*Number of claims and number of near-misses for **telematics pricing** in automobile insurance*

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Fundación BBVA

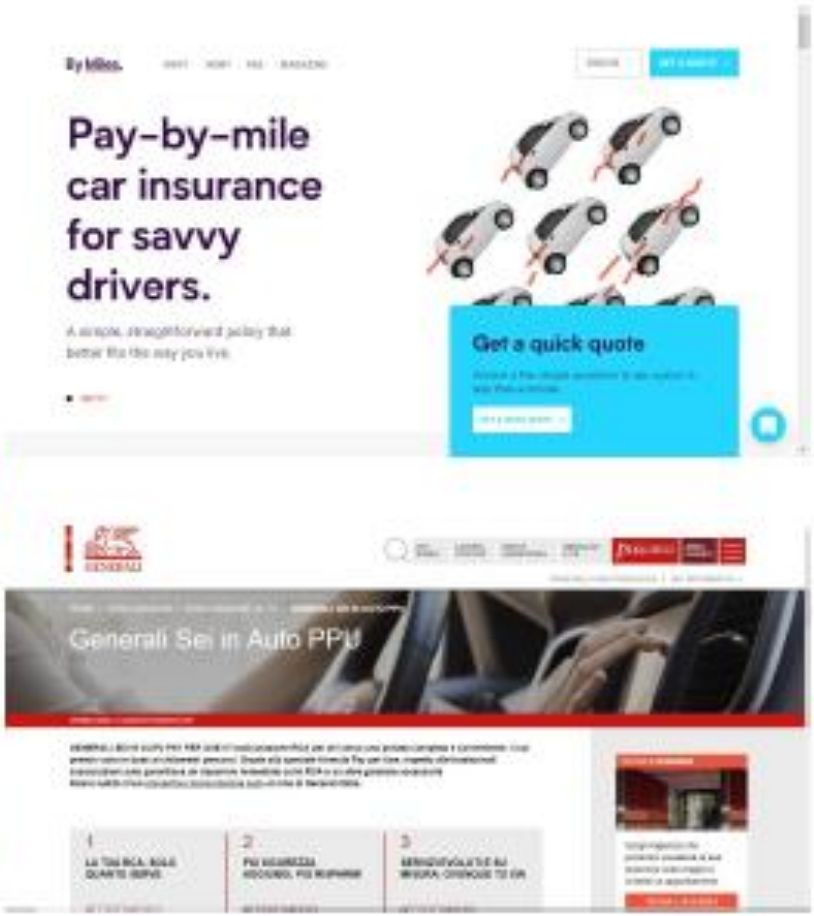
GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN

