2nd Webinar on Risk Management
July 31, 2020
Time 1400 to 1530 IST

COVID-19 and Basis Risk in Assumptions

Dr Richard Marshall FIA CERA
Willis Towers Watson

Agenda

Quick refresher: what do we mean by basis risk?

Effect 1: Medical risk factors for COVID-19 morbidity and mortality

Effect 2: Other risk factors: geography, behaviour, socioeconomics

Effect 3: Longer-term changes in mortality and morbidity

Conclusions

Quick refresher

What do we mean by basis risk?

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Basis risk

In a demographic context, this arises when…

… data relating to one population is used to estimate parameters for a model

… which is then applied to another (different) population.

Polling question 1

Does your organisation consider basis risk when setting margins for adverse deviations (MAD)?

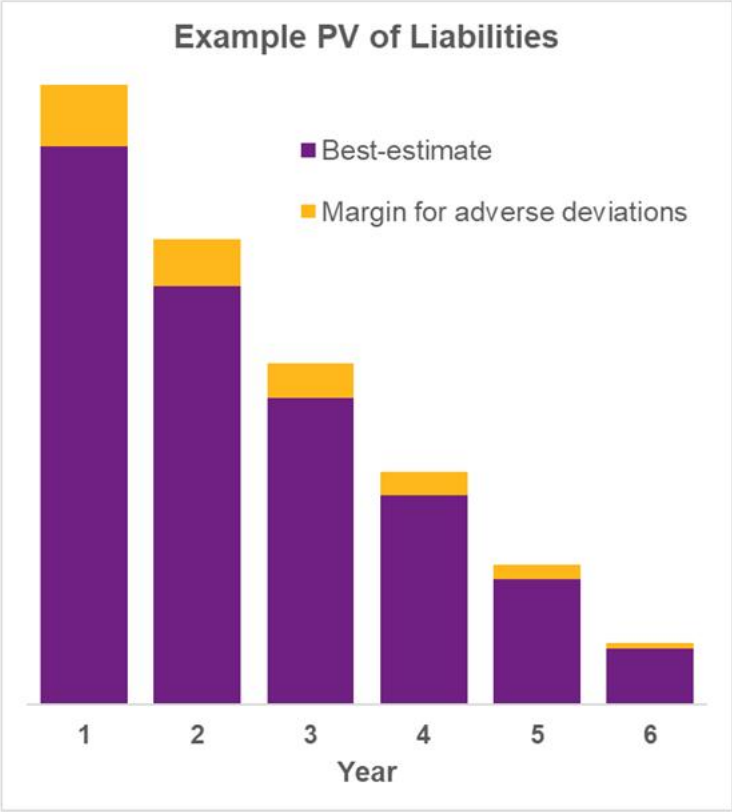
1	Yes, we add an explicit margin for this.
2	Yes, we consider this, but believe the MAD is already sufficient.
3	No, we have not considered this.
4	No, we consider ‘basis risk’ immaterial.

Why do we care?

Emergence of surplus

Basis risk can affect emergence of surplus on existing business

- GPV reserving allows for margins for adverse deviation.
- Expected profits will depend on the release of those margins.
- Basis risk can mean that those margins are narrower than expected.



Why do we care?

Assumed demographic profile of consumers differs from reality

This is a major topical issue for insurers in India at present…

2-3 years 'price war'

Term rates spiralled down driven by:

- Cheap reinsurance rates
- High sums assured targeting highly educated, affluent young population via online channels

Market saturation

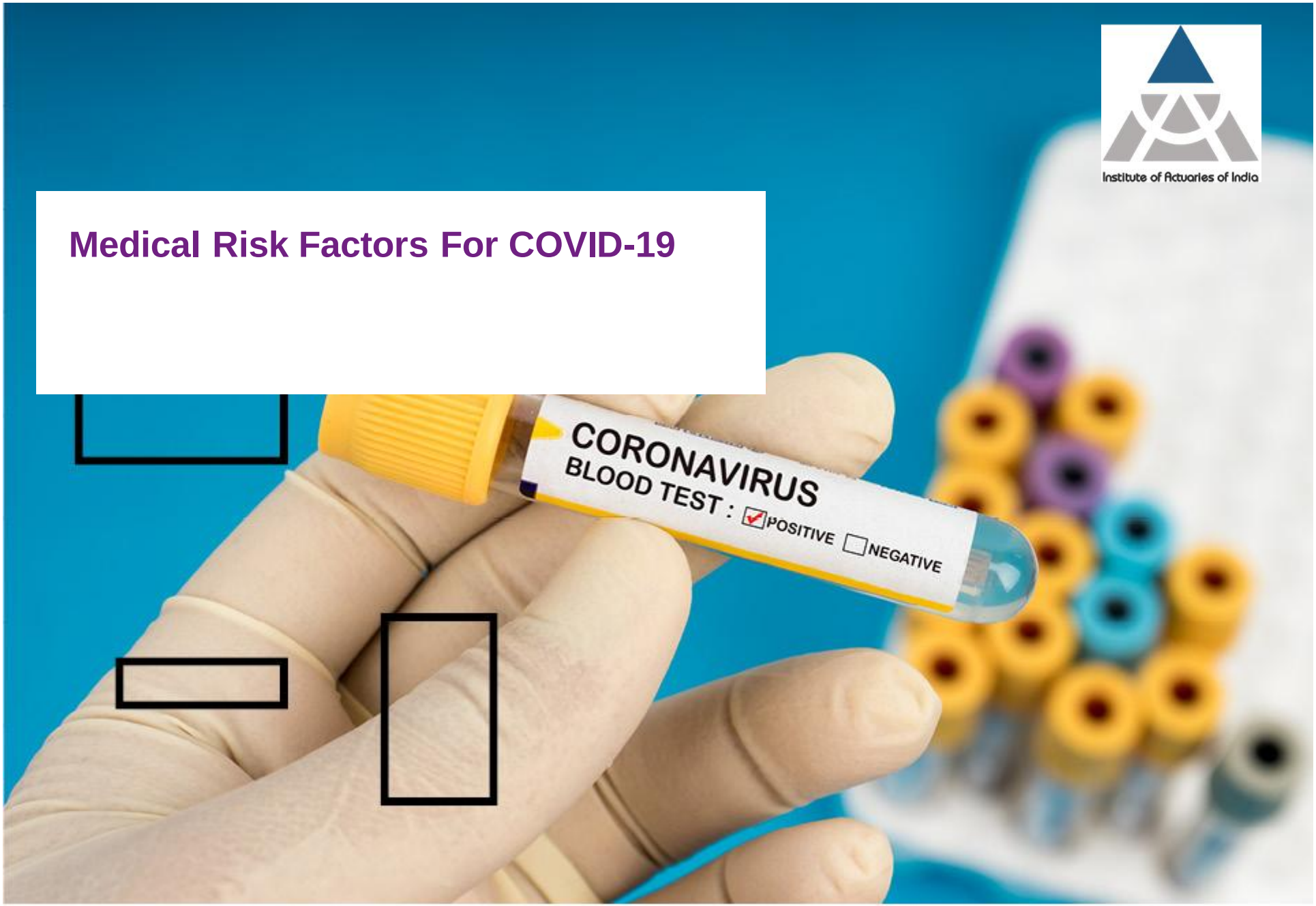
Mid-/mass-market customers picking up the same rates

- Digital revolution – banking / mobile phone access in rural India
- Worse than expected experience
- Reinsurers rates revised significantly
- Some lines discontinued, others repriced

Asymmetries in the effects of COVID-19 may make the re-alignment of prices to consumers more complex, affecting:

- Purchasing decisions in different segments of society
- Potential future mortality and morbidity rates for those potential customers

Medical Risk Factors For COVID-19



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Medical risk factors for COVID-19

Background

- We expect a change in base mortality and morbidity rates due to:

Normal expected mortality improvements (e.g. new pharma, infrastructure)	**COVID-19 deaths disproportionately affecting those already in ill-health**	**Future deaths from COVID-19** (second waves)	**Short-term effects of interruption to medical diagnoses and care**

- We can express the change in mortality between year t and year $t+1$ as follows:

$$q_{x,t+1}^{Total} = \left(q_{x,t}^{Total} - q_{x,t}^{C19}\right)\left(1 - i_{x,t+1}\right) \cdot \theta_x + q_{x,t+1}^{C19}$$

- Where:

$$q_{x,t}^{C19} = \text{COVID}-19 \text{ mortality (observed or anticipated) in year t}$$

$$\theta_x = \text{select effect due to health disparity in COVID}-19 \text{ deaths}$$

Polling question 2

Do you believe that COVID-19 will affect insured lives in India differently to the general population?

