Valuation in the Life Settlements Market

New Empirical Evidence

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Western Risk and Insurance Association 2018 Annual Meeting





Agenda

1. Motivation of the study
2. Methodology
3. Empirical analysis
4. Interpretations of the findings

Motivation of the study

The study is conducted to fulfill multiple objectives

The research objectives listed below are tightly connected and not mutually exclusive:

To comply with regulations

Several regulations require assets to be held at fair value

- International Financial Reporting Standards (IFRS) 13
- Alternative Investment Fund managers Directive (AIFMD)

To provide guidance for life settlement bidders

The two-variable model developed in the study can be used as a valuation rule of thumb.

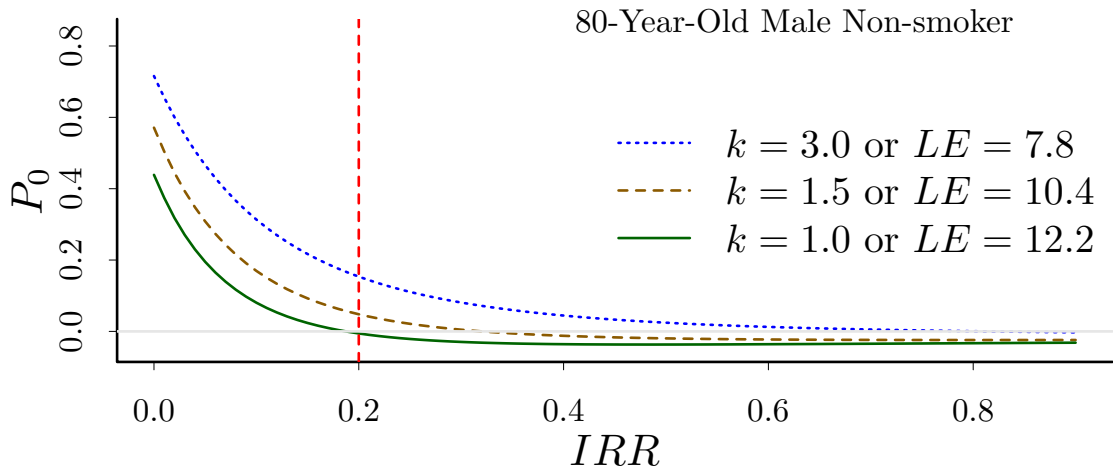
To raise the awareness of the importance of LE accuracy

LE is the driver of life settlement valuation.

Motivation of the study

Life expectancy is the key driver of price — theoretical evidence

Simulated $P_0 - IRR - k$-relationship



k, or its natural logarithm $\ln k$, is used to indicate underwriting aggressiveness, throughout the study

$P_0 = -\sum_{i=0}^{\infty} \frac{\pi_i Prob_i}{IRR^i} + \sum_{i=1}^{\infty} \frac{1-Prob_i}{IRR^i}$, where

$P_0 = \frac{TP}{DB}$: transaction price (TP) as a fraction of death benefit (DB)
k: implied mortality multiplier (VBT 2015) LE: life expectancy (in years)
$Prob_i$: Survival probability at time i π_i: premium rate (to DB) at time i

k up $\rightarrow$ $Prob_i$ down & LE down & P_0 up

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Methodology

Dependent variables

Two variables to proxy valuation:

- $\frac{TP}{DB}$: Price multiplier; Transaction price TP as a fraction of death benefit DB
  - "We bought the policy at 20 cents on the dollar"
  - cash-flow-based
  - more direct, less comparable
- RP: Risk premium; internal rate of return IRR in excess of risk-free rate r
  - "This policy was sold at 20%"
  - return-based
  - less direct, more comparable

Relation of the two:

$$\frac{TP}{DB} = f(RP) = \sum_{i=0}^{\infty} \frac{C_i}{(1 + RP + r)^i},$$

Methodology

Independent variables

Log-linear best describes LE-$\frac{TP}{DB}$ relationship:

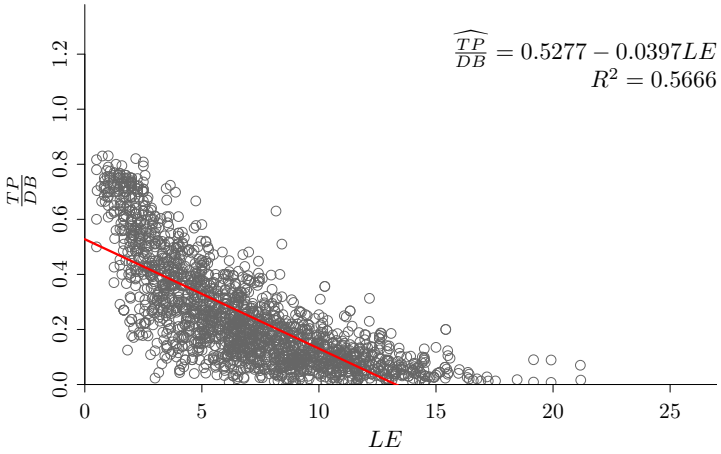


Figure: Linear

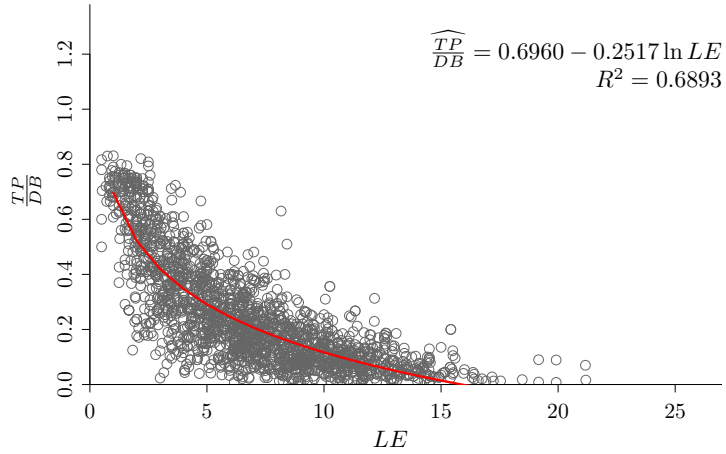


Figure: Log-linear

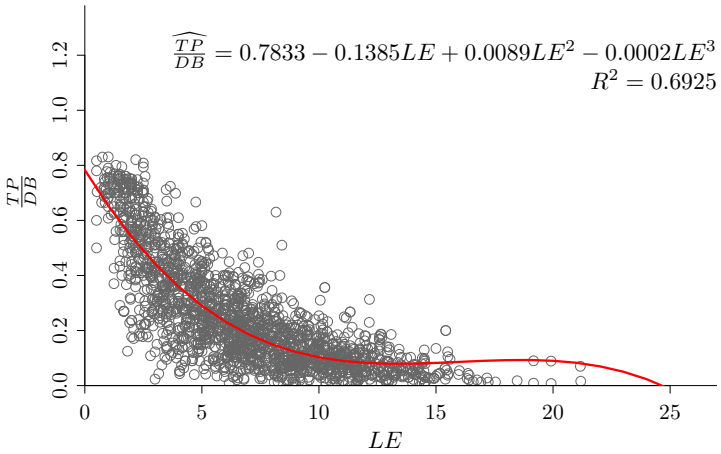


Figure: Polynomial

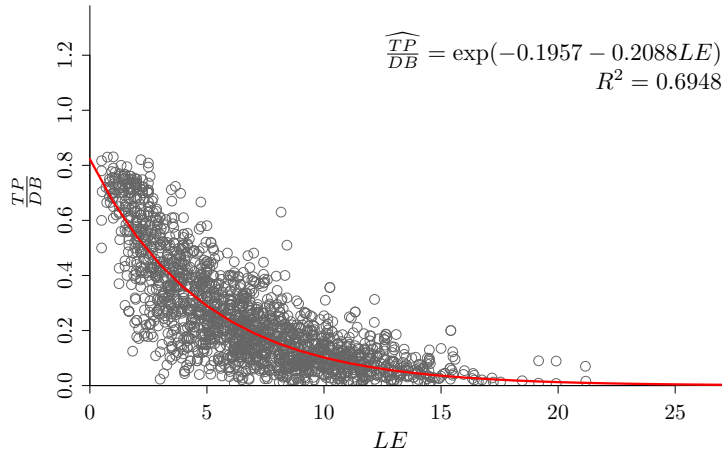


Figure: Exponential

Risk proxies I

Independent variables

Variables that affect both valuation proxies: risk
— risk up → $\frac{TP}{DB}$ down; RP up

Longevity risk

Stemming from inaccurate (or most likely too short) LE estimates

- $\ln LE$ — Natural logarithm of life expectancy
- $\ln DB$ — Natural logarithm of death benefit
- DI — Difference in LE estimates
- MK — Market
- NO — Number of LE estimates
- AG — Insured's age
- CO — Premium convexity

Risk proxies II

Independent variables

Premium risk

Pertaining to an increase in premiums of an in-force policy

- $\frac{PM}{DB}$ — Sum of expected premiums as a fraction of death benefit

Default risk

Linked to the uncertainty in insurers' ability to honor claims should financial distress occur

- RT — Credit rating

Rescission risk

Associated with insurance carriers' refusal to pay the death benefit due to a lack of insurable interest or other fraudulent behavior at issue

- VI — Vintage