ICREA

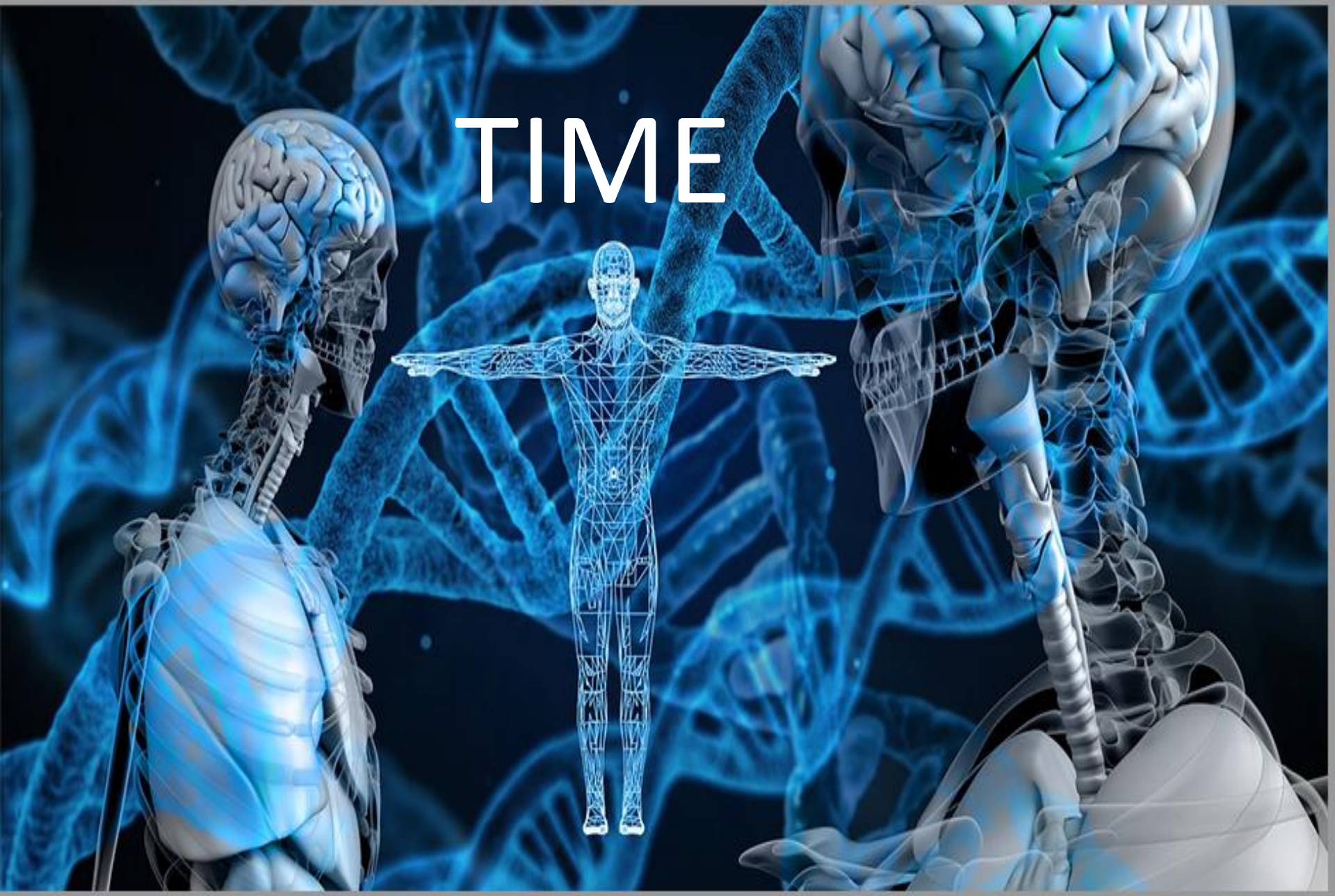
Contents

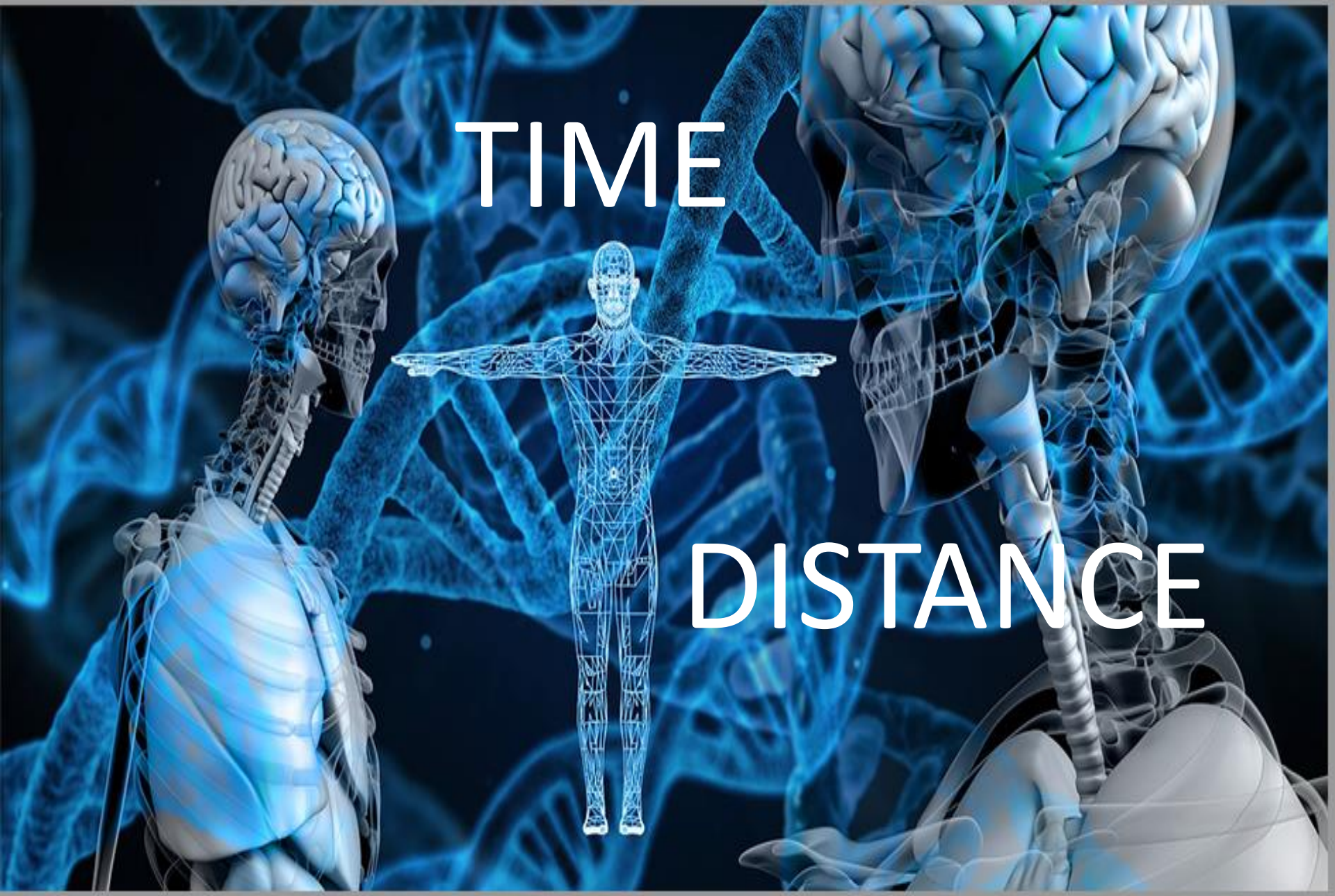
1. Introduction (3 minutes)
2. Data & methods (5 minutes)
3. Results (4 minutes)
4. Conclusions (3 minutes)