1	Yes: higher excess mortality rates amongst insured lives (same age/gender).
2	Yes: lower excess mortality rates amongst insured lives (same age/gender).
3	No: expect excess mortality rates to be the same.

Medical risk factors for COVID-19

Determining the select effect (θ_x)

Selected Risk Factors	Hazard Ratios (Age/Sex adjusted)	Hazard Ratios (fully adjusted)
Obesity	1.57 to 2.97 (Increases with BMI)	1.27 to 2.27 (Increases with BMI)
Social deprivation	1.00 to 2.13 (Least- to most-deprived 20%)	1.00 to 1.75 (Least- to most-deprived 20%)
Respiratory disease (Excluding Asthma)	2.35	1.78
Diabetes	2.02 to 3.61 (Increases with poorer control)	1.50 to 2.36 (Increases with poorer control)
Stroke/dementia	2.34	1.79
Kidney disease	2.19	1.72

Source: OpenSAFELY collaborative (2020)

https://www.medrxiv.org/content/10.1101/2020.05.06.20092999v1.full.pdf

Medical risk factors for COVID-19

Determining the select effect (θ_x)

- Overall (pre- and post-COVID) mortality is a weighted average

$$q_x^{Pre} = \sum_{\gamma \in \Gamma} W_\gamma \cdot q_x^\gamma \qquad q_x^{Post} = \sum_{\gamma \in \Gamma} W'_\gamma \cdot q_x^\gamma$$

$$W'_\gamma = W_\gamma \cdot \left(1 - q_x^{COVID} \cdot RR_\gamma\right) \qquad \theta_x = \frac{q_x^{Post}}{q_x^{Pre}}$$

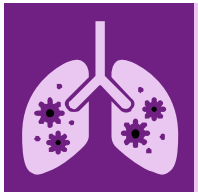
- For over-65s in the UK, in a scenario with roughly 0.5% excess mortality (within this age group); we estimated a select effect:
  - 0.1% relative reduction in mortality in the least deprived 20%. ($\theta_x = 0.999$)
  - 0.25% relative reduction in mortality for the most deprived 20%. ($\theta_x = 0.9975$)

- The effect at younger ages is significantly smaller. (θ_x is closer to 1)

Medical risk factors for COVID-19

Determining the select effect (θ_x)

COVID-19 deaths disproportionately affect those already in ill-health, but:



Population mortality will be unlikely to fall significantly unless COVID-19 deaths materially exceed 1% of the population.

For insured lives (younger, expected to be lower deprivation, less risk of poor health due to underwriting) any reduction in mortality will likely be lower still.

Therefore, we might remove the select effect from our estimate:

$$q_{x,t+1}^{Total} = \left(q_{x,t}^{Total} - q_{x,t}^{C19}\right)\left(1 - i_{x,t+1}\right) + q_{x,t+1}^{C19}$$

This implies that basis risk is most likely to affect our assessment of excess deaths due to COVID-19 in 2021 (a similar result would apply for hospitalisation).

Medical risk factors for COVID-19

Similar results for risk of hospitalisation

Selected Risk Factors	Odds Ratios
Obesity	4.26 to 6.2 (Increases with BMI)
Heart Failure	4.29
Kidney disease	3.07
Diabetes	2.81
Gender = Male	2.80

No statistically significant effect of pulmonary disease or hypertension in the multivariate analysis.

Source: Petrilli et al.

https://www.medrxiv.org/content/10.1101/2020.04.08.20057794v1.full.pdf

Other Risk Factors

Geography, behaviour, socioeconomics

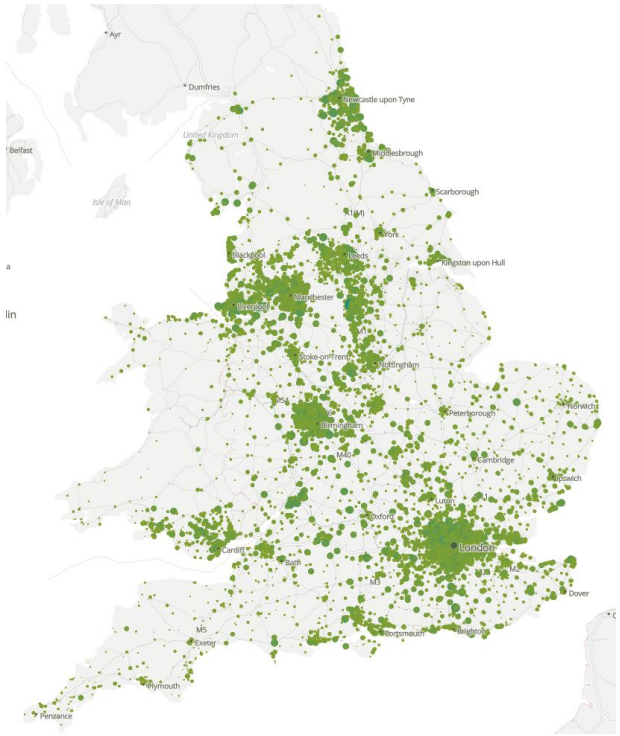
http://www.actuariesindia.org/

Geographical risk factors

- Population density would be expected to have a strong impact on the rate of spread of COVID-19. The following is an example of the urban/rural split of COVID-19 deaths in the UK. (Office for National Statistics)

- Dark green areas include:
  - London
  - Birmingham
  - Manchester
  - Leeds
  - Newcastle-upon-Tyne
  - Liverpool

