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Estimation Of The Crash Rates Of Vehicles Considering Vehicle Age, Crash Period And Vehicle Cohort

Vehicle age-period-cohort effects on crash rates

- Analogies exist in public health
- E.g. Cancer rates vary according to
  - Age
  - Time (period)
  - Year of birth (cohort)
- Examining data on disease along the lines of age, period and cohort reveal patterns an trajectories in the data not apparent when the data are viewed in other ways

- Why not apply the approach to vehicles?

Why would such effects be present?

- Age:
  - Annual VKT varies with age,
  - Ownership varies with age, and hence
  - crash patterns vary with age
- Cohort
  - Crashworthiness varies with cohort
  - Primary safety varies with cohort
- Period
  - Speeds change over time
  - Per vehicle VKT is changing over time
  - Infrastructure is generally safer over time

Why care?

- Because the number and timing of crashes should be of importance
  - Distilling age effects will allow appropriate discounting of crash rates.

- Because the past is an uncertain guide to the future.
  - E.g. Examining crashes from 10 years ago, involving 25 year old cars may not reveal the crash risk of vehicle built in 2015 in 2030.

- High likelihood that analyses on the benefits of new technology are confounded
  - Analyses risk double counting benefits (e.g. counting period effects as cohort effects)

Objectives

- To introduce the use of A-P-C analysis of vehicle-based crash data
- To characterise crash data when disaggregated along A-P-C
- Preliminary examination of trends in lifetime crash involvement vehicle cohorts

Data

- NSW crash data from 1999-2009
- ABS vehicle census data for the same period
- Crash rates use the maximum size of the cohort as the denominator
- Correction is made for interstate transfers