Companies selling motor insurance based on telematics around the world

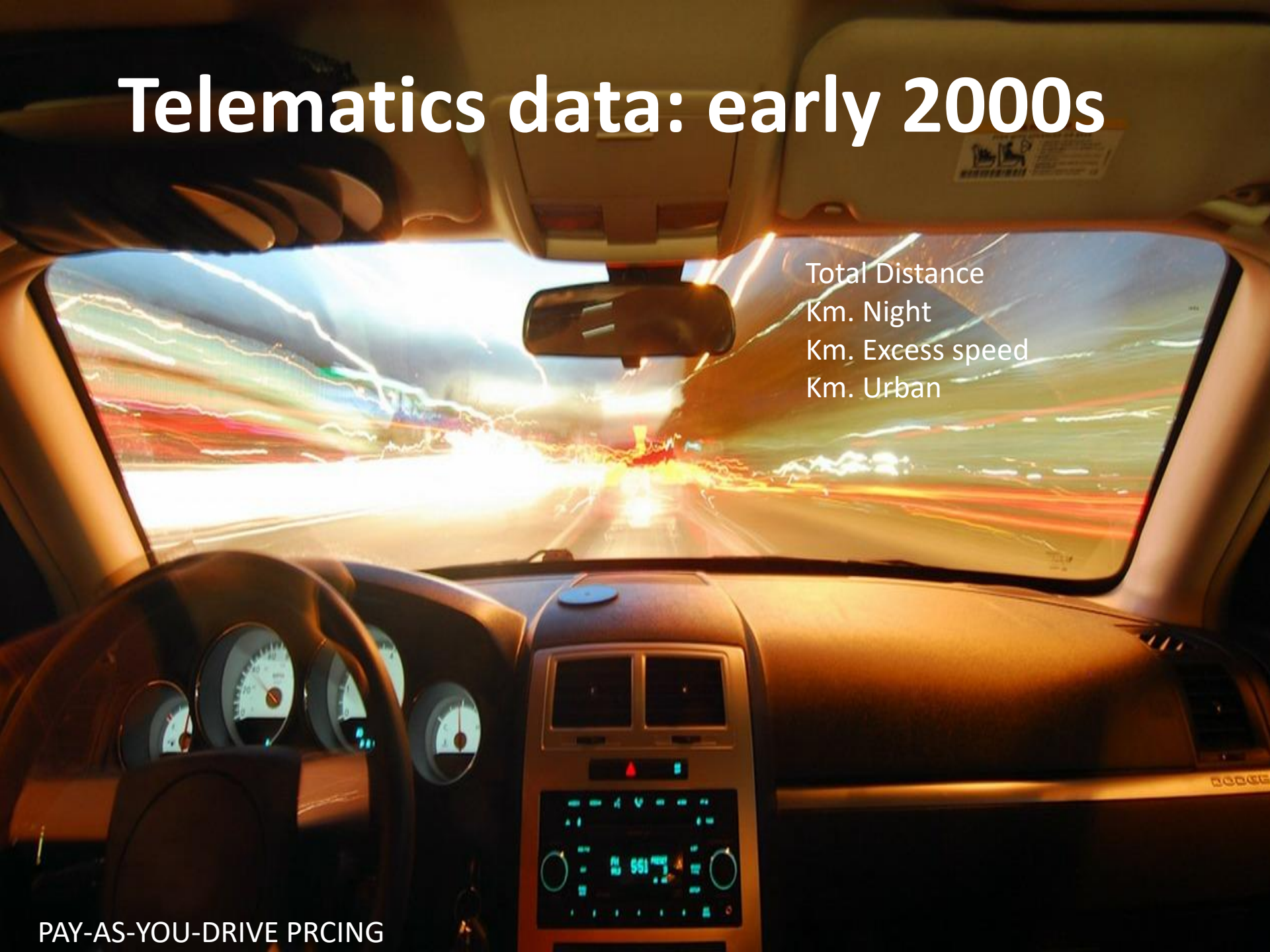


PAY-AS-YOU-DRIVE PRICING = **BASE PREMIUM** + DISTANCE***COST per UNIT**


TIME


TIME
DISTANCE

Telematics data: early 2000s



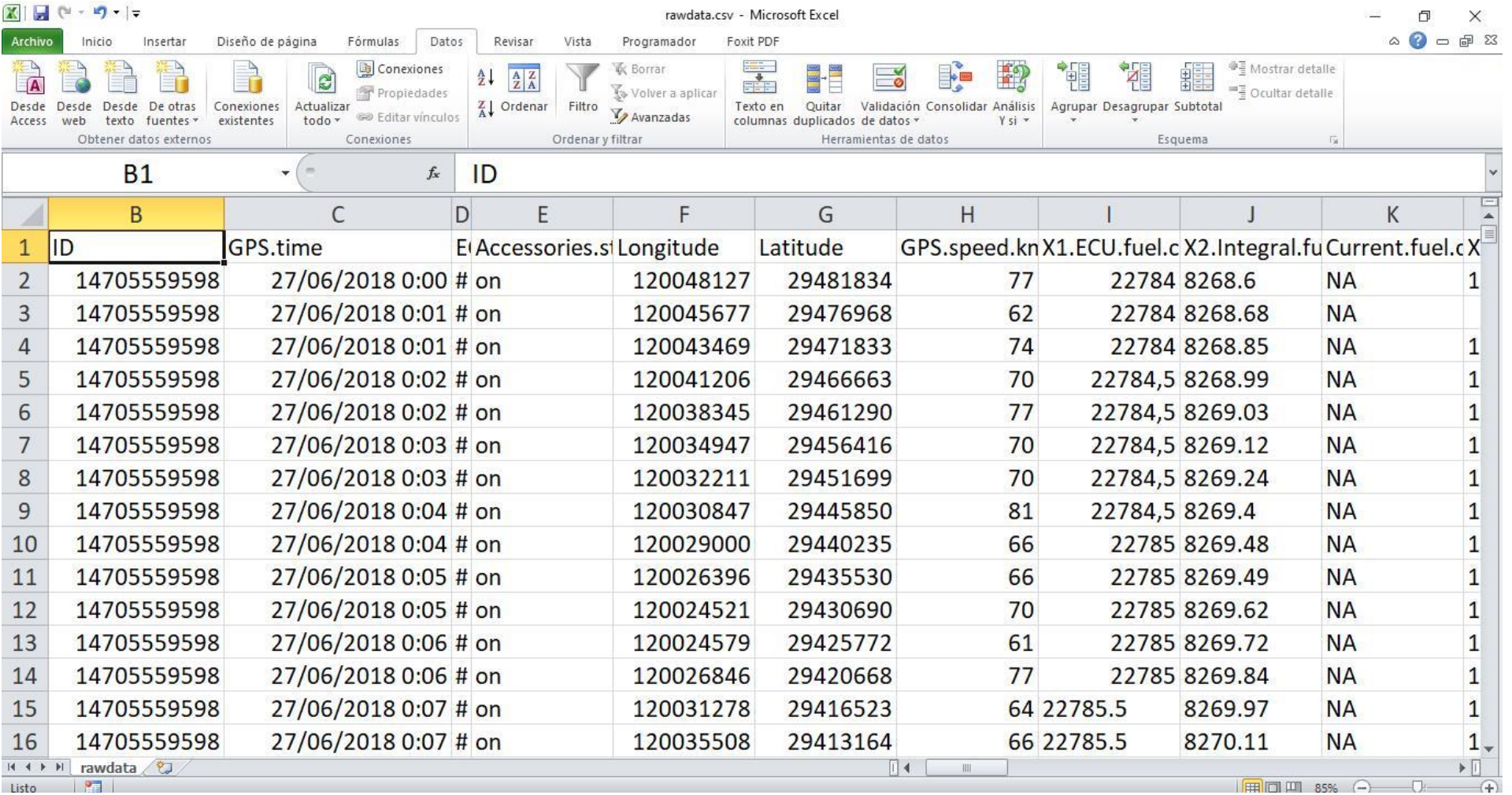
Telematics data: 2020+

MORE DETAILS


WSD
FOOT
OCTO
CE 1909
Super Easy Octo Telematics

2. DATA & METHODS

How do raw telematics data look like?



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2	14705559598	27/06/2018 0:00	#	on	120048127	29481834	77	22784	8268.6	NA	1
3	14705559598	27/06/2018 0:01	#	on	120045677	29476968	62	22784	8268.68	NA	
4	14705559598	27/06/2018 0:01	#	on	120043469	29471833	74	22784	8268.85	NA	1
5	14705559598	27/06/2018 0:02	#	on	120041206	29466663	70	22784,5	8268.99	NA	1
6	14705559598	27/06/2018 0:02	#	on	120038345	29461290	77	22784,5	8269.03	NA	1
7	14705559598	27/06/2018 0:03	#	on	120034947	29456416	70	22784,5	8269.12	NA	1
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13	14705559598	27/06/2018 0:06	#	on	120024579	29425772	61	22785	8269.72	NA	1
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16	14705559598	27/06/2018 0:07	#	on	120035508	29413164	66	22785.5	8270.11	NA	1

Raw data file. Sun et al. (2020)

DATA IN MOTOR INSURANCE, EVERY 30''

What is the problem with the low frequency of claims?

- Telematics data have detailed information:

  Years> Months> Weeks> Days> Hours> Minutes> Seconds

  -- But the **accident event phenomenon is unlikely**.

  1/10 > 1/120 > 1/480 > 1>3655 > 1 / 87720 >1/5263200 > 1 accident every 315 millions of seconds

- Statistical methods for rare events
  - "Excess of zeros"
  - *Corrections for imbalanced classes*: SMOTE
  - Rarity

What is a *near-miss*?

- A **near-miss** is a term borrowed from aviation safety – a situation in which an accident is narrowly avoided, such as when a driver brakes suddenly in order to avoid a crash (Arai et al., 2001).