- All are major urban centres

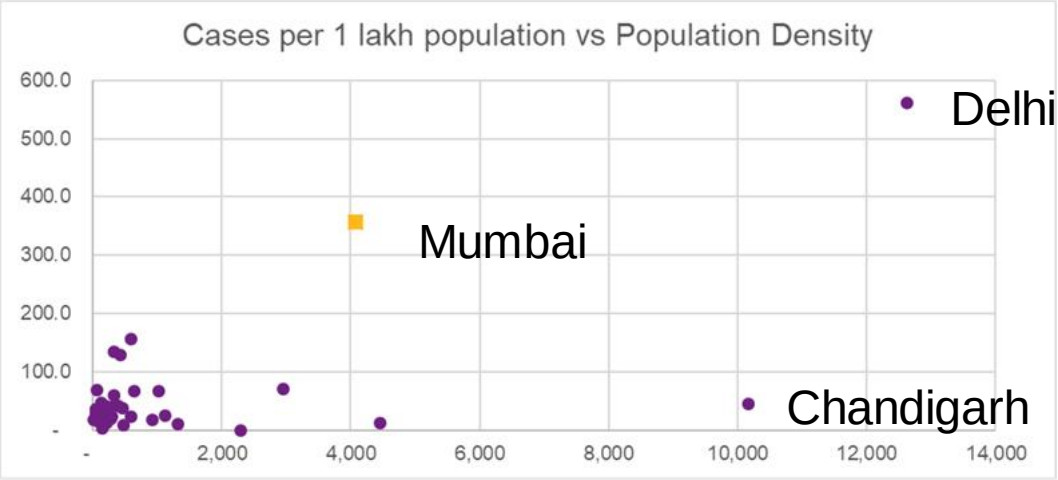


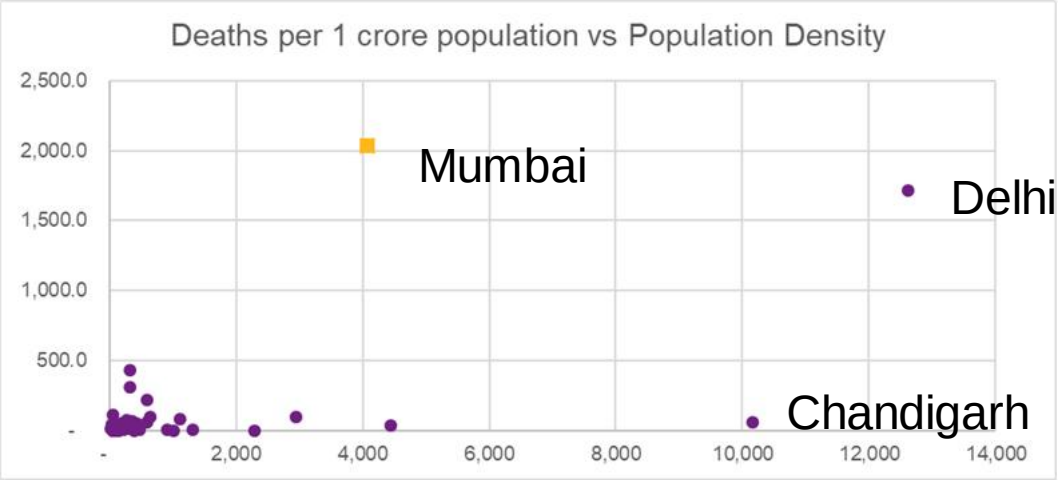
Geographical risk factors

- The same difference might be expected between major Indian cities and rural areas.
  - We considered the relationship between population density in persons per Km^2 and the number of cases per state / union territory.
  - The state-wide data hides high-density cities with particularly high levels of outbreak. Urban vs. rural will be an important consideration in assessing future mortality risk from COVID-19.
  - As an example, on the next slide, we've separated Mumbai out from Maharashtra and highlighted this location on the graphics.

    This has high cases:population and deaths:population ratios, similar to Delhi.

Geographical risk factors





Mumbai data: https://mumbaimirror.indiatimes.com/coronavirus/news/

Notes:

- Timing of epidemic growth differs by region
- Some outbreaks were established some time ago.
- Others are just becoming established.

  E.g. due to return of migrant workers to poorer, rural regions of India.

Behavioural risk factors

Exploring behavioural change through mobility data

- Socio-economic variation in observation of social-distancing measures
  - Google Mobility Reports show disparity in behavioural change within India by state / union territory.
  - Interesting to look at those contributing the most to NB premiums and compare to the overall national effects (perhaps standardised vs. population).

Polling question 3

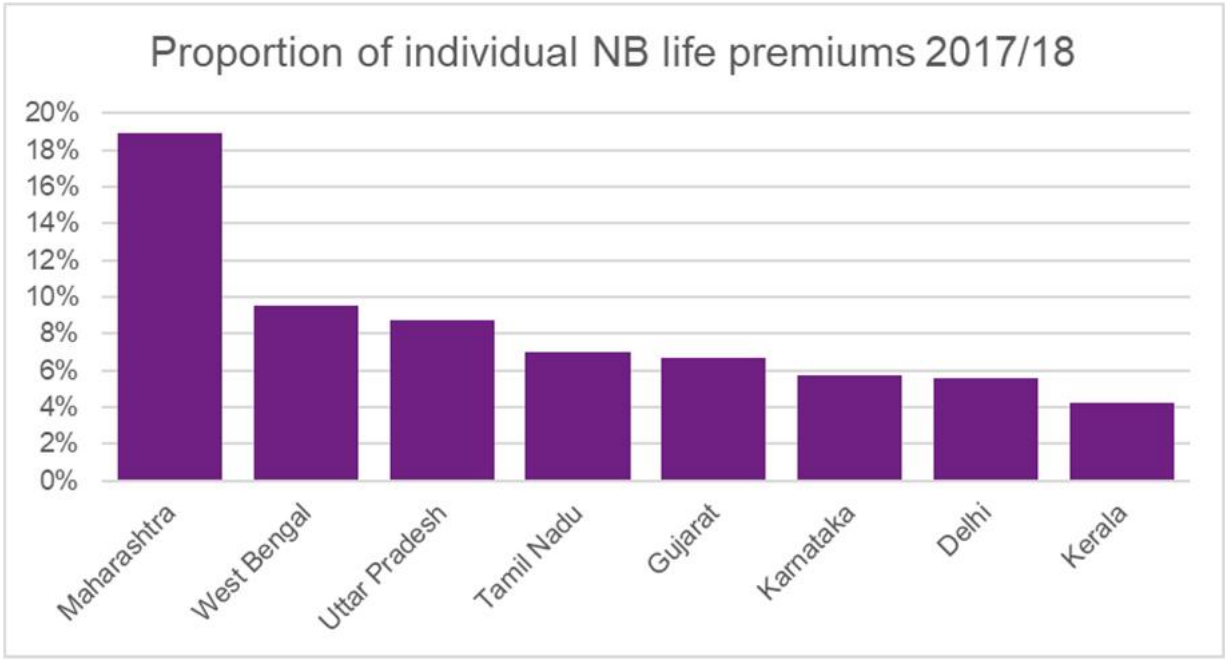
Which of the following states/union territories do you think has seen the greatest behavioural changes over the past 4 months?

1	Delhi
2	Maharashtra
3	Karnataka
4	Tamil Nadu
5	Kerala

Behavioural risk factors

Some states/UTs matter more to insurers than others

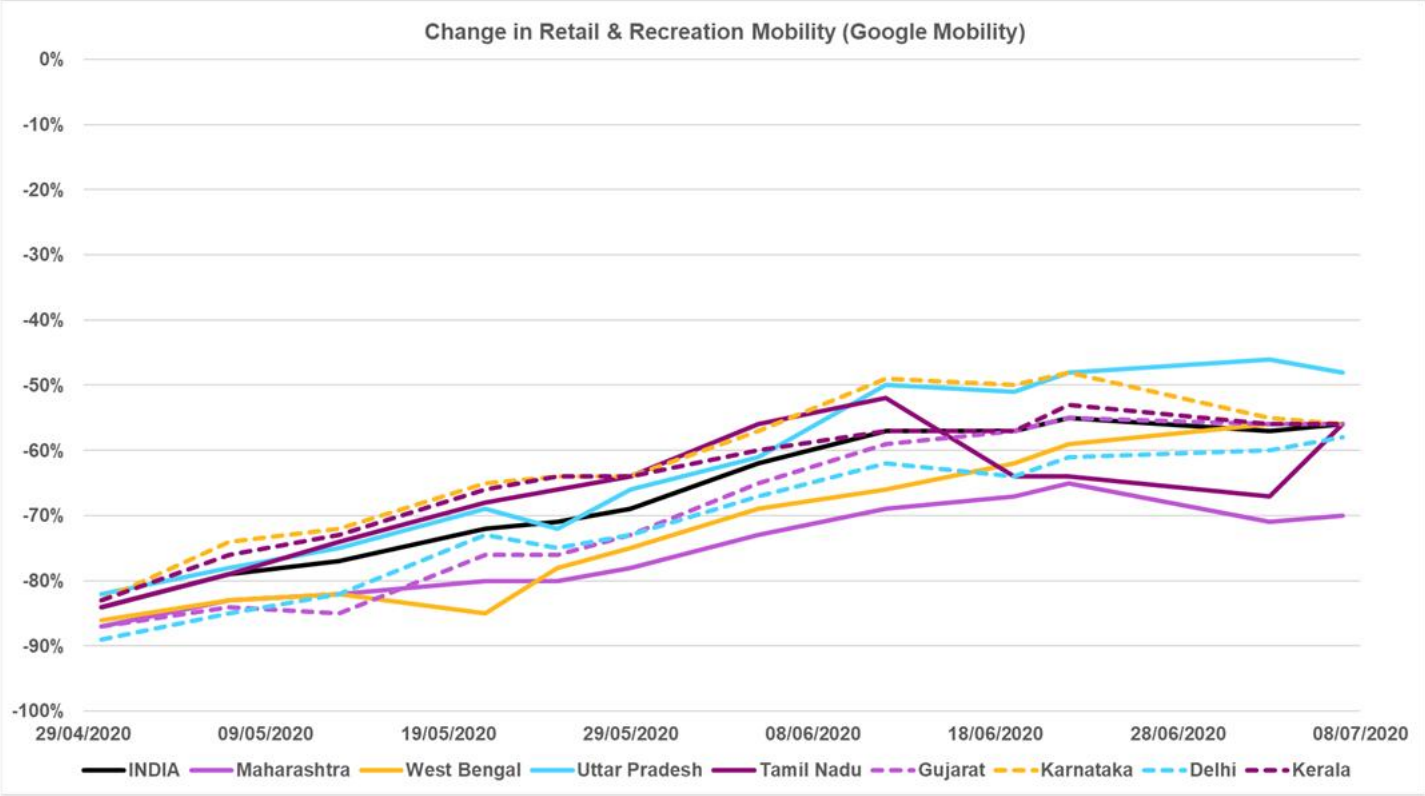
- 66% of individual new business life premiums in 2017/18 were in just 8 regions.



