically predict claims

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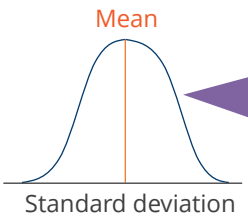
The Law of Large Numbers



Some risks of loss are distributed in a 'normal distribution' making them highly predictable in large numbers

Household and car insurance generally follow predictable loss patterns so the losses can be predicted mathematically with a high degree of confidence

Some risks don't follow predictable loss distributions e.g. terrorism insurance

Insuring less predictable risks is more expensive.

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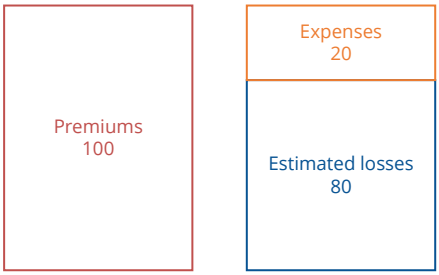
Premiums and the Combined Ratio

Paid by the customer to insure against loss



Some of the premiums are used to run the business

$$Expense\ ratio = \frac{Expenses}{Premiums}$$

$$Claims\ ratio = \frac{Losses}{Premiums}$$

Actuaries make an estimate of the expected payout for losses

$$Combined\ ratio = expense\ ratio + claims\ ratio$$

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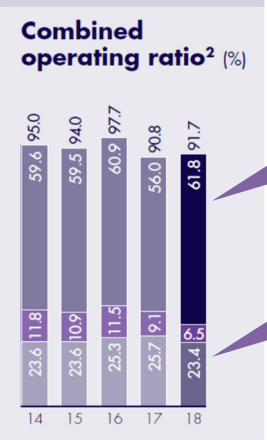
Combined Ratio Over Time

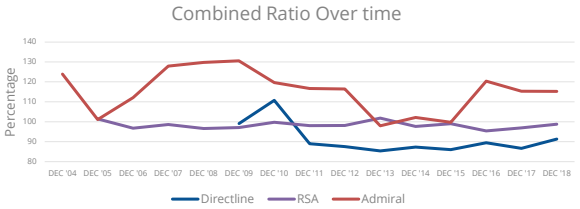


Estimated losses / claims by actuaries

Commissions + expenses to run the business

A combined ratio of under 100% means an underwriting profit

However, often across the cycle the combined ratio average is close to 100% for most insurance companies.



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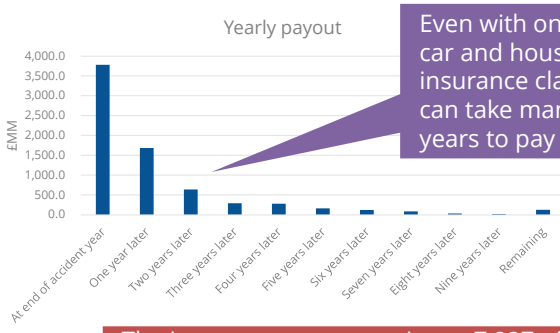
Reserves

Aviva 2009 year	Total payout	Yearly payout
At end of accident year	3,780.0	3,780.0
One year later	5,464.0	1,684.0
Two years later	6,102.0	638.0
Three years later	6,393.0	291.0
Four years later	6,672.0	279.0
Five years later	6,836.0	164.0
Six years later	6,958.0	122.0
Seven years later	7,043.0	85.0
Eight years later	7,078.0	35.0
Nine years later	7,100.0	22.0
Remaining		127.0
Total estimated claims	7,227.0	

Expense for one-year cover in the policy year (2009)



Even with one-year car and household insurance claims can take many years to pay out

The insurance company sits on 7,227 of assets from premiums until they are paid out – which they can invest

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Reserves Development Table (Aviva Property and Casualty)