Notation

- Periods are prefixed with a P
- Cohorts and prefixed with a C

The Lexis Diagram

Period

	P2007	P2008	P2009	P2010	P2011
Crashes	13542	13739	14003	12785	12732

The Lexis Diagram

Period

P2007	P2008	P2009	P2010	P20

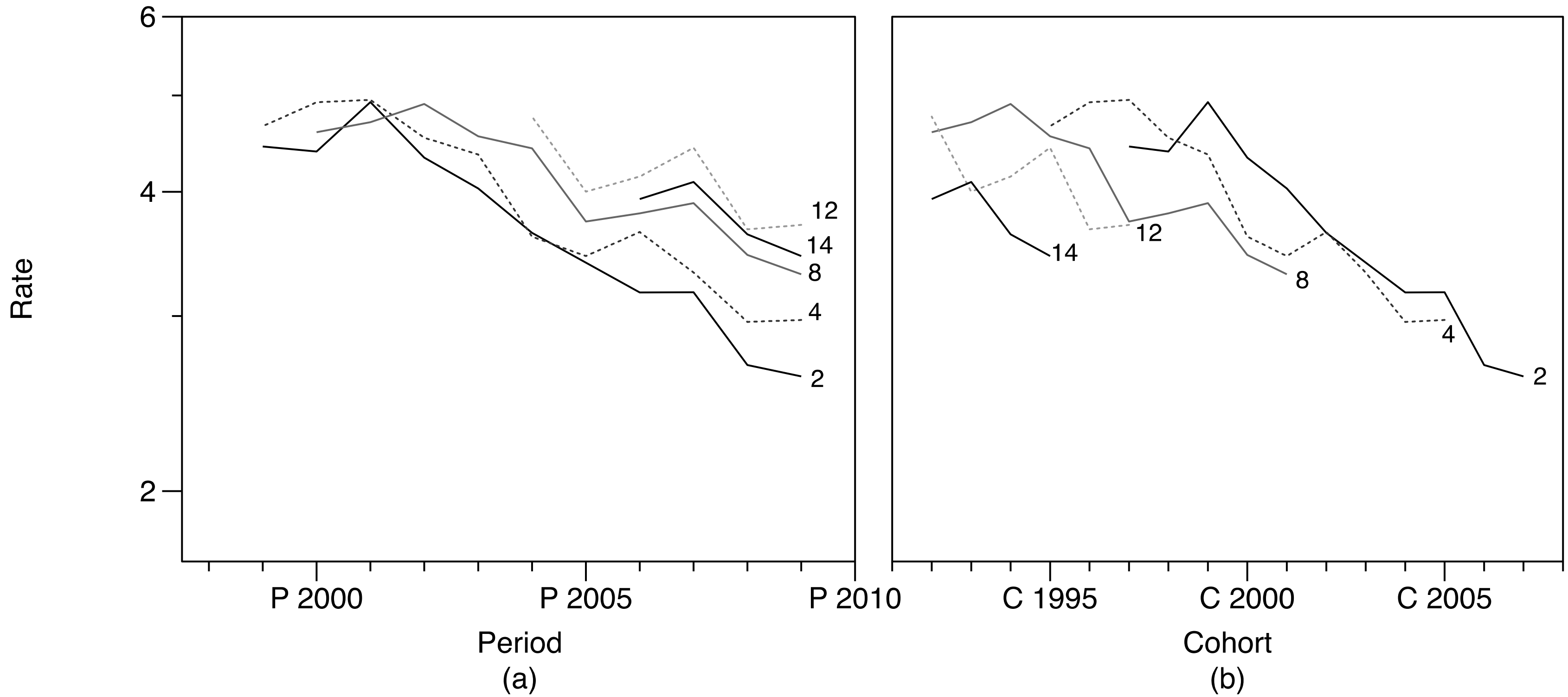
Cohort

Period

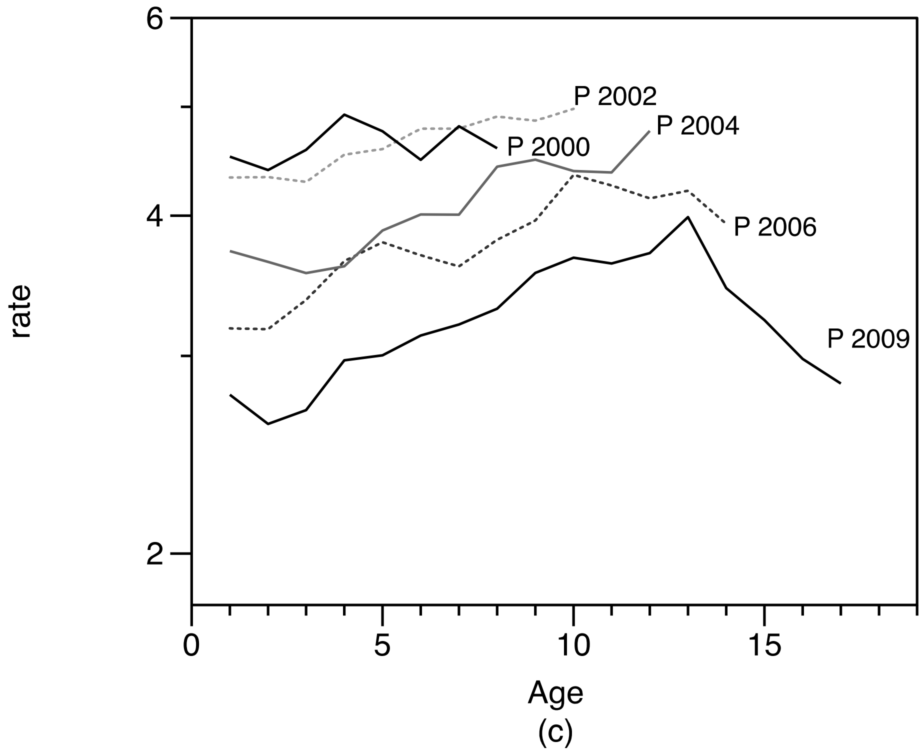
Age	P2007	P2008	P2009	P2010	P2011
1	319	271	303	263	193
2	804	784	723	680	661
3	835	773	783	639	660
4	753	821	780	719	635
5	734	811	798	706	718
>5	10097	10279	10616	9778	9865

