Telematics and Asymmetric Information in Automobile Insurance

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Impact of private information on contract choice and risk

Adverse selection

- policyholders have private information about their risk type
- riskier policyholders are screened into higher coverage contracts

Moral hazard

- insurance reduces incentive to invest in risk control
- policyholders who purchase more insurance coverage are riskier

Empirical prediction

- positive correlation between insurance coverage and conditional risk

Empirical evidence is mixed

- empirical evidence based on insurance data only
  - Auto: Puelz and Snow (1994), Chiappori and Salanié (2000), Cohen (2005)
  - Health: Cutler and Reber (1998), Cutler and Zeckhauser (1998)
  - Annuity: Finkelstein and Poterba (2004)
- empirical evidence based on insurance data and/or survey data
  - Long-term care: Finkelstein and McGarry (2006)
  - Health: Fang et al. (2008)
- empirical evidence based on insurance data including "unused observables"
  - Annuity: Finkelstein and Poterba (2006)
  - Auto: Saito (2006)

Our contribution

We combine insurance data with telematic data

- that contains detailed private information about driving behavior
- that is not accessible to the insurer
  - "unused observables" might be used by insurance company through different channel than pricing, e.g. cancellation policy
- that provides "hard facts"
  - survey responses might be biased (Hurd et al. 1998, Hurd 1999)

Data set

- driving data from 2340 cars
  - 3.7 Mio data points
  - between Feb. 1st and April 30th 2009
  - each data point includes date, time, GPS-coordinates, direction, speed, distance, ignition status and road type
  - data point is recorded when engine is started, after every two km driven, and then engine is switched off
- 2000 insurance contracts
  - all the information used for pricing the contract
  - Feb. 1st, 2009 and Feb. 1st, 2010

Insurance data set

- Risk: downgrade in bonus-malus class = submission of at least one claim during one year
- Coverage:
  - first-party: none, comprehensive (incl. vandalism, theft, weather), full comprehensive (in addition at-fault collision)
  - liability: €10 million, € 15 million

Driving behavior

We use the following indices of driving behavior:

- **AvgSpeeding:** average speed driven above the legal speed limits

$$\textbf{AvgSpeeding} = \frac{\sum_j \sum_{i \in \Delta_n} (v_{ij} - u_j)}{n}$$

  - j road type, u_j legal speed limit for road type j
  - $i = 1, ..., n$ is data point, v_{ij} is the speed of the car at data point i on road type j
  - $\Delta_n = \{i = 1, \ldots, n | v_{ij} > u_j\}$ set of data points where the speed of the car is above the legal speed limit
- **#Rides:** number of car rides
- **%DistWE:** distance driven on weekends relative to the total distance driven
- **%DistNight:** distance driven at night relative to the total distance driven

Econometric model

- bivariate probit model by Chiappori and Salanié (2000)

$$Coverage = 1(X\beta_1 + \varepsilon > 0)$$
$$Risk = 1(X\gamma_1 + \eta > 0)$$

- bivariate probit model including private information by Finkelstein and Poterba (2006) and Finkelstein and McGarry (2006)

$$Coverage = 1(X\beta_1 + \beta_2 AvgSpeeding + \beta_3 \#Rides + \beta_4 \%DistWE + \beta_5 \%DistNight + \varepsilon > 0)$$
$$Risk = 1(X\gamma_1 + \gamma_2 AvgSpeeding + \gamma_3 \#Rides + \gamma_4 \%DistWE + \gamma_5 \%DistNight + \eta > 0)$$

Liability insurance

		w/o telematic data	including telematic data
ρ		-0.017 (0.7771)	-0.007 (0.9036)
AvgSpeeding	Liability Coverage Risk		-0.0107* 0.0031
#Rides	Liability Coverage Risk		-0.0002* 0.0002***
%DistWE	Liability Coverage Risk		0.0219 0.0829*
%DistNight	Liability Coverage Risk		0.0496 -0.2268*

Liability insurance

- no statistically significant correlation of the error terms BUT private information does matter for contract choice and risk
- not consistent with asymmetric information about risk type
- could be explained by hidden degree of risk aversion (de Meza and Webb, 2001)
  - policyholders who are more risk averse purchase more liability insurance, speed on average less, and undertake fewer car rides

First-party insurance

		w/o telematic data	including telematic data
ρ		0.069 (0.3000)	0.0606 (0.3775)
AvgSpeeding	First-Party Coverage Risk		0.0054 0.0031
#Rides	First-Party Coverage Risk		0.0003** 0.0002***
%DistWE	Liability Coverage Risk		-0.1318 0.0835*
%DistNight	Liability Coverage Risk		-0.0189 -0.2273*

First-party insurance

- no statistically significant correlation of the error terms BUT private information does matter for contract choice and risk
- result is consistent with asymmetric information about risk type
  - policyholders who undertake more car rides both purchase more first-party coverage and are more likely to submit a claim

First-party insurance

		w/o telematic data		including telematic data	
liability coverage		0	1	0	1
ρ		0.011	0.27*	-0.006	0.275*
		(0.883)	(0.054)	(0.938)	(0.086)
AvgSpeed	First-Party Coverage			0.0137	-0.0117
	Risk			0.0041	-0.0001
#Rides	First-Party Coverage			0.0003**	0.0002
	Risk			0.0002**	0.0002**
%DistWE	First-Party Coverage			-0.2149	-0.1138
	Risk			-0.0026	0.1768***
%DistNight	First-PartyCoverage			0.3579	-0.6253**
	Risk			-0.1986	-0.3274

First-party insurance

- splitting the data set according to the level of liability coverage reveals that correlation of error terms between the level of first-party insurance and risk is significantly positive for subset of policyholders who purchase more liability insurance
  - consistent with asymmetric information about risk type

Conclusion

- private information is relevant for contract choice and conditional risk
  - number of car rides positively related to level of first-party coverage, but negatively related to level of liability coverage
  - average speeding above speed limits is negatively related to level of level of liability coverage
  - number of car rides, distance driven on weekend or at night are positively related to likelihood of submitting a claim
- no significant correlation between level of insurance coverage and risk
  - exception: positive correlation between first-party coverage and risk among policyholders with high liability coverage

Conclusion

- asymmetric information is not solely based on risk characteristics
  - results suggest that heterogeneity of hidden risk aversion is relevant
- opposite results for first-party and for liability coverage suggest counteracting effects depending on
  - size of the potential loss
  - potential harm to others