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Descriptive statistics

Full sample divided into in-sample and out-of-sample data

	n	Min	Median	Max	μ	σ	γ	κ
Full sample (01/07/2011 – 12/31/2016)								
TP (kUSD)	2,863	0.30	178.03	16,191.00	368.11	739.69	10.20	169.59
PM (kUSD)	2,863	0.00	205.73	11,276.32	511.48	813.93	3.80	24.03
CS (kUSD)	2,838	-164.70	0.00	1,617.16	23.59	88.54	8.28	96.09
DB (kUSD)	2,863	20.00	1,000.00	30,000.00	1,832.78	2,583.92	3.67	20.90
LE (year)	2,863	0.43	6.26	28.50	6.64	3.76	0.72	0.52
AG (year)	2,863	20.22	80.31	97.80	77.89	11.32	-1.16	1.42
VI (year)	2,698	1.14	10.34	36.92	11.99	7.07	0.81	0.05
k (—)	2,863	0.39	3.31	4,625.67	67.92	273.45	8.18	92.53
RP (%)	2,863	-1.95	16.60	247.48	21.89	21.59	5.16	37.35
$\frac{TP}{DB}$ (%)	2,863	0.25	20.84	85.38	26.87	20.66	0.89	-0.22
$\frac{PM}{DB}$ (%)	2,863	0.00	26.62	96.50	26.35	17.28	0.33	-0.23
$\frac{CS}{DB}$ (%)	2,838	-4.02	0.00	44.42	1.64	4.15	4.06	20.47

In-sample (01/07/2011 – 10/14/2015): 2/3 of full sample for model training

Out-of-sample (10/14/2015 – 12/31/2016): 1/3 of full sample for backtesting

Statistical similarity between the in-sample and the out-of-sample data legitimizes modelling policy values empirically