Crash rate over period by age

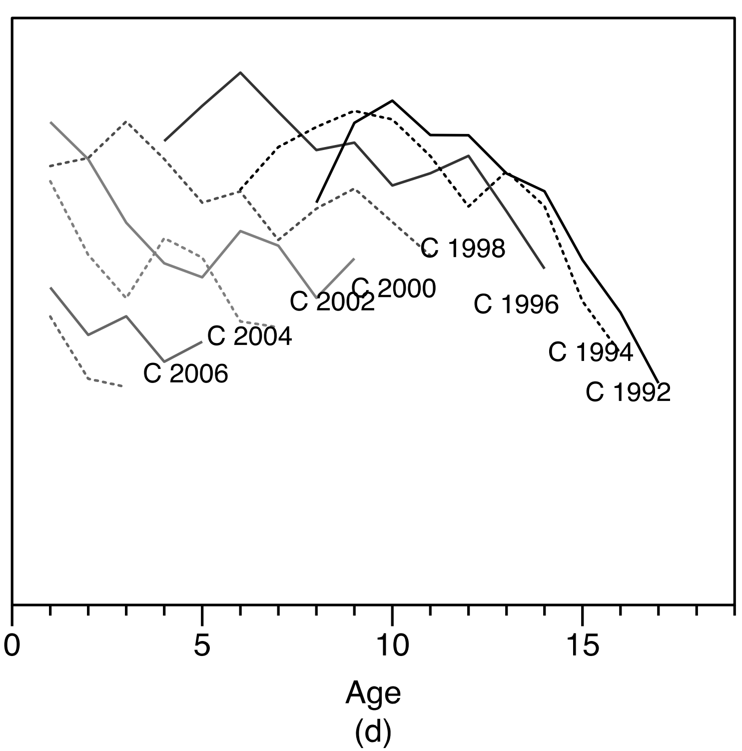
Crash rate over cohort by age



Crash rate over age by period

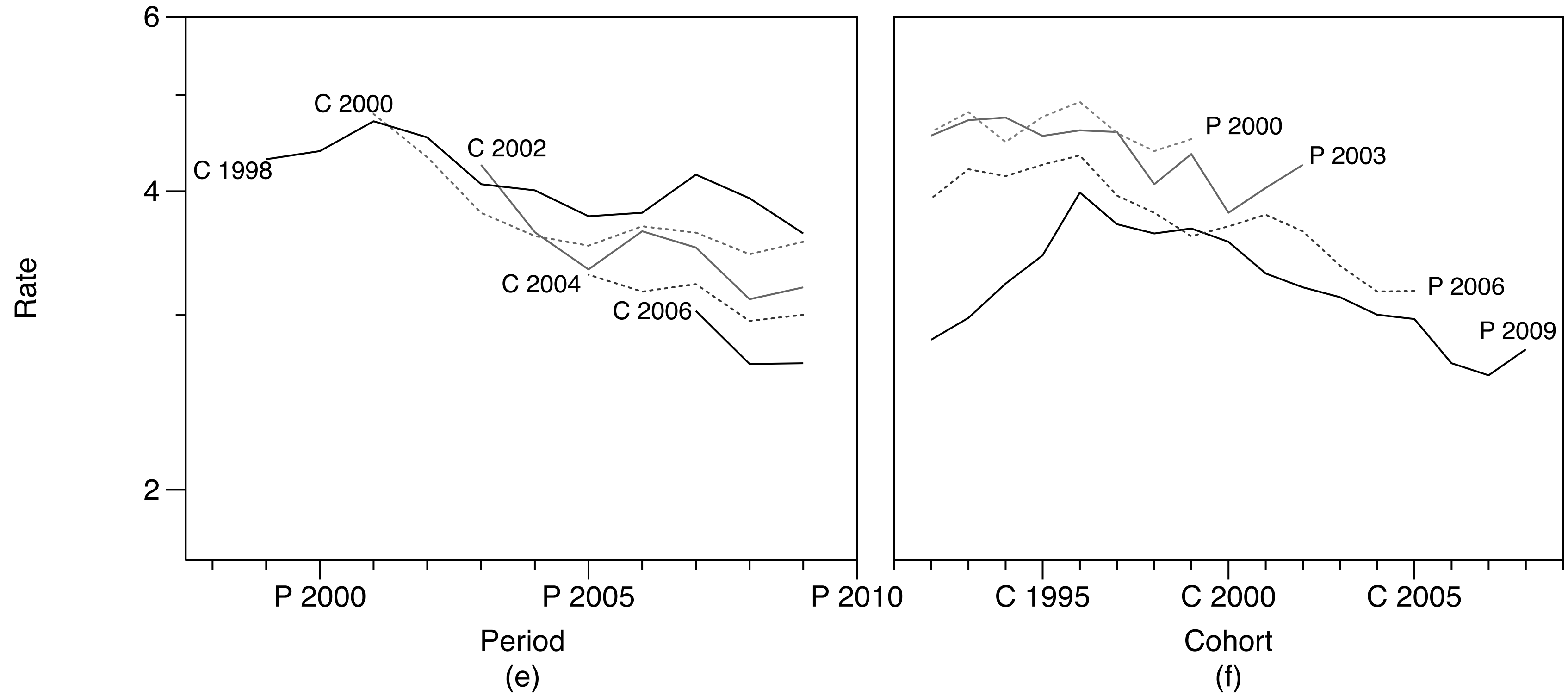


Crash rate over age by cohort



Crash rate over period by cohort

Crash rate over cohort by period



Observations

- All three factors – age, period and cohort – appear to influence crash rates

- A limitation needs to be mentioned at this point:
- It is not possible to formally disentangle each of the the three effects from the others