Premiums: https://www.irdai.gov.in/ADMINCMS/cms/frmGeneral_Layout.aspx?page=PageNo3729&flag=1

Behavioural risk factors

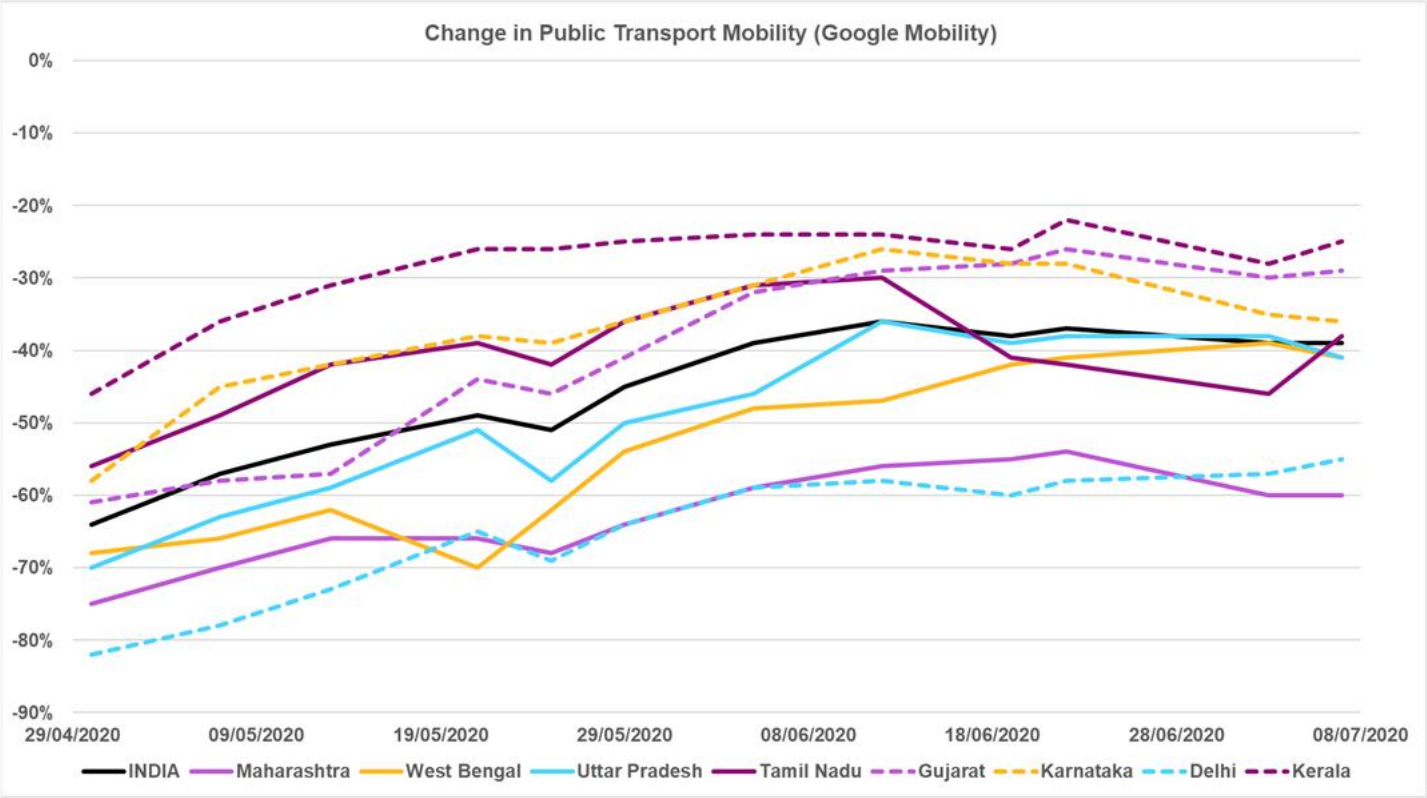
‘Retail and recreation’ mobility (Google Mobility Reports)



Source data: https://www.gstatic.com/covid19/mobility/2020-07-07_IN_Mobility_Report_en-GB.pdf (and earlier versions)

Behavioural risk factors

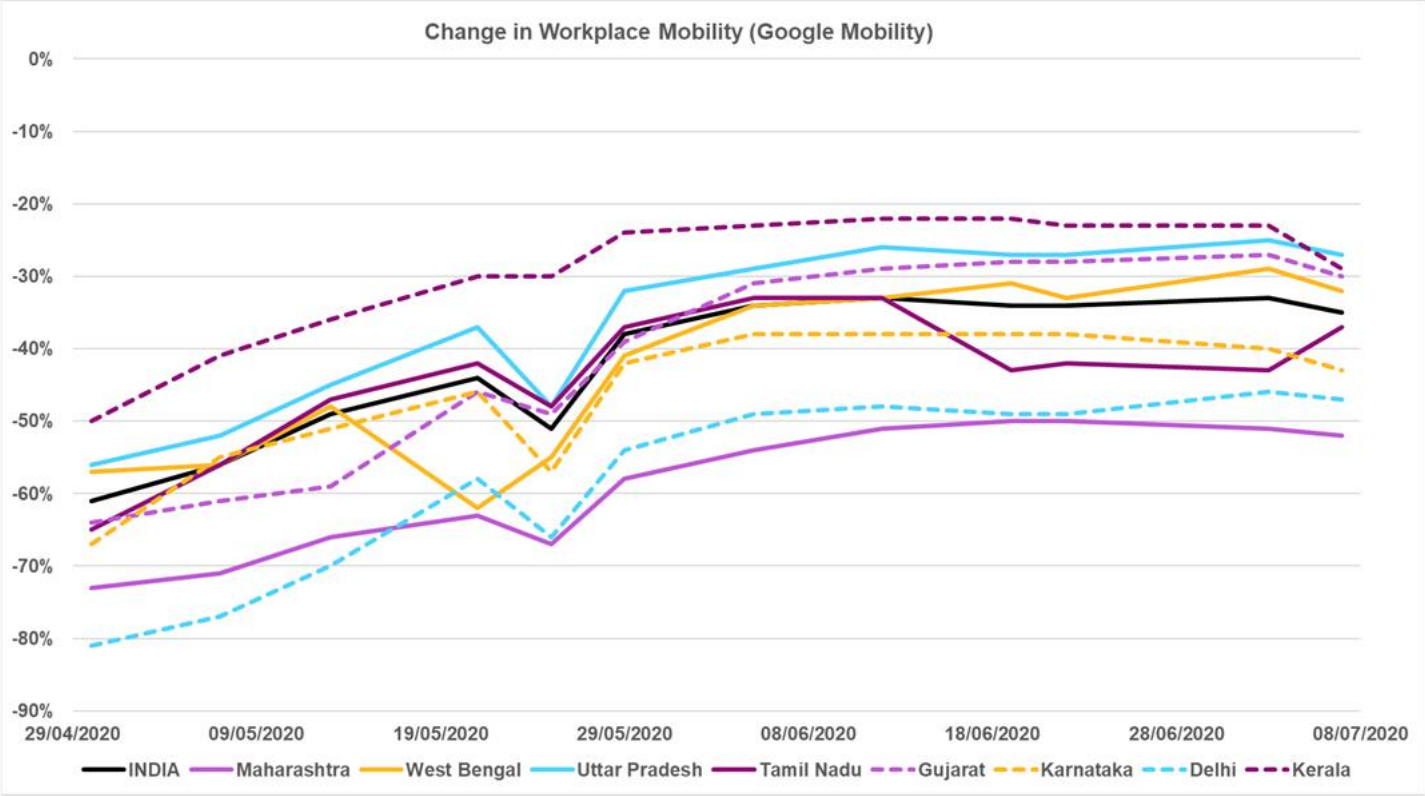
‘Public transport’ mobility (Google Mobility Reports)