Regression modelling

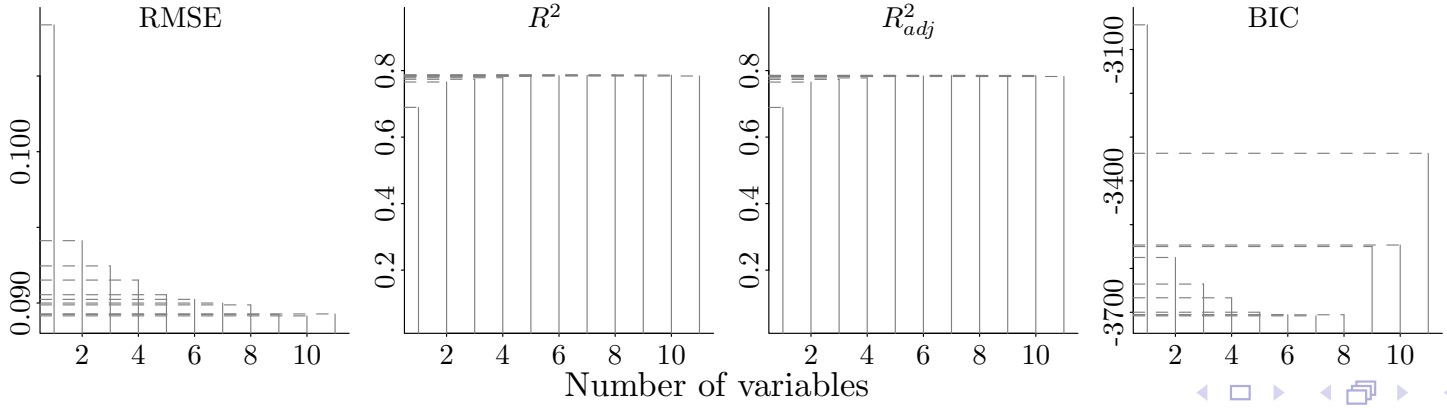
A two-variable linear model is most efficient for $\frac{TP}{DB}$

Standardized coefficient

Number of variables	c	$\ln LE$	$\ln DB$	$\frac{PM}{DB}$	DI	RT	MK	PT	NO	AG	VI	CO	df	RMSE	R^2	R^2_{adj}	BIC
11	***	-0.67 ***	-0.10 ***	-0.30 ***	-0.05 ***	0.04 **	0.08 ***	0.02	0.03 *	-0.09 ***	0.00	-0.02 *	1,710	0.089	0.784	0.782	-3,337
10	***	-0.68 ***	-0.09 ***	-0.29 ***	-0.05 ***	0.03 **	0.07 ***	0.03 *	0.03 *	-0.10 ***		-0.02	1,810	0.089	0.786	0.785	-3,546
9	***	-0.67 ***	-0.09 ***	-0.29 ***	-0.05 ***	0.03 **	0.08 ***		0.03 *	-0.09 ***		-0.02	1,811	0.089	0.786	0.785	-3,550
8	***	-0.67 ***	-0.09 ***	-0.29 ***	-0.05 ***	0.04 ***	0.08 ***		0.03 *	-0.09 ***			1,900	0.090	0.786	0.785	-3,706
7	***	-0.67 ***	-0.08 ***	-0.29 ***	-0.04 **	0.04 ***	0.08 ***			-0.08 ***			1,901	0.090	0.786	0.785	-3,708
6	***	-0.68 ***	-0.08 ***	-0.29 ***		0.04 ***	0.08 ***			-0.08 ***			1,902	0.090	0.785	0.784	-3,705
5	***	-0.68 ***	-0.08 ***	-0.29 ***			0.08 ***			-0.08 ***			1,903	0.091	0.783	0.783	-3,700
4	***	-0.66 ***	-0.09 ***	-0.32 ***			0.07 ***						1,904	0.092	0.778	0.778	-3,667
3	***	-0.66 ***	-0.09 ***	-0.31 ***									1,905	0.092	0.774	0.774	-3,636
2	***	-0.69 ***		-0.31 ***									1,906	0.094	0.766	0.765	-3,575
1	***	-0.83 ***											1,907	0.108	0.689	0.689	-3,044