Near-misses (or incidents) have been shown to be **correlated** with claims in auto insurance

Ma, Y. L., Zhu, X., Hu, X. and Chiu, Y. C. (2018). The use of context-sensitive insurance telematics data in auto insurance ratemaking, ***Transportation Research Part A*** *113, 243–258.*

Guillen et al. (2021) Near-miss telematics in motor insurance. ***Journal of Risk and Insurance*** *https://onlinelibrary.wiley.com/doi/epdf/10.1111/jori.12340*

Examples: near-misses

- **Aceleration:** >6m/s2, (Hynes & Dickey, 2008).
- **Braking:** <-6/s2
- **Dangerous Turns:** speed combined with angle
- **Use of smart phone while driving**

North American Actuarial Journal (2019) we proposed modeling ***near-miss events***

Problem: *(at fault near-misses?)*

Key concept that changes **automobile insurance pricing**

- Frequency and severity of **claims**
- **New approaches** that take into account "**near-miss**" incidents
  - Frequency models :
    - Claims (too rare)
    - Near-misses (difficulty to price them)
    - Claims (with near-misses as inputs)

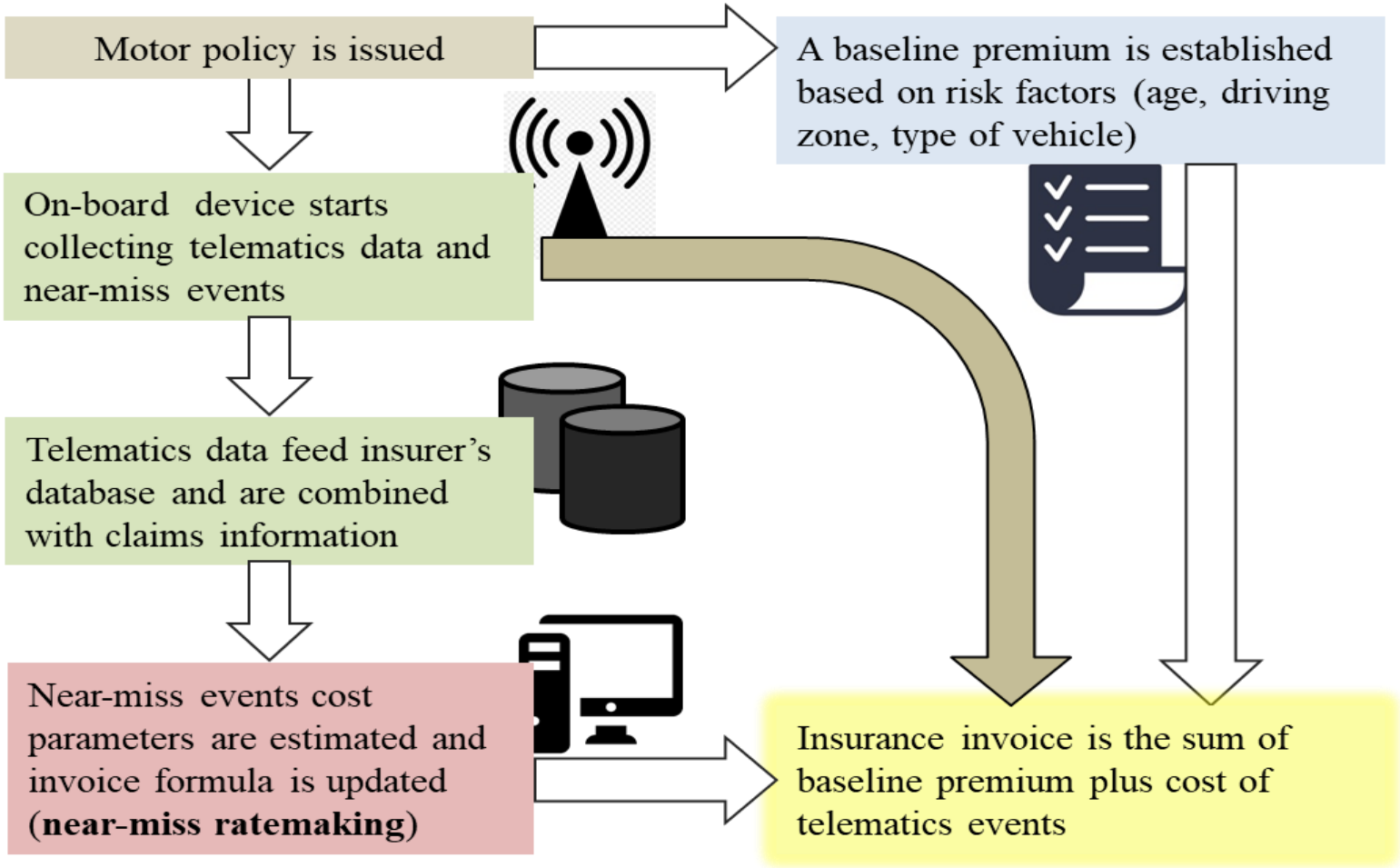
New models *Number of CLAIMS where near-misses are used as risk factors, i.e. new pricing tools*

In **Journal of Risk ans Insurance** (2021) we have proposed using ***near-miss events as covariates for pricing***

- **Aceleration:** >6m/s2
- **Braking:** <-6/s2
- **Use of smart phone while driving**