$$\text{Age} = \text{Period} - \text{Cohort}$$

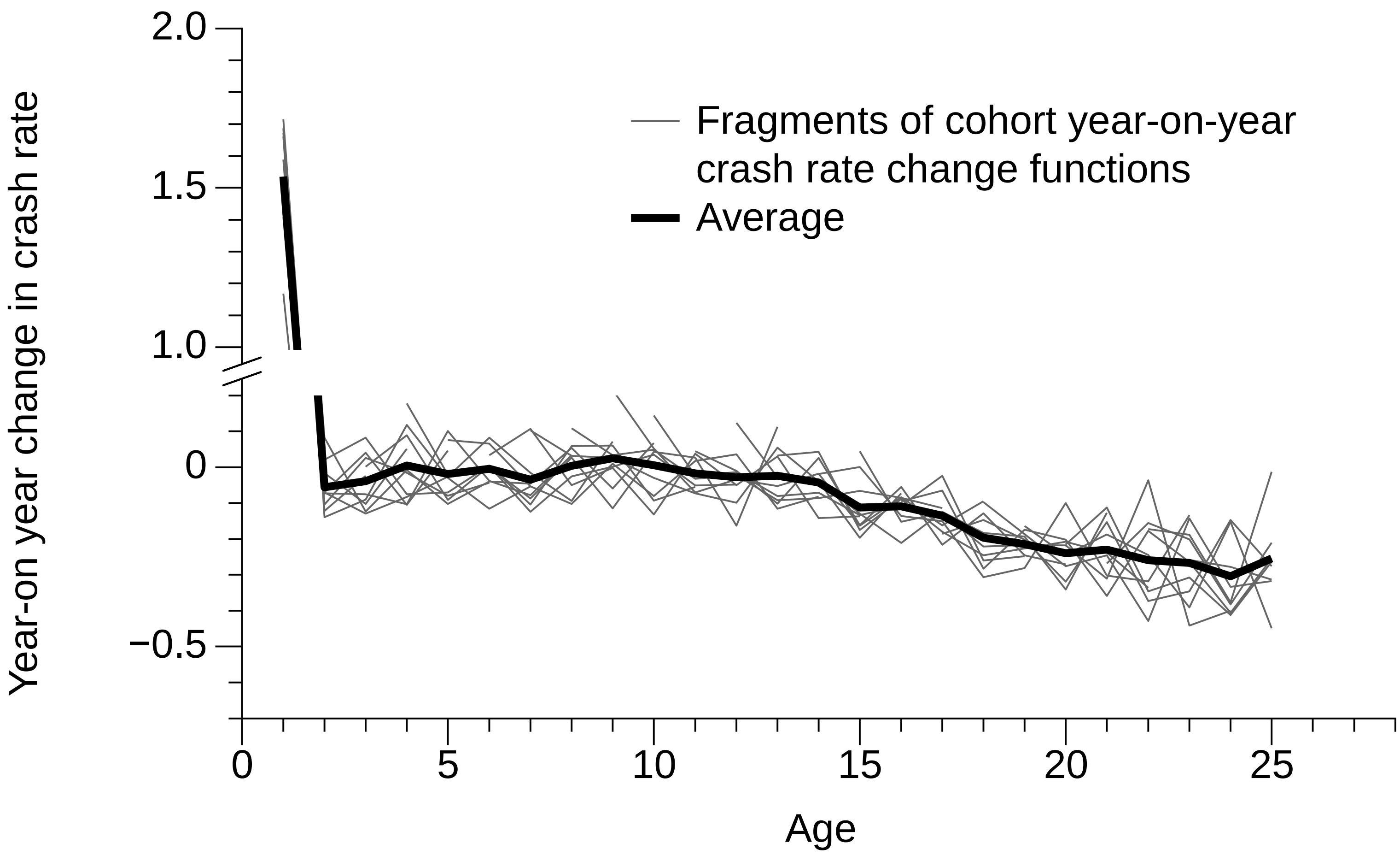
- Note also that only fragments of cohort specific, age-related crash data are available