Source data: https://www.gstatic.com/covid19/mobility/2020-07-07_IN_Mobility_Report_en-GB.pdf (and earlier versions)

Behavioural risk factors

‘Workplace’ mobility (Google Mobility Reports)



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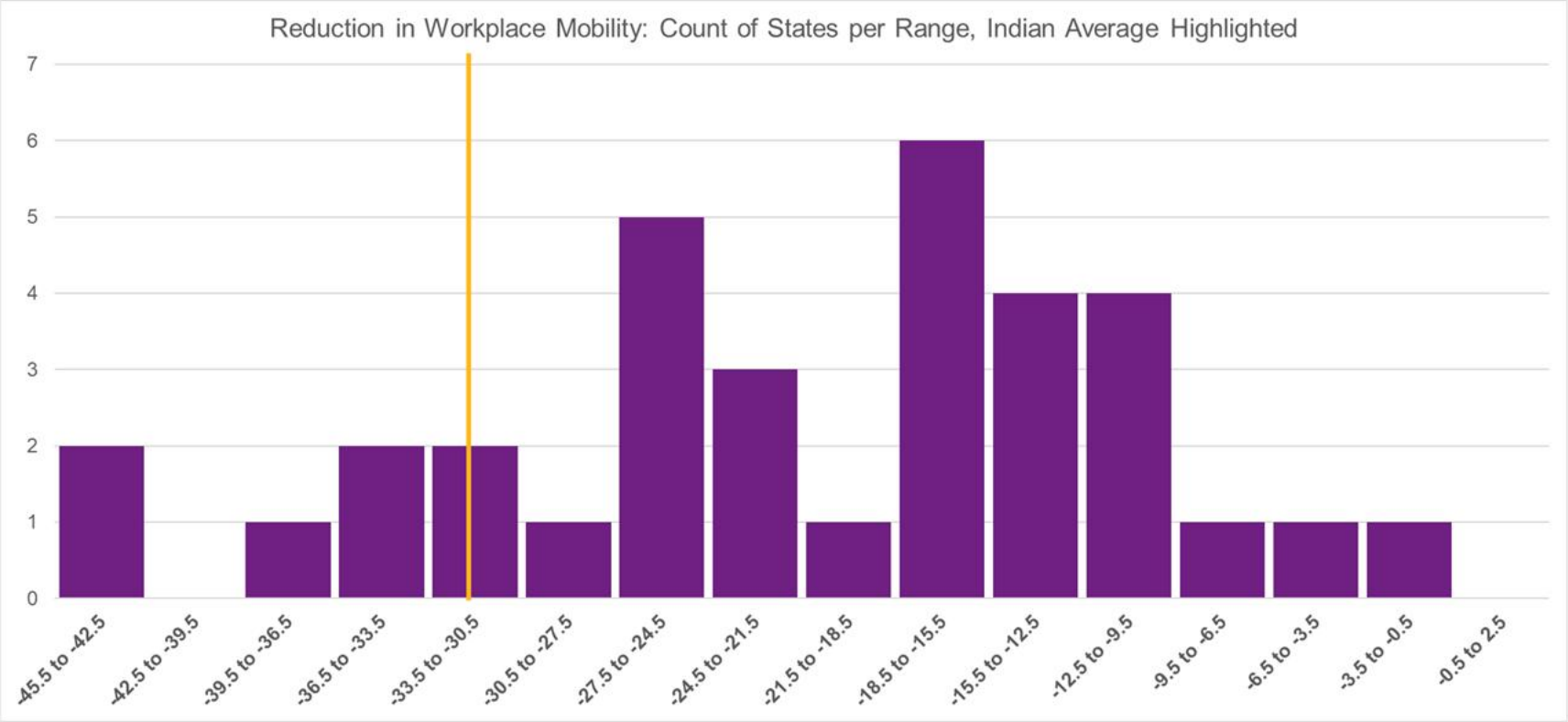
Behavioural risk factors

‘Indian average’ mobility reduction inconsistent with individual states

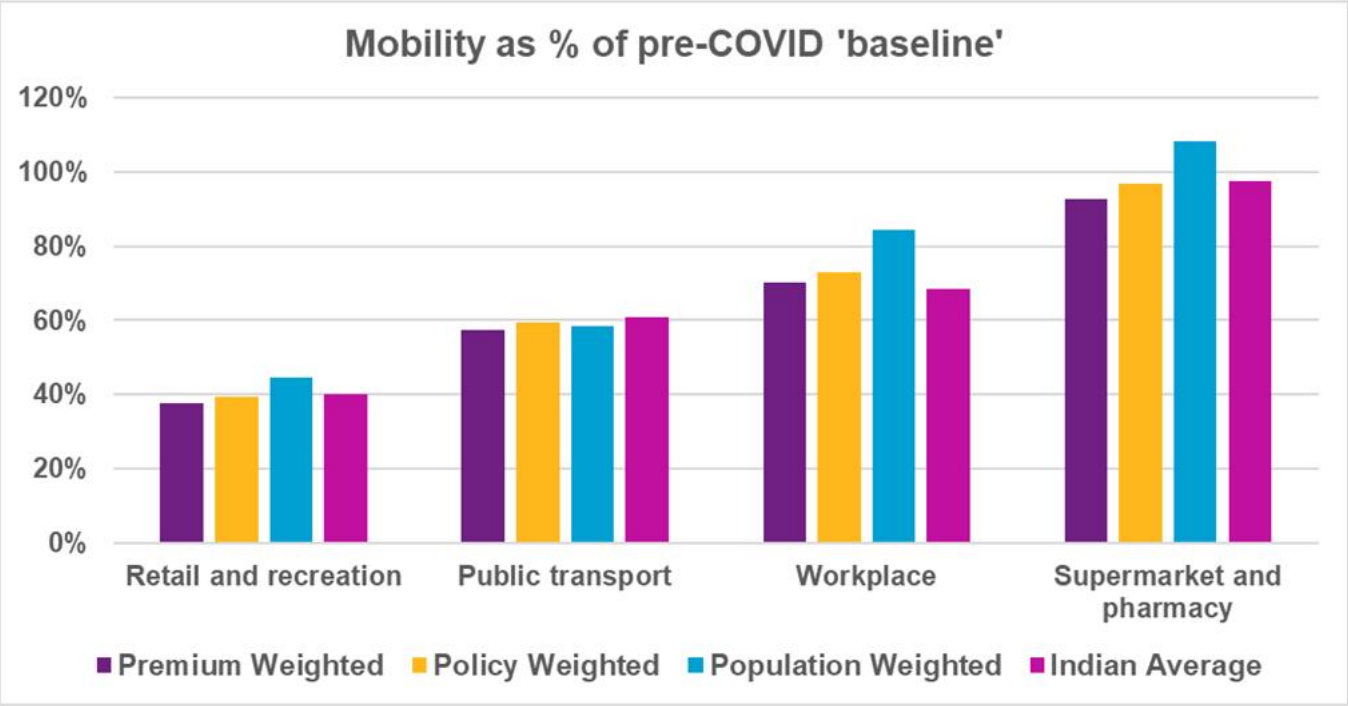


% change in mobility

Source data: https://www.gstatic.com/covid19/mobility/2020-07-07_IN_Mobility_Report_en-GB.pdf (and earlier versions)