Near-miss telematics

motor insurance pricing



Notation and Poisson model specification

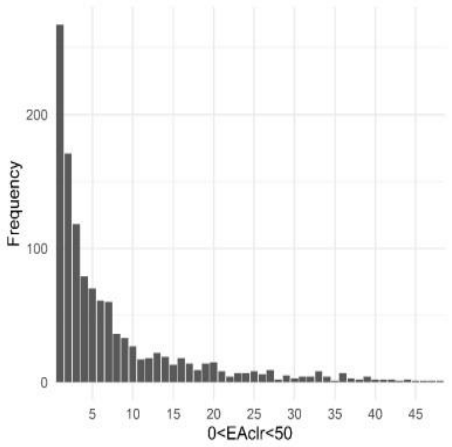
- $\mathrm{Y_i}$ number of claims at fault policy i , $i = 1, \dots, n$
- $\mathrm{T_i}$ risk exposure, offset for policy i
- $\mathrm{x_i}, \mathrm{E_i}$ ratemaking factors (traditional, telematics)

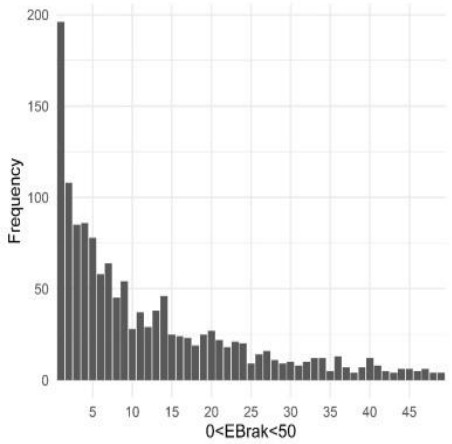
$$\mathrm{E}(\mathrm{Y_i}|\mathrm{x_i}, \mathrm{E_i}) = \mathrm{T_i}\exp(\mathrm{x_i'}\beta + \mathrm{E_i}'\alpha)$$
$$= \mathrm{T_i}\exp(\mathrm{x_i'}\beta)\exp(\mathrm{E_i}'\alpha)$$

3. RESULTS

- SPANISH YEARLY DATA (MAPFRE):
  - Number of claims (what happens when we introduce telematics informaton?) PAYD/PHYD scheme.
  - Distance driven (can we identify factors that affect exposure?)
  - Percentile charts (can we score drivers?)
- CYPRUS DATA (EMERGENT):
  - Near-misses are correlated with Claims
  - Near-miss telematics pricing
- SPANISH TRIP DATA:
  - Finding patterns for near-misses
- CHINESE TICK DATA:
  - Driver's ECG. (New concept simliar to eletrocardiogram)

Near-miss telematics





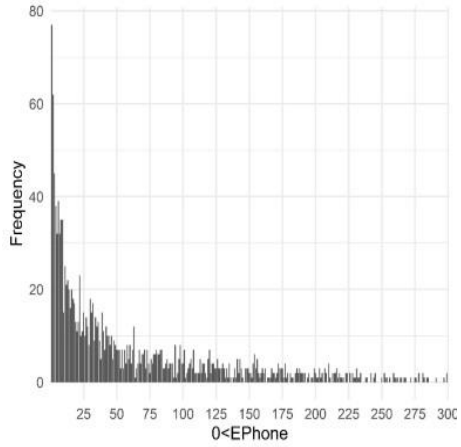


Figure 1, 2 and 3 show the histogram of EBrak, EAclr and EPhone. Due to the large frequency of zeroes we decided to remove them from the graphs, therefore only positive observations are represented. The data present a long right tail, so we also decided to limit the representation up to a maximum value, specifically 50 for EAclr and EBrak, and 300 for EPhone. Note that EAclr has 83.66% of zeroes, and 0.62% are equal or greater than 50. EBrak has 80.91% of zeroes, and 0.82% are equal or greater than 50, and finally EPhone has 79.78% of zeroes and 0.65% are higher than 300.

3. RESULTS

Claims frequency using near-miss events as covariates

Table 3. Parameter estimates of the Poisson model of the weekly rate of at fault claims for the telematics and claims data set

Parameter	Estimate	Standard Error	p-value
Intercept	-8.0637	0.0673	<.0001
EAclr1	-0.0825	0.0265	0.0019
EAclr2	0.3069	0.1277	0.0162
EAclr3	0.0095	0.0390	0.8072
EBrak1	0.0268	0.0086	0.0018
EBrak2	-0.4966	0.0770	<.0001
EBrak3	0.0984	0.0336	0.0034
EPhon	0.0004	0.0002	0.0776
EngineCapacity	0.3644	0.0287	<.0001

The AIC equals 7345.00 and the BIC equals 7407.39. The pseudo-R^2 equals 21.83%.

Claims frequecy using near-miss events as covariates

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3. RESULTS

Near-miss telematics ratemaking

- Basic rate plus additional cost of near misses.

Table 1. Weekly breakdown of a total bill per week. Pure premium in motor insurance as a function of near-miss events for a driver of a car with engine capacity 1,769 cc. Basic weekly rate 1.95 Eur.

Week	Distance driven (km)	Number of near-miss brakes (a)	Number of near-miss accelerations (b)	Minutes of smart phone use (c)	Cost of near-misses (Eur) (d)	Bill per week (Eur) (e)
1	30	0	0	0	0,00	1,95
2	73	0	0	2	0,37	2,32
3	104	2	2	2	6,59	8,54
4	260	6	2	1	9,40	11,35
5	705	19	4	21	27,51	29,46

Total bill for five weeks: 53.61 Eur.
(e)=1.95+(d)
(d)=0.75(a)+2.36(b)+0.18(c)

3. RESULTS

Near-miss telematics ratemaking

- Basic rate with a reward for safe driving and additional charge for near misses.