Accident year	All prior years £m	2009 £m	2010 £m	2011 £m	2012 £m	2013 £m	2014 £m	2015 £m	2016 £m	2017 £m	2018 £m	Total £m
Gross cumulative claim payments												
At end of accident year		(3,780)	(3,502)	(3,420)	(3,055)	(3,068)	(3,102)	(2,991)	(3,534)	(3,517)	(3,769)	
One year later		(5,464)	(5,466)	(4,765)	(4,373)	(4,476)	(4,295)	(4,285)	(4,972)	(4,952)		
Two years later		(6,102)	(5,875)	(5,150)	(4,812)	(4,916)	(4,681)	(4,710)	(5,435)			
Three years later		(6,393)	(6,163)	(5,457)	(5,118)	(5,221)	(4,974)	(4,997)				
Four years later		(6,672)	(6,405)	(5,712)	(5,376)	(5,467)	(5,244)					
Five years later		(6,836)	(6,564)	(5,864)	(5,556)	(5,645)						
Six years later		(6,958)	(6,649)	(5,978)	(5,635)							
Seven years later		(7,043)	(6,690)	(6,032)								
Eight years later		(7,078)	(6,718)									
Nine years later		(7,100)										
Estimate of gross ultimate claims												
At end of accident year		7,364	6,911	6,428	6,201	6,122	5,896	5,851	6,947	6,894	7,185	
One year later		7,297	7,006	6,330	6,028	6,039	5,833	5,930	6,931	6,796		
Two years later		7,281	6,950	6,315	6,002	6,029	5,865	5,912	6,864			
Three years later		7,215	6,914	6,292	5,952	6,067	5,842	5,814				
Four years later		7,204	6,912	6,262	6,002	6,034	5,772					
Five years later		7,239	6,906	6,265	5,979	5,996						
Six years later		7,217	6,926	6,265	5,910							
Seven years later		7,256	6,913	6,223								
Eight years later		7,228	6,877									
Nine years later		7,227										
Estimate of gross ultimate claims		7,227	6,877	6,223	5,910	5,996	5,772	5,814	6,864	6,796	7,185	
Cumulative payments		(7,100)	(6,718)	(6,032)	(5,635)	(5,645)	(5,244)	(4,997)	(5,435)	(4,952)	(3,769)	
	2,388	127	159	191	275	351	528	817	1,429	1,844	3,416	**11,525**

The older the accident year the fewer unpaid claims

Claims still unpaid. Liabilities funding assets which can be reinvested

Total claims estimates can change over time

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Premiums Versus Reserves

	£m
Gross earned premium	3,306.7
Reinsurance premium	(217.2)
Net earned premium	3,089.5
Investment return	154.6
Instalment income	119.9
Other operating income	72.1
Total income	3,436.1
Insurance claims	(1,966.9)
Insurance claims recoverable	55.1
Net insurance claims	(1,911.8)

Premiums earned

Returns on assets

Estimated total claims from one year of premiums

Liabilities	
Subordinated liabilities	259.5
Insurance liabilities	4,005.9
Unearned premium reserve	1,505.5
Borrowings	62.0
Derivative financial instr	25.9
Trade and other payc es,	554.1
Deferred tax liabili	7.6
Current tax liabil	46.0
Total liabilities	6,466.5

Cumulative unpaid claims from multiple years

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The Income Statement and Balance Sheet - Simple

Assumptions			Income statement			Balance sheet		
Claims ratio	80.0%		Premiums	100.0		Invested assets	260.2	=260.2
Expense ratio	20.0%		Claims expense	(80.0)	=100*80%*-1	Total assets	260.2	=260.2
Combined ratio	100.0%	=80.0%+20.0%	Expenses	(20.0)	=100*20%*-1			
Tax rate	20.0%		Underwriting profit	0.0	=100-80-20	Reserves	194.5	=194.5%*100
Equity / premiums	65.7%					Equity	65.7	=65.7%*100
Reserves / premiums	194.5%		Financial income	10.4	=4.0%*260.2	Total L&E	260.2	=194.5+65.7
Return on invested asse	4.0%		Profit before tax	10.4	=0+10.4			
			Tax	(2.1)	=20%*10.4*-1			
			Net income	8.3	=10.4-2.1			
			Return on equity	12.7%	=8.3/65.7			

Invested assets is a plug

Reserves are linked to premiums

Combined ratio = 100% so all profits come from the investment return

Shareholders' equity is driven by the regulatory requirements

ROE is an important KPI which will drive the price to book value multiple

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The Income Statement

	2018 £m
Gross earned premium	3,306.7
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Net earned premium	3,089.5
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Other operating income	72.1
Total income	3,436.1
Insurance claims	(1,966.9)
Insurance claims recoverable f	55.1
Net insurance claims	(1,911.8)
Commission expenses	(200.4)
Operating expenses	(722.2)
Total expenses	(922.6)
Operating profit	601.7
Finance costs	(19.1)
Profit before tax	582.6
Tax charge	(108.9)
Profit for the year attributable	473.7