Behavioural risk factors

‘Indian average’ mobility reduction inconsistent with individual states

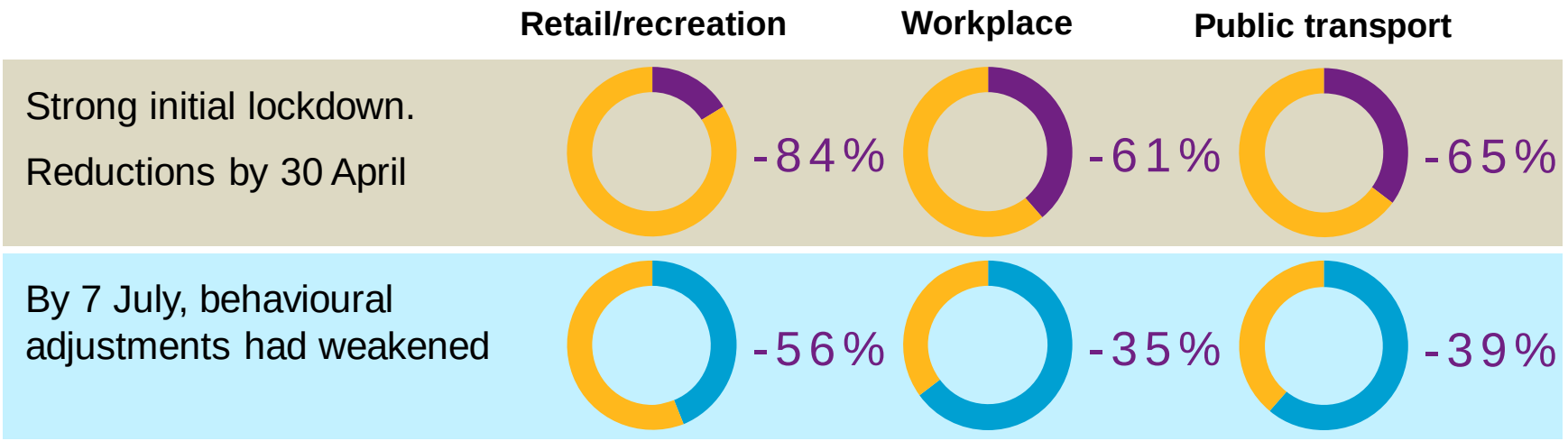


- Weighted average of (all) state/UT reductions in mobility (weighting varies by series) shows that:
  - On average, behavioural changes may be stronger in areas with more insured lives and higher premiums.
  - Indian coverage of (Android) smart-phones is not consistent between states (or data is shared with Google inconsistently between users in different states).

Source data: https://www.gstatic.com/covid19/mobility/2020-07-07_IN_Mobility_Report_en-GB.pdf

Behavioural risk factors

Summary of observations from Google Mobility Reports

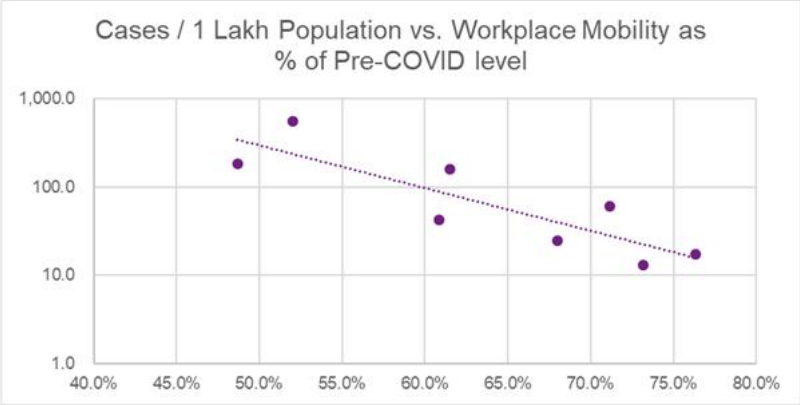


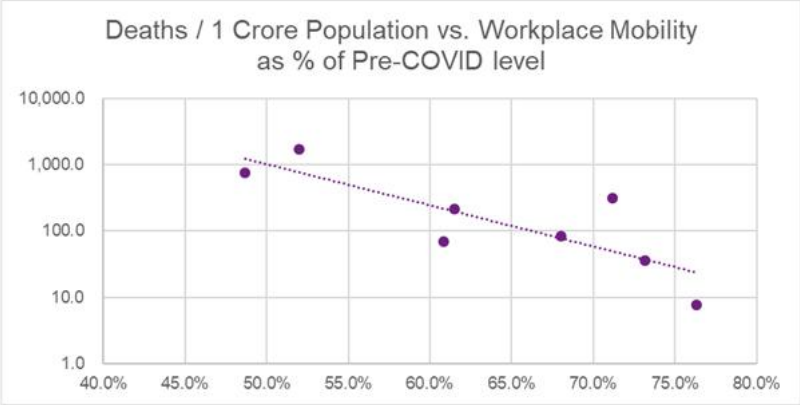
Individual states vary significantly. Of the 8 states/UTs with the greatest NB premiums:

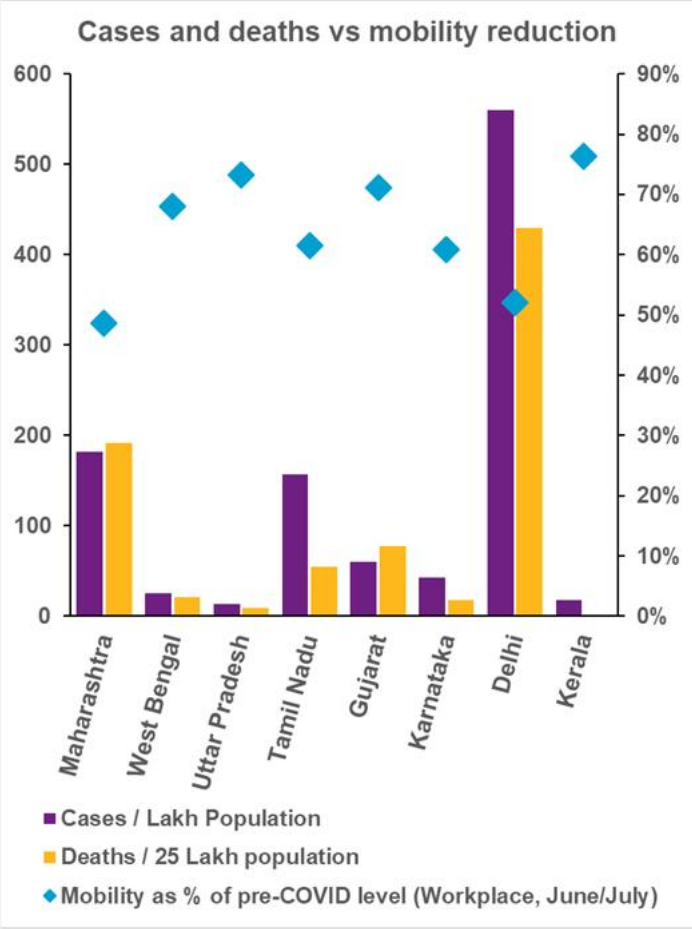
Maharashtra / Delhi	West Bengal / Gujarat
Significantly stronger reductions in mobility Persisted up until the present	Stronger-than-average response Not persisted
Kerala / Uttar Pradesh / Karnataka (less so)	**Tamil Nadu**
Generally weaker response	Also initially weaker, but has now strengthened its response

Behavioural risk factors

Comparison to case numbers and deaths







Cases / Deaths: https://www.mohfw.gov.in/
Populations: http://statisticstimes.com/demographics/population-of-indian-states.php
Mobility data: https://www.gstatic.com/covid19/mobility/2020-07-07_IN_Mobility_Report_en-GB.pdf

Behavioural risk factors

Exploring behavioural change through mobility data

- The evidence suggests that there has been a stronger response to the lockdown in regions with the highest number of cases and deaths.
  - This could be the result of a more immediate sense of the dangers of catching COVID-19.
- However, care should be taken in interpreting these statistics:
  - (As in many countries) under-reporting of cases (and deaths) is likely.
  - Under-reporting may be more likely in more socio-economically deprived areas.
  - There are potential biases within the statistics as well.
- Whilst future behavioural factors will likely be important in determining the effect of the pandemic on each state, other factors such as population density are likely to have a significant impact.