Table 2. Weekly bill of pure premium in motor insurance as a function of near-miss events for a driver of a car with engine capacity 1,769 cc). Basic weekly rate (6.66 Eur) minus discounts for safe driving, or plus penalizations for near misses.

Week	Distance driven (km)	Number of near-miss brakes (a)	Number of near-miss acceleration (b)	Minutes of smart phone use (c)	Cost of near-misses (Eur) (d)	Total weekly bill (Eur) (e)
1	30	0	0	0	-5.65	1.01
2	73	0	0	2	-5.29	1.37
3	104	2	2	2	0.93	7.59
4	260	6	2	1	9.00	15.66
5	705	19	4	21	54.94	61.60

Total bill for five weeks: 87.23 Eur

(e)=6.66+(d)

(d)=if ((a)>2, 1.5(a), -0.75(1-(a)),)+if ((b)>2, 4.71(b), -2.36(2-(b)))+if ((c)>2, 0.36(c), -0.18(1-(c)))

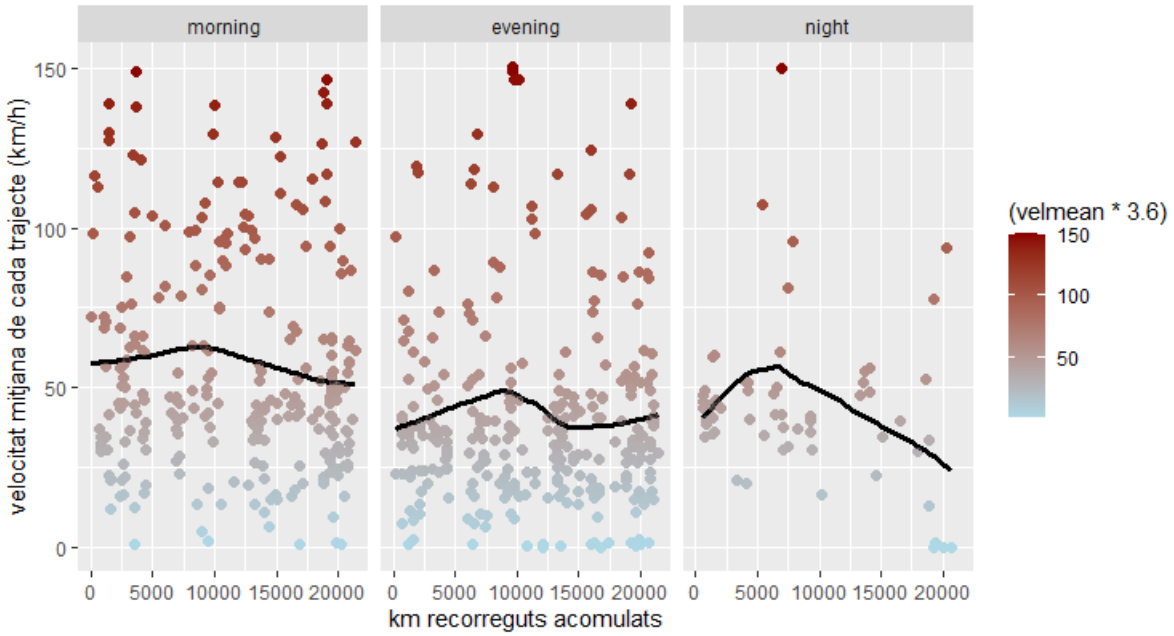
5. RESULTS


HISTORICAL INFORMATON
ON CLAIMS
5. RESULTADS

Empirical exercise with Spanish insurer MAPFRE

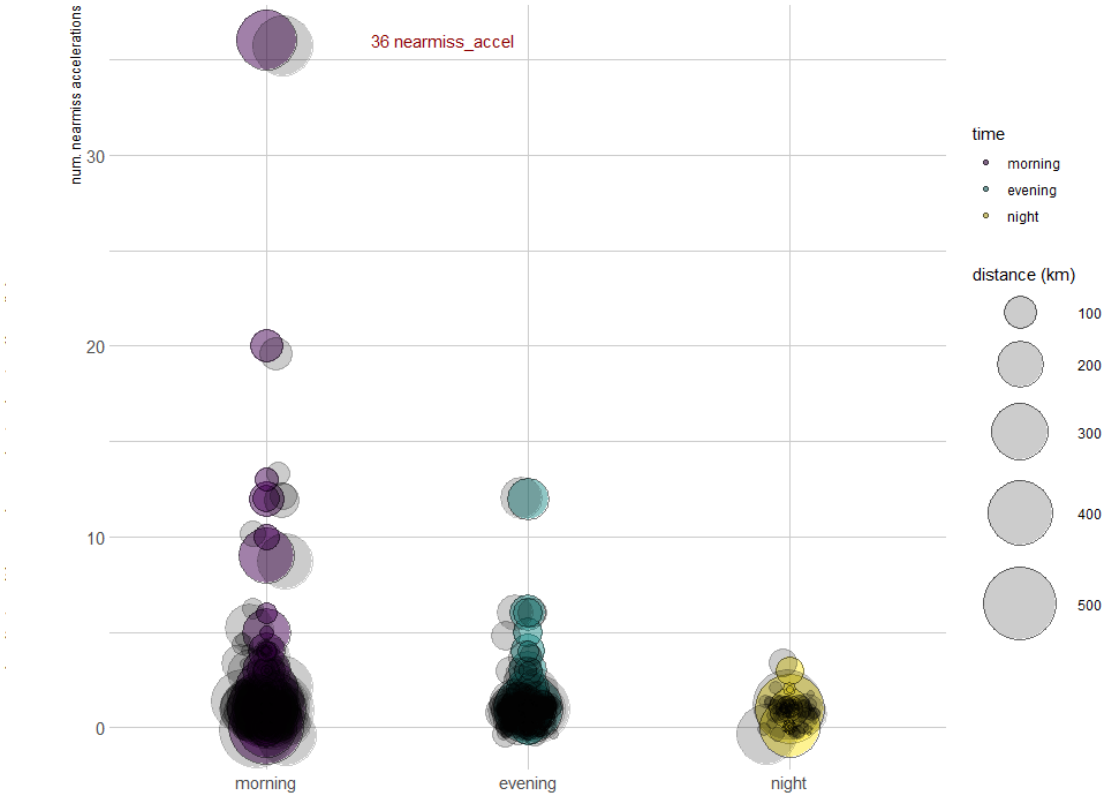
Trip data 2018