Use of the data to estimate lifetime crash rates

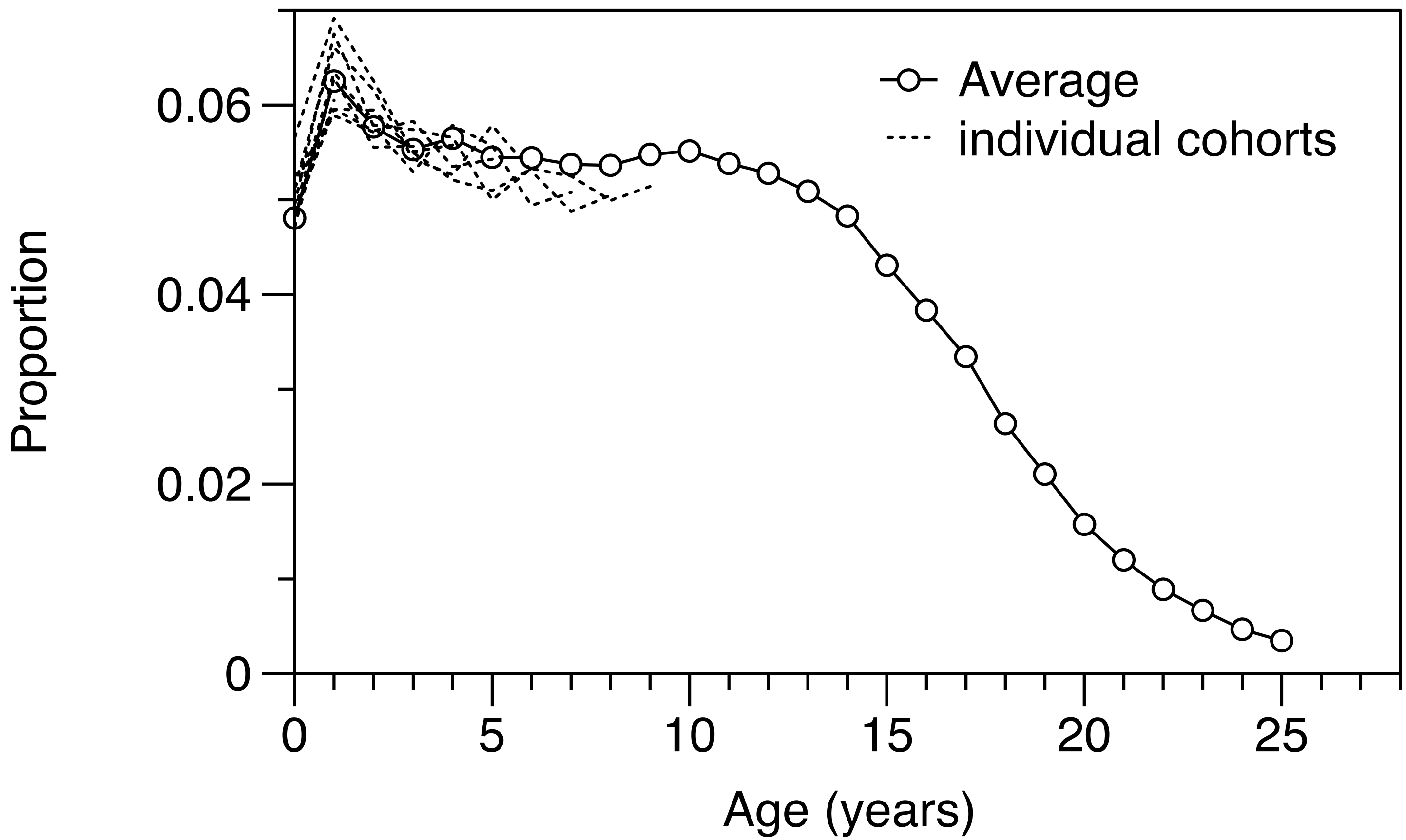
- Fragments of age-related crash rates were combined

- It was notable that the proportional change in the crash rate from one age to the next at any given age is quite consistent over all cohorts

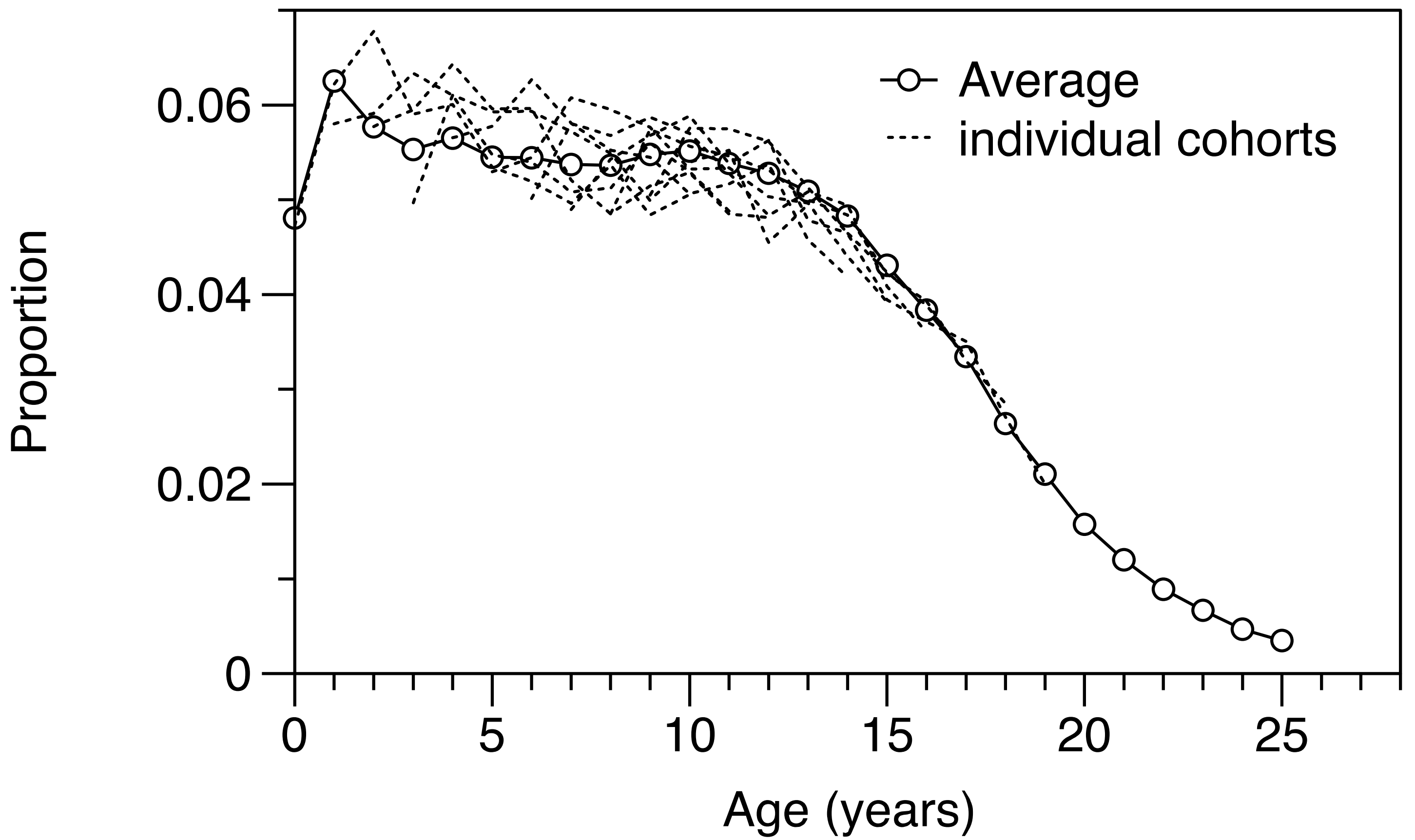
Proportional change in crash rates for many cohorts