Behavioural risk factors

A note of caution

- Location data sharing by individuals may be patchy and Android phone coverage may vary by state and socioeconomic group
  (Note that Apple also captures some mobility data separately)
- Baselines may not be appropriate due to seasonal variation in mobility.
- Changes in behaviour may reflect only a certain socioeconomic subset of the overall population of a given state or union territory.
- Different industries may have been subject to different restrictions (e.g. agriculture)
- Past behavioural change is not necessarily a guide to the future:
  - Lockdown fatigue may set in in an area with previously good compliance.
  - Alternatively, an area with (until now) very few cases may see a spike and hence see renewed efforts to control the virus.

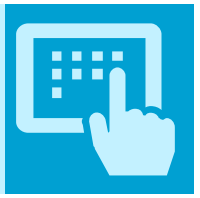
Socio-economic risk factors

Other factors to consider (not exhaustive)

Family size / occupancy of place of residence
Will this be the same for insured or non-insured population?

Job type – are insured or non-insured lives more likely to be able to work from home?

Frequency of shopping trips for daily necessities may vary between insured and non-insured lives



Population vs. Portfolio

Summary

? **What about deaths in a portfolio of lives?** ?

Different health and behaviours to the general population?	Different mix of socio-economic groups?
‘Recently underwritten’ effect which persists for a number of years	Insured lives more likely from a less-deprived background
Insured lives more risk-averse?	Behavioural change may be greater in higher socio-economic groups
	Wealth and job type may make working from home easier to sustain

Back to our formula (again)

Allowing for socioeconomic effects

Possible differences in COVID-19 mortality experience this year (& any further waves) by state and socio-economic group should be factored into our calculations:

Population	$q_{x,t+1}^{Total,Pop} = (q_{x,t}^{Total,Pop} - q_{x,t}^{C19,Pop})(1 - i_{x,t+1}^{Pop}) + q_{x,t+1}^{C19,Pop}$
Portfolio	$q_{x,t+1}^{Total,Port} = (q_{x,t}^{Total,Port} - q_{x,t}^{C19,Port})(1 - i_{x,t+1}^{Port}) + q_{x,t+1}^{C19,Port}$

$$q_{x,t}^{C19,Port} = \alpha_x \cdot q_{x,t}^{C19,Pop}$$

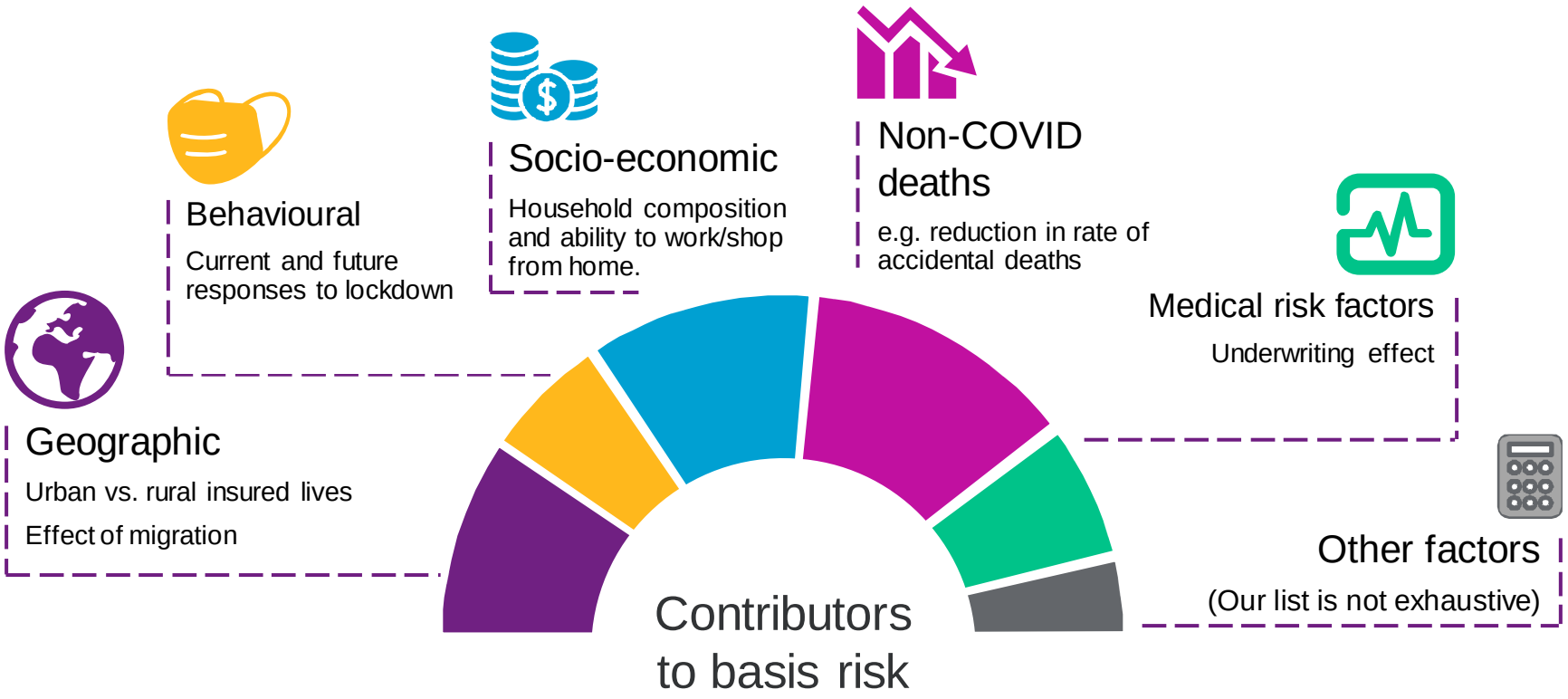
$$q_{x,t+1}^{C19,Port} = \beta_x \cdot q_{x,t+1}^{C19,Pop}$$

$$i_{x,t+1}^{Port} = i_{x,t+1}^{Pop} + \delta_x$$

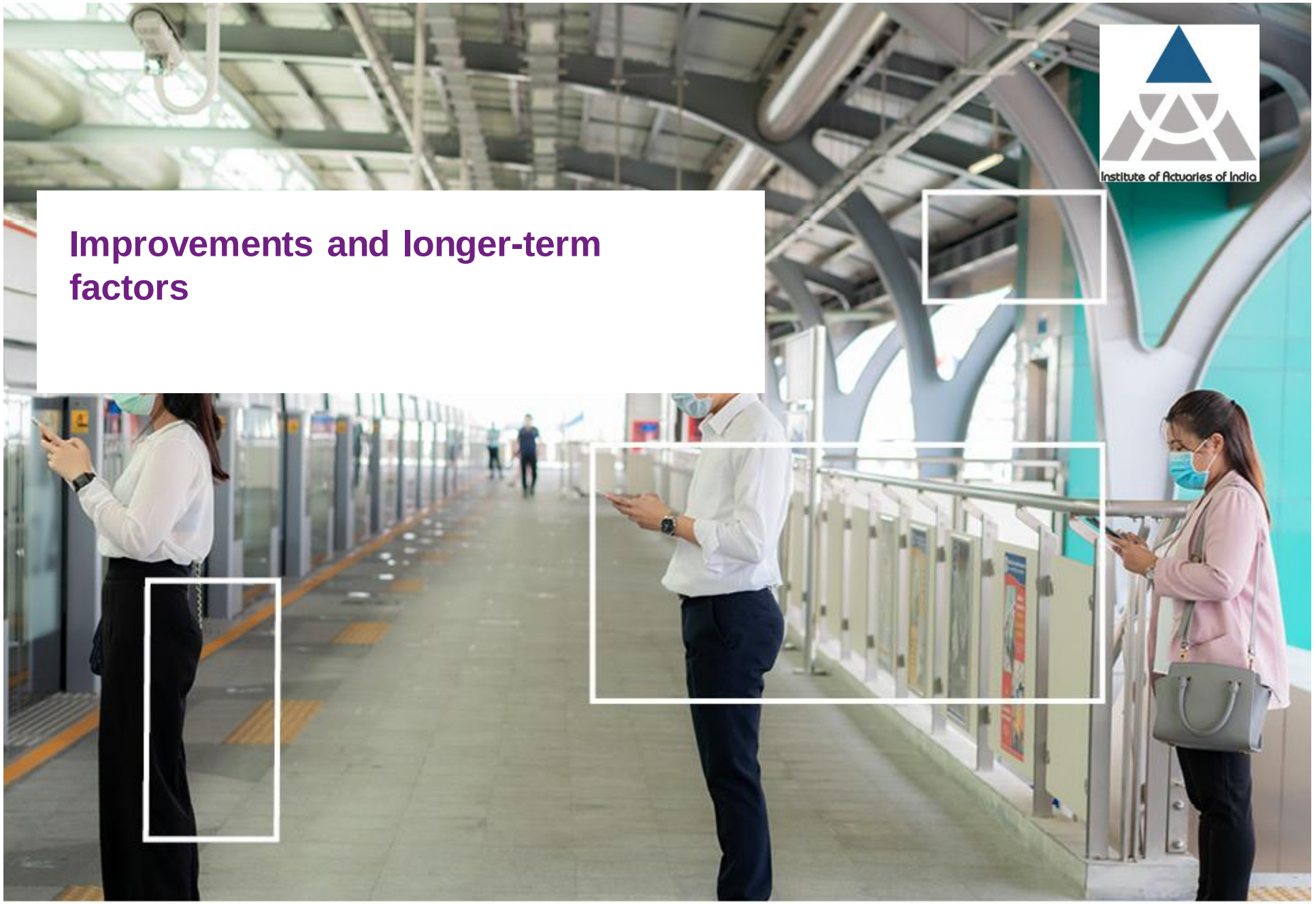
Basis risk due to COVID-19 is the risk that our estimates of α_x, β_x and δ_x are incorrect (along with future equivalents to δ_x)