Telematics trip data: More information
Average speed



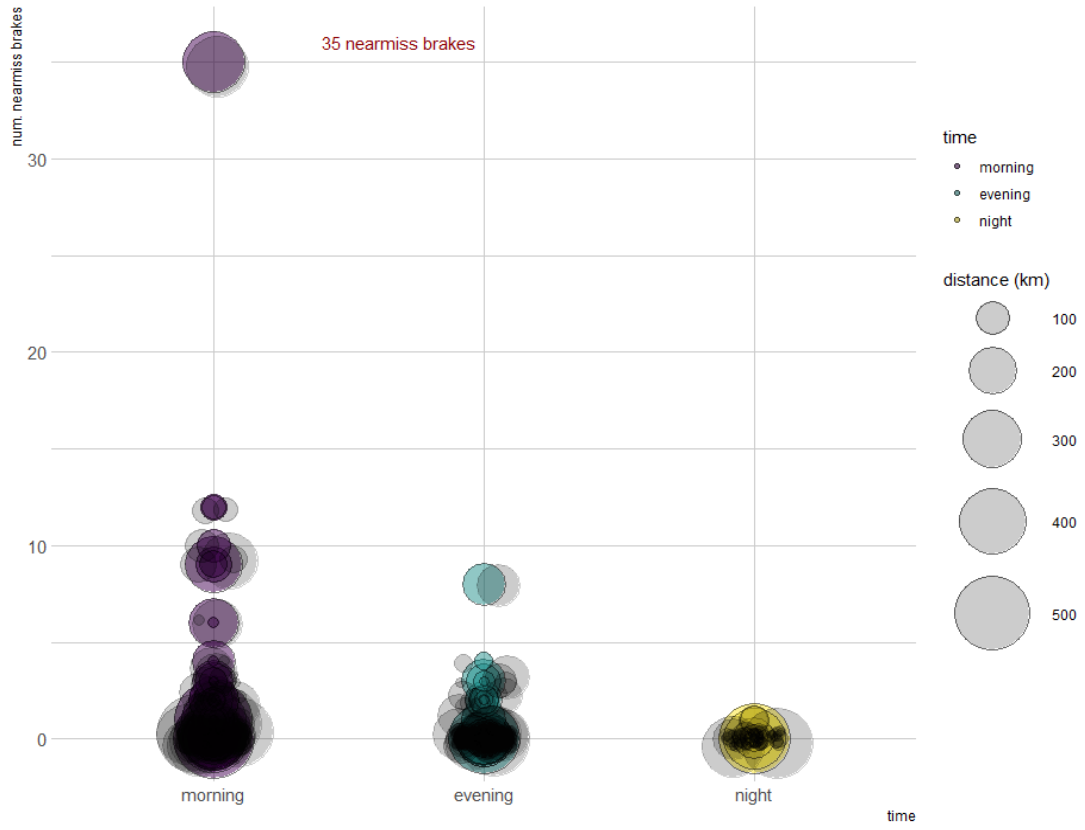
Highest average speeds in the morning (left) According to total km

Telematics data: Acceleration events



Acceleration events (vertical axis) in the morning (left) according to tripdistance (bubble).

Telematics data: Braking events



Braking events (vertical axis) in the morning (left) according to tripdistance (bubble).

4. CONCLUSIONS

Will motor insurance change?

- Consumers
  - Personalization
  - More interaction with insurers
- Manufacturers
  - Vehicles will be equiped with telematics and possibly vehicles provide a service (insurance included)
- Insurers
  - Products are more demanding 24/7.
  - Data analysts are needed. **Preprocessing is crucial.**
  - Communication to mass consumers of complex pricing
  - Prevention and service provision.

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