Often the reported income statement mixes the underwriting the financial result together

Before modeling separate out the underwriting result and the financial return

Income statement		
Gross written premiums	3,392.1	3,211.9
Gross earned premium	3,339.7	3,306.7
Reinsurance premium	(204.7)	(217.2)
Net earned premium	3,135.0	3,089.5
Insurance claims	(1,571.1)	(1,966.9)
Insurance claims recoverable from / (payable to	(183.1)	55.1
Net insurance claims	(1,754.2)	(1,911.8)
Claims ratio	(56.0%)	(61.9%)
Commission expenses	(286.4)	(200.4)
Operating expenses	(806.3)	(722.2)
Total expenses	(1,092.7)	(922.6)
Expense ratio	(34.9%)	(29.9%)
Underwriting result	288.1	255.1
Combined ratio	(90.8%)	(91.7%)
Investment return	175.4	154.6
Instalment income	116.4	119.9
Other operating income	62.9	72.1
Operating profit	642.8	601.7
Finance costs	(103.8)	(19.1)
Profit before tax	539.0	582.6
Tax charge	(105.0)	(108.9)
Net income	434.0	473.7

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The Income Statement – Alternative Presentation

	£m
Income	
Gross written premiums	7,467
Less: reinsurance premiums	(997)
Net written premiums	6,470
Change in gross provision for unearned premiums	61
Less: change in provision for unearned reinsurance premiums	6
Change in provision for unearned premiums	67
Net earned premiums	6,537
Net investment return	343
Other operating income	138
Total income	7,018

Frequently the accounts are presented as the cash item and then the change in the reserve to get to the income (expense)

Here the net written premiums + change in the unearned premiums = earned premiums

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The Balance Sheet - Assets

	£m
Assets	
Goodwill and other intangible assets	566.8
Property, plant and equipment	156.2
Investment property	322.1
Reinsurance assets	1,208.7
Current tax assets	–
Deferred acquisition costs	171.0
Insurance and other receivables	875.9
Prepayments, accrued income and other assets	128.0
Derivative financial instruments	48.2
Retirement benefit asset	17.0
Financial investments	4,737.8
Cash and cash equivalents	1,154.4
Assets held for sale	–
Total assets	9,386.1

By far the largest asset are financial investments. This is often referred to as the 'float' = money effectively borrowed from policy holders.

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The Balance Sheet - Liabilities

Liabilities	
Subordinated liabilities	259.5
Insurance liabilities	4,005.9
Unearned premium reserve	1,505.5
Borrowings	62.0
Derivative financial instruments	25.9
Trade and other payables, including insurance payables	554.1
Deferred tax liabilities	7.6
Current tax liabilities	46.0
Total liabilities	6,466.5
Total equity and liabilities	9,386.1

The amount owed to policy holders paid out in the future (over many years even with a policy lasting only one year)

Even one-year insurance lines can generate long liabilities as some claims such as health care create payments over many years

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The Balance Sheet in More Detail

- Payoff diagrams
- Reinsurance assets
- Deferred acquisition costs
- Unearned premium reserve
- Incurred but not reported (IBNR)
- Claims handling provision

	£m
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Claims Development and Payoff diagrams - Historical