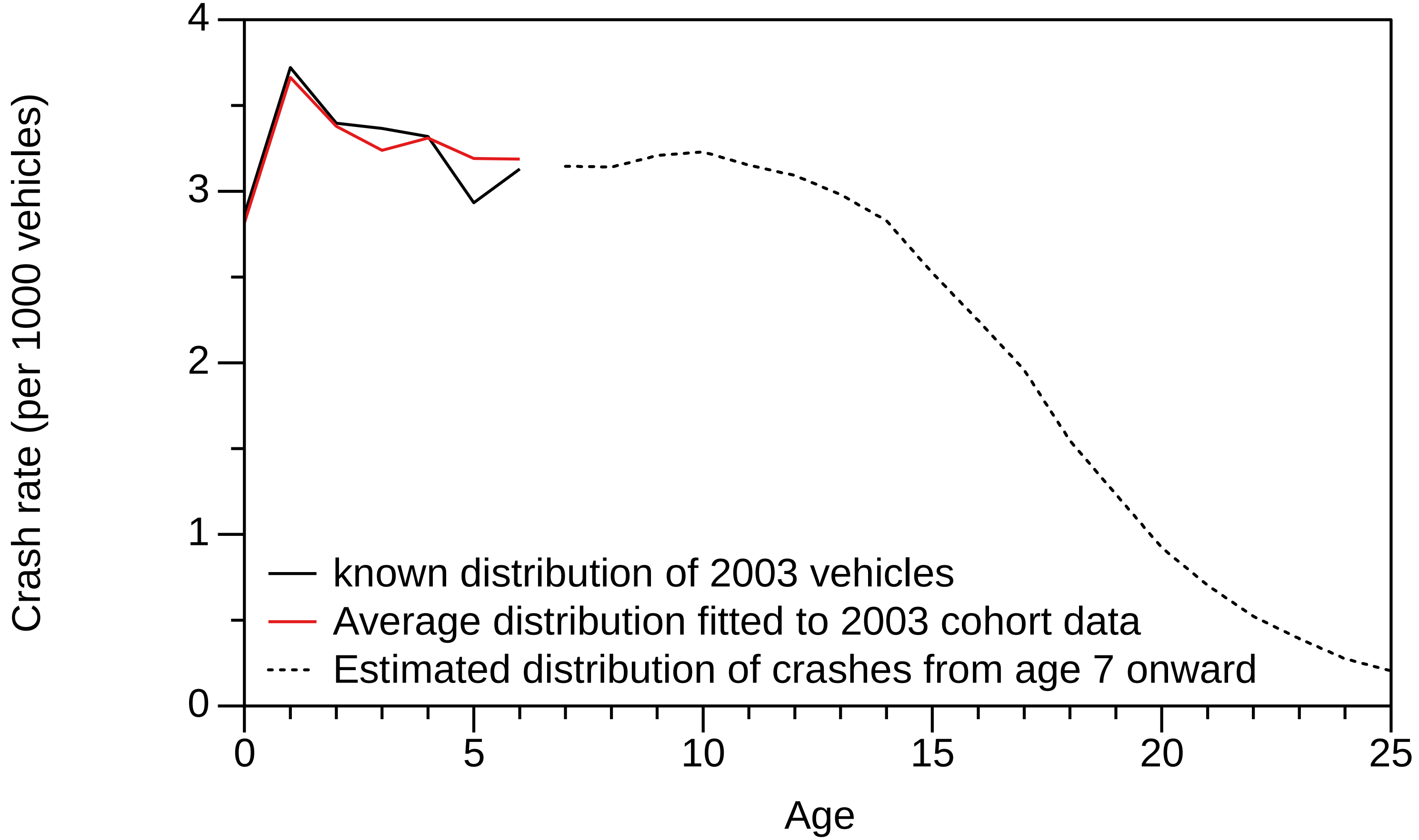
Injury crash rates as a function of age

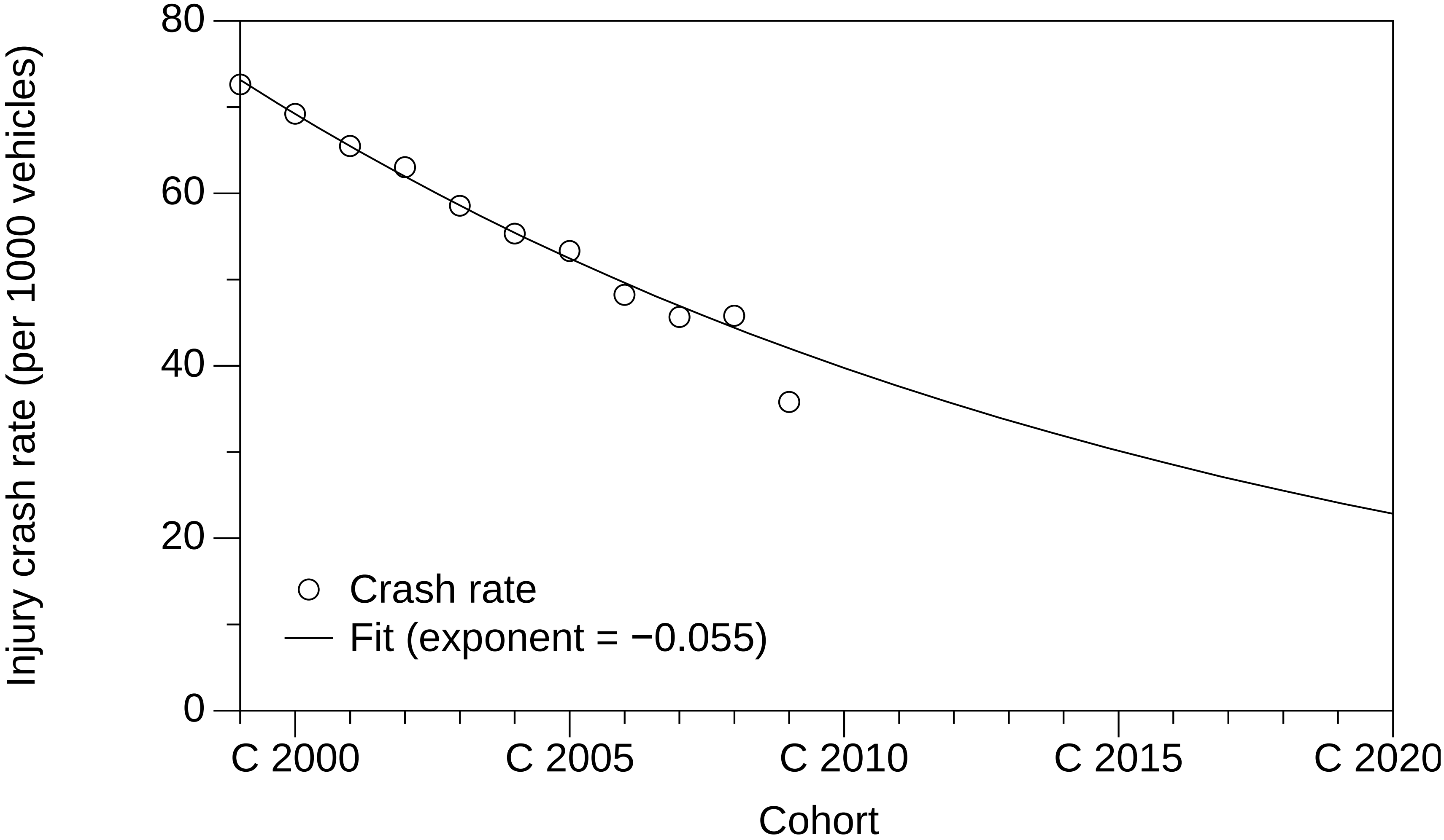


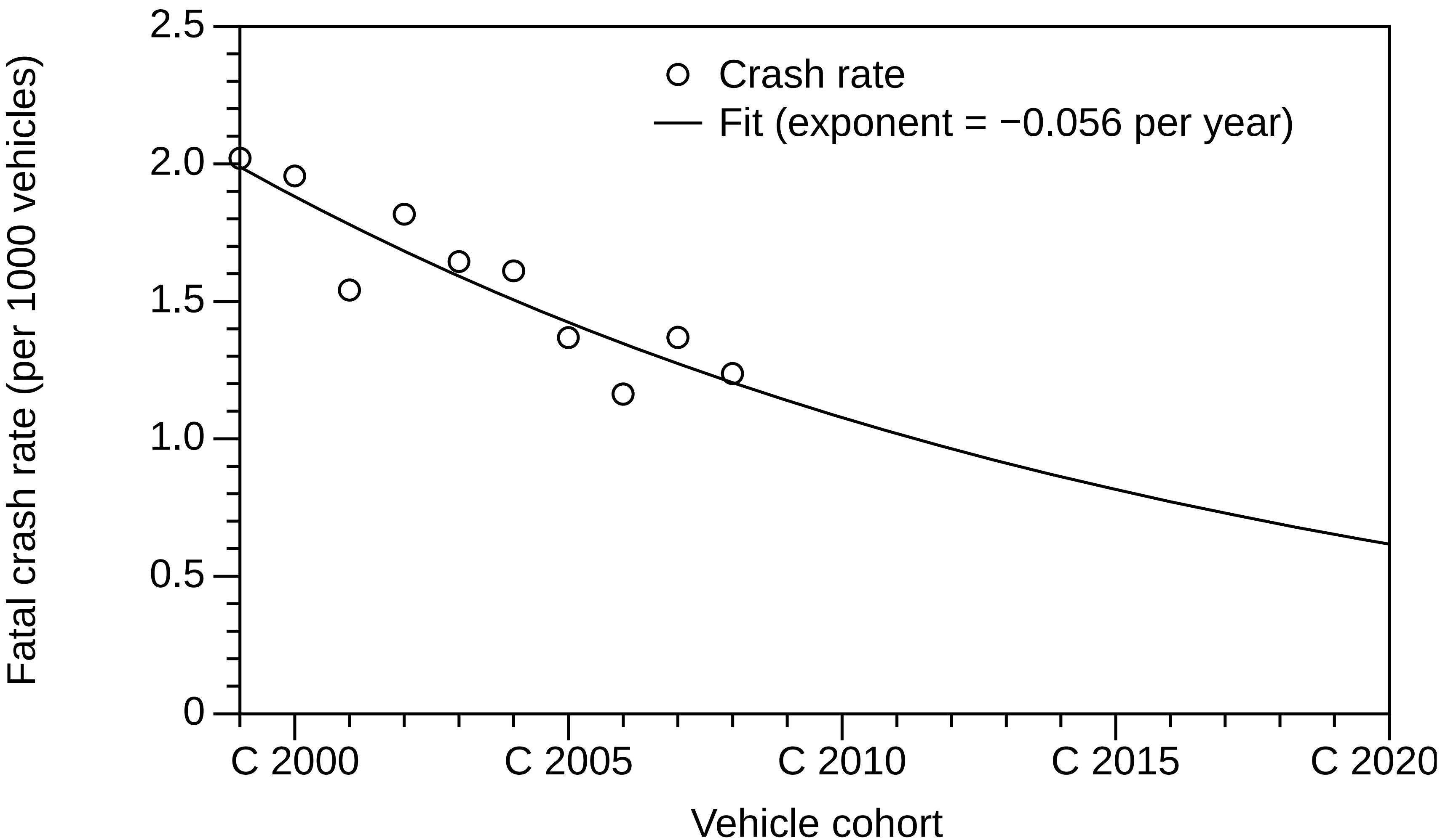
Injury crash rates as a function of age



Fitting the distribution to fragmentary data on a single cohort




Injury crash rate (per 1000 vehicles)
80
60
40
20
0
Crash rate
Fit (exponent = −0.055)
C 2000
C 2005
C 2010
C 2015
C 2020
Cohort


Crash rate
Fit (exponent = −0.056 per year)
Fatal crash rate (per 1000 vehicles)
2.5
2.0
1.5
1.0
0.5
0
C 2000
C 2005
C 2010
C 2015
C 2020
Vehicle cohort

Limitations

- A stationary age-period effect was assumed.
  - Are vehicle lives getting longer?
  - The period effect assumed is a constant per-period decline in the crash rate and this might not always be a fair representation of the period effect

- However, similar assumptions are made when projecting cross-sectional crash rates into the future
- Nevertheless, the validity of these assumptions do need to be checked.

Discussion

- A brief introduction to A-P-C modelling of vehicle crashes has been presented
- To date, it has been common to present trends in cross-sectional data to examine the scope of new technology to prevent crashes.
  - But such data are heterogeneous when examined by cohort
- A-P-C disaggregation and analysis is likely to improve on these other methods, as it should provide more insight into important effects present in the data

Discussion

- Injury and fatality rates reducing at about 5-6% per cohort year
- Lifetime injury and fatality rates of vehicles appear to be halving every 12 cohort years
- These are effects of **period and cohort combined**
- Methods can be adapted for particular vehicle types and crash types
- More work necessary before these results are finalised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