Back to our formula (again)

Our estimates of α_x, β_x will depend on the following factors



Improvements and longer-term factors



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Longer-term factors

Our estimate of δ_x (improvement differentials) requires us to consider drivers of mortality beyond the immediate effects of COVID-19

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Lifestyle factors

Changes in exercise habits, work location, environment, diet and other lifestyle factors.

Will they persist?

Economic impacts

Long-term funding of health services, unemployment and effect on mental health

Each factor can affect mortality in the short-, medium- or long-term future

Medical factors

Lasting effects of **severe COVID-19** infection:
e.g. kidney damage or delayed cancer diagnoses

Endemic COVID?

Possible **additional waves of** COVID-19 (or other mutated coronaviruses)

Polling question 4

Which of the following do you think poses the biggest challenge for product pricing for the remainder of 2020?

1	A change in the consumer base choosing to purchase insurance.
2	A long-term change in the behaviour of insured lives.
3	A second (or subsequent) wave of COVID-19.
4	The economic and infrastructural impacts of COVID-19 on health/mortality.

Improvement modelling

Potential impacts of COVID-19 on model/data appropriateness

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Population data

Will show a spike in mortality in 2020

Model selection and fitting

Models typically assume a constant long-term trend and roughly constant volatility.

Projections may be sensitive to 2020 mortality

Implied basis risk

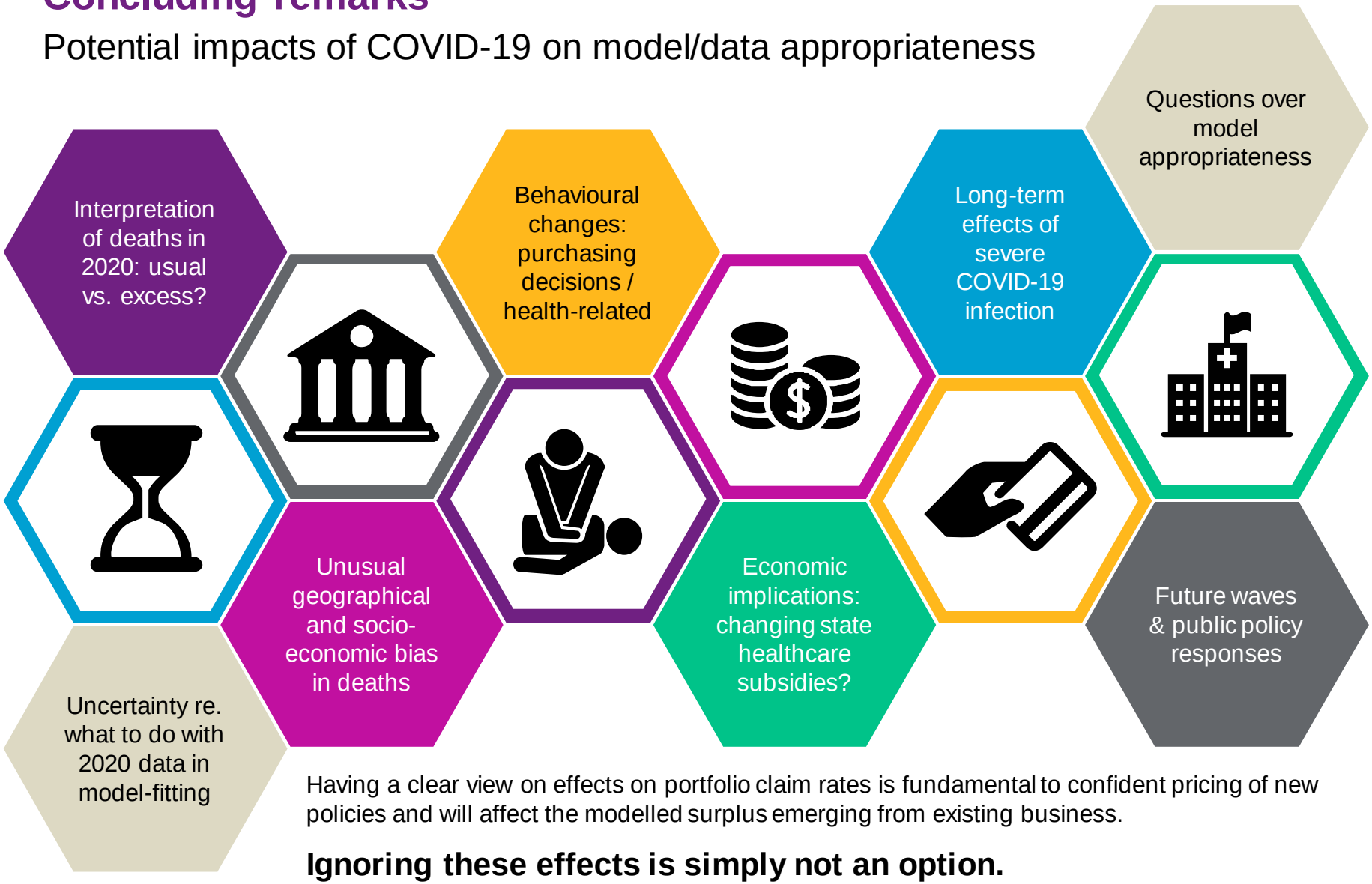
May not reflect differences in population and portfolio:

- Select effects
- Behavioural/lifestyle changes
- Effects of health-service stress and changes in funding
- Effects of possible future waves of Covid-19 (e.g. winter mortality in 2020/21)

Concluding remarks

Concluding remarks

Potential impacts of COVID-19 on model/data appropriateness



Having a clear view on effects on portfolio claim rates is fundamental to confident pricing of new policies and will affect the modelled surplus emerging from existing business.

Ignoring these effects is simply not an option.

Concluding remarks

What can be done now?

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Changes to underwriting practices to prevent purchases when COVID-19 is already suspected.

Update best-estimate mortality and morbidity assumptions: more granular by state, allowing for at-risk groups

Update short-term improvement assumptions: consider range of possible first/second wave impacts

Develop a view of longer-term effects: allow for economic and behavioural impacts in the mid-/long-term

Assess margins for adverse deviation: Has uncertainty materially increased due to COVID-19?

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