	A	B	C	D	E
1	**Analysis of historical claims in one year**	**Cumulative payments**	**Incremental payments**	**% paid out**	
2	End of accident year	3,650.0	3,650.0	53.9%	=C2/$B$11
3	One year later	5,286.0	1,636.0	24.2%	=C3/$B$11
4	Two years later	5,885.0	599.0	8.8%	=C4/$B$11
5	Three years later	6,177.0	292.0	4.3%	=C5/$B$11
6	Four years later	6,410.0	233.0	3.4%	=C6/$B$11
7	Five years later	6,568.0	158.0	2.3%	=C7/$B$11
8	Six years later	6,657.0	89.0	1.3%	=C8/$B$11
9	Seven years later	6,708.0	51.0	0.8%	=C9/$B$11
10	Eight years later	6,744.0	36.0	0.5%	=C10/$B$11
11	Nine years later	6,771.0	27.0	0.4%	=C11/$B$11
12					
13	**Payout of historical claims expense**			Year 1	Year 2
14		**Claims expense**		53.9%	24.2%
15	Historical year -1	6,997.0		1,690.6	619.0
16	Historical year -2	6,591.0		583.1	284.2
17	Historical year -3	6,377.0		275.0	219.4
18	Historical year -4	5,517.0		189.8	128.7
19	Historical year -5	5,490.0		128.1	72.2
20	Historical year -6	5,653.0		74.3	42.6
21	Historical year -7	5,631.0		42.4	29.9
22	Historical year -8	5,967.0		31.7	23.8
23	Historical year -9	6,590.0		26.3	=B23*M14
24	Historical year -10	6,901.0			
25					
26	Total forecast payouts for historical policies			3,041.4	1,419.9

	F	G	H	I	J	K	L	M	N	O
13	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10		
14	8.8%	4.3%	3.4%	2.3%	1.3%	0.8%	0.5%	0.4%	=TRANSPOSE(D2:D11)	
15	301.7	240.8	163.3	92.0	52.7	37.2	27.9	=$B$15*M14		
16	226.8	153.8	86.6	49.6	35.0	26.3	=$B$16*M14			
17	148.8	83.8	48.0	33.9	25.4	=$B$17*M14				
18	72.5	41.6	29.3	22.0	=$B$18*M14					
19	41.4	29.2	21.9	=$B$19*M14						
20	30.1	22.5	=$B$20*M14							
21	22.5	=$B$21*M14								
22	=$B$22*M14									
23										
24										
25										
26	843.7	571.7	349.2	197.5	113.2	63.5	27.9	0.0	=SUM(M15:M24)	

Analyze the oldest historical year to establish the payout profile (note we will get an estimate – the actual could change with a changing business mix)

Now use the percentages to estimate the payout of the remaining claims estimates

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Claims Development and Payoff diagrams - Forecast

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1			Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	
2	Growth in claims expense			4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	
3	Forecast claims expense		6,997.0	7,276.9	7,568.0	7,870.7	8,185.5	8,512.9	8,853.4	9,207.6	9,575.9	9,958.9	10,357.3	=L3*(1+M2)
4														
5	Payout			53.9%	24.2%	8.8%	4.3%	3.4%	2.3%	1.3%	0.8%	0.5%	0.4%	=M42
6														
7	Forecast year 1			3,922.7	1,758.2	643.8	313.8	250.4	169.8	95.6	54.8	38.7	29.0	=$D$3*M5
8	Forecast year 2				4,079.6	1,828.6	669.5	326.4	260.4	176.6	99.5	57.0	40.2	=$E$3*L5
9	Forecast year 3					4,242.8	1,901.7	696.3	339.4	270.8	183.7	103.5	59.3	=$F$3*K5
10	Forecast year 4						4,412.5	1,977.8	724.1	353.0	281.7	191.0	107.6	=$G$3*J5
11	Forecast year 5							4,589.0	2,056.9	753.1	367.1	292.9	198.6	=$H$3*I5
12	Forecast year 6								4,772.6	2,139.2	783.2	381.8	304.7	=$I$3*H5
13	Forecast year 7									4,963.5	2,224.7	814.6	397.1	=$J$3*G5
14	Forecast year 8										5,162.0	2,313.7	847.1	=$K$3*F5
15	Forecast year 9											5,368.5	2,406.3	=$L$3*E5
16	Forecast year 10												5,583.2	=M3*D5
17														
18	Total payouts for forecast policies			3,922.7	5,837.8	6,715.1	7,297.5	7,839.8	8,323.2	8,751.8	9,156.7	9,561.7	9,973.1	=SUM(M7:M16)

Using the same payout development you can forecast the payment of future claims expense

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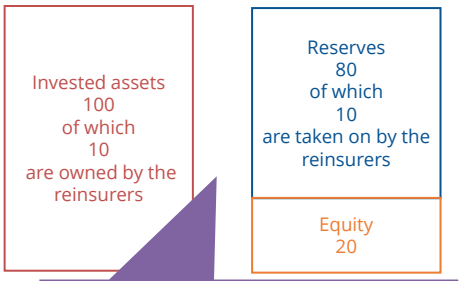
Reinsurance assets

Some firms have asset concentration due to sector or geographical specialization

They can sell insurance premiums (and the related risk) to the wholesale market (reinsurance)

The balance sheet show 100% of the reserves so we carve out the assets given to the reinsurers



The balance sheet is gross of reinsurance. The reserves include the reinsurer's share and an asset reflect their premiums

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Reinsurance Assets and Liabilities

	2018 £m
Assets	
Goodwill and other intangible assets	792
Property and equipment	90
Investment property	310
Investments in associates	13
Financial assets	11,458
Total investments	11,781
Reinsurers' share of insurance contract liabilities	2,271
Insurance and reinsurance debtors	2,954

	Gross 2018 £m	RI 2018 £m	Net 2018 £m
Provision for unearned premiums	3,244	(739)	2,505
Provision for losses and loss adjustment expenses	10,072	(2,136)	7,936
Total insurance contract liabilities	13,316	(2,875)	10,441
Less: Held for sale provisions for losses and loss adjustment expenses	604	(604)	–
Provision for unearned premiums at 31 December net of held for sale	3,244	(739)	2,505
Provision for losses and loss adjustment expenses at 31 December net	9,468	(1,532)	7,936
Total insurance contract liabilities excluding held for sale	12,712	(2,271)	10,441

The balance sheet is gross of reinsurance. The reserves include the reinsurer's share and an asset reflect their premiums

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Unearned Premium Reserve

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1		Policies written (month beg)	Months remaining	Amount earned at year end	Amount unearned at year end												
2	January	100.0	12.0	100.0	0.0	=B2-D2				Historical	Year 1	Year 2	Year 3	Year 4	Year 5		
3	February	100.0	11.0	91.7	8.3	=B3-D3					4.0%	4.0%	4.0%	4.0%	4.0%		
4	March	100.0	10.0	83.3	16.7	=B4-D4	Written premiums			100.0	104.0	108.2	112.5	117.0	121.7	=N4*(1+O3)	
5	April	100.0	9.0	75.0	25.0	=B5-D5	% earned in year				56.3	58.6	60.9	63.4	65.9	=O4*$D$15	
6	May	100.0	8.0	66.7	33.3	=B6-D6	% unearned in year				47.7	49.6	51.6	53.6	55.8	=O4-O5	
7	June	100.0	7.0	58.3	41.7	=B7-D7											
8	July	100.0	6.0	50.0	50.0	=B8-D8	Unearned premium reserve										
9	August	100.0	5.0	41.7	58.3	=B9-D9	Beginning				45.8	47.7	49.6	51.6	53.6	=N12	
10	September	100.0	4.0	33.3	66.7	=B10-D10	Additions				47.7	49.6	51.6	53.6	55.8	=O6	
11	October	100.0	3.0	25.0	75.0	=B11-D11	Subtractions				(45.8)	(47.7)	(49.6)	(51.6)	(53.6)	=N12*-1	
12	November	100.0	2.0	16.7	83.3	=B12-D12	Ending			45.8	47.7	49.6	51.6	53.6	55.8	=SUM(O9:O11)	
13	December	100.0	1.0	8.3	91.7	=B13-D13											
14	Total	1,200.0		650.0	550.0	=SUM(E2:E13)	Written premiums				104.0	108.2	112.5	117.0	121.7	=O4	
15	%			54.2%	45.8%	=1-D15	(Inc) dec in unearned premium reserve				(1.8)	(1.9)	(2.0)	(2.1)	(2.1)	=N12-O12	
16							Earned premiums				102.2	106.3	110.5	114.9	119.5	=SUM(O14:O15)	

Premiums are earned gradually over the cover period

Forecast written premiums and put the unearned premiums onto the balance sheet as a liability

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Deferred Acquisition Costs (DAC)

Insurance companies often pay fees to brokers who sell policies

Insurance companies often pay fees to brokers who sell policies

Like premiums, commissions are expensed over the life of the policy

Commissions are paid on written premiums, but only expensed over the life of the policy

	A		D	E	F	G	H
1		Year 1	Year 2	Year 3	Year 4		
2	Growth in written premi	4.0%	4.0%	4.0%	4.0%		
3	Written premiums	104.0	108.2	112.5	117.0	=E3*(1+F2)	
4							
5	% earned premiums	54.2%	54.2%	54.2%	54.2%		
6	Commissions % written premiums	13.6%	13.6%	13.6%	13.6%		
7	Cash commissions	14.1	14.7	15.3	15.9	=F6*F3	
8	New commissions expensed	7.7	8.0	8.3	8.6	=F7*F5	
9							
10	Deferred acquisition costs						
11	Beginning	6.2	6.5	6.7	7.0	=E14	
12	Additions	6.5	6.7	7.0	7.3	=F7-F8	
13	Subtractions	(6.2)	(6.5)	(6.7)	(7.0)	=-F11	
14	Ending 6.2	6.5	6.7	7.0	7.3	=SUM(F11:F13)	

On the balance sheet Deferred Acquisition Costs (DAC) are unexpensed commissions

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Incurred But Not Reported (IBNR)

General insurance and health	
Outstanding claims provisions	9,046
Provision for claims incurred but not reported	2,360
	11,406

Known cases – and an estimate of the potential future payments (maybe discounted to the present value)

Everything goes to IBNR and then comes out as claims are made by customers and can be properly loss assessed

	A	B	C	D
1	Premiums written	100.0		
2	Change in unearned premiums reserve	(10.0)		
3	Earned premiums	90.0	=SUM(B1:B2)	
4				
5	Claims expense ratio	76.0%		
6	Claims expense	68.4	=B3*B5	
7				
8	IBNR			
9	Beginning	65.0		
10	Claims expense	68.4	=B6	
11	Claims reported	(66.0)		
12	Ending	67.4	=SUM(B9:B11)	
13				
14	Outstanding claims reserves			
15	Beginning	170.0		
16	Claims reported	66.0	=-B11	
17	Claims payable	(60.0)		
18	Ending	176.0	=SUM(B15:B17)	
19				
20	Total reserves	243.4	=B12+B18	
21				

The outstanding claims and IBNR are often combined on the balance sheet

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Other Items

Claims handling provision

Claims can be costly to settle so often you might see broken out a claims handling provision

In force policies

Policies that on a given date are active and against which the company will pay, following a valid insurance claim.

Solvency ratio

The amount of regulatory capital the company has versus the legal minimums:

- Available regulatory capital = 140
- Required regulatory capital = 100
- Solvency ratio = 140%

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Understanding Equity Forecasting

Reconciliation of IFRS shareholders' equity to solvency II own funds

At 31 December	2018 £bn	2017[1] £bn
Total shareholders' equity	2.57	2.72
Goodwill and intangible assets	(0.57)	(0.47)
Change in valuation of technical provisions	(0.15)	(0.13)
Other asset and liability adjustments	(0.09)	(0.08)
Foreseeable dividends	(0.31)	(0.39)
Tier 1 capital – unrestricted	1.45	1.65
Tier 1 capital – restricted	0.35	0.35
Tier 1 capital	1.80	2.00
Tier 2 capital – subordinated debt	0.26	0.26
Tier 3 capital – deferred tax	0.09	0.04
Total own funds	2.15	2.30

Remove intangibles are these assets don't provide funds for policy holder in a liquidation scenario

available.
Total own funds – solvency requirement = capital surplus

Total own funds / solvency requirement = solvency capital

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Modeling the Equity

1. Set target Solvency II ratio
2. Calculate expected Solvency Capital Requirement
3. Back out required Own Funds
4. Add back intangibles, DAC, DTAs etc which gives Shareholders' Equity
5. Calculate Equity surplus (dividend) or Capital requirement
6. Link Equity into Balance Sheet and deal with the circular reference

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Steps to Building a Model

Remember to have the iteration setting turned OFF before starting

1. Input historical data for income statement and balance sheet
2. Calculate ratios and statistics
3. Decide on forecast assumptions
4. Forecast GWP + balance sheet except equity, investments and cash
5. Forecast income statement except investment income
6. Balance the balance sheet (investments and cash is plug)
7. Forecast investment income and equity
8. Link equity into balance sheet and deal with the circular reference

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