Model selected:

$$\widehat{\frac{TP}{DB}} = 1.237 - 0.209 \ln LE - 0.356 \frac{PM}{DB}$$



Regression modelling

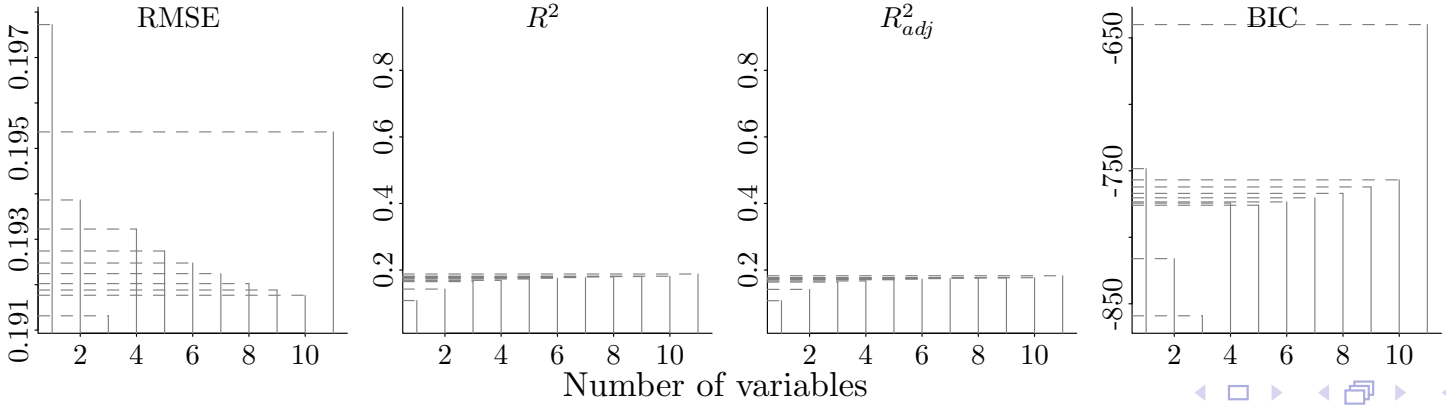
A three-variable linear model is most efficient for *RP*

Standardized coefficient

Number of variables	c	$\ln LE$	$\ln DB$	$\frac{PM}{DB}$	DI	RT	MK	PT	NO	AG	VI	CO	df	RMSE	R^2	R^2_{adj}	BIC
11	**	-0.28 ***	0.19 ***	-0.21 ***	0.06 *	-0.03	-0.04	-0.04	-0.09 ***	0.06 *	0.00	0.09 ***	1,710	0.195	0.188	0.183	-640
10		-0.27 ***	0.17 ***	-0.21 ***	0.06 *	-0.03	-0.04	-0.05	-0.09 ***	0.07 **		0.07 ***	1,810	0.192	0.181	0.177	-757
9		-0.27 ***	0.17 ***	-0.21 ***	0.06 *		-0.04	-0.05	-0.09 ***	0.07 **		0.07 ***	1,811	0.192	0.180	0.176	-762
8		-0.27 ***	0.18 ***	-0.22 ***	0.06 *			-0.05 *	-0.10 ***	0.07 **		0.07 ***	1,812	0.192	0.179	0.176	-767
7		-0.28 ***	0.17 ***	-0.22 ***	0.06 *				-0.11 ***	0.05 *		0.07 ***	1,813	0.192	0.177	0.174	-770
6		-0.29 ***	0.18 ***	-0.19 ***	0.06 *				-0.09 ***			0.07 **	1,814	0.192	0.175	0.173	-773
5		-0.28 ***	0.18 ***	-0.20 ***					-0.07 **			0.07 **	1,815	0.193	0.173	0.171	-776
4		-0.28 ***	0.16 ***	-0.21 ***								0.07 **	1,816	0.193	0.169	0.167	-774
3	***	-0.28 ***	0.16 ***	-0.20 ***									1,905	0.191	0.165	0.164	-859
2	***	-0.24 ***		-0.21 ***									1,906	0.194	0.143	0.142	-816
1	***	-0.33 ***											1,907	0.198	0.108	0.108	-748

Model selected:

$$\widehat{RP} = 0.295 - 0.092 \ln LE + 0.027 \ln DB - 0.253 \frac{PM}{DB}$$



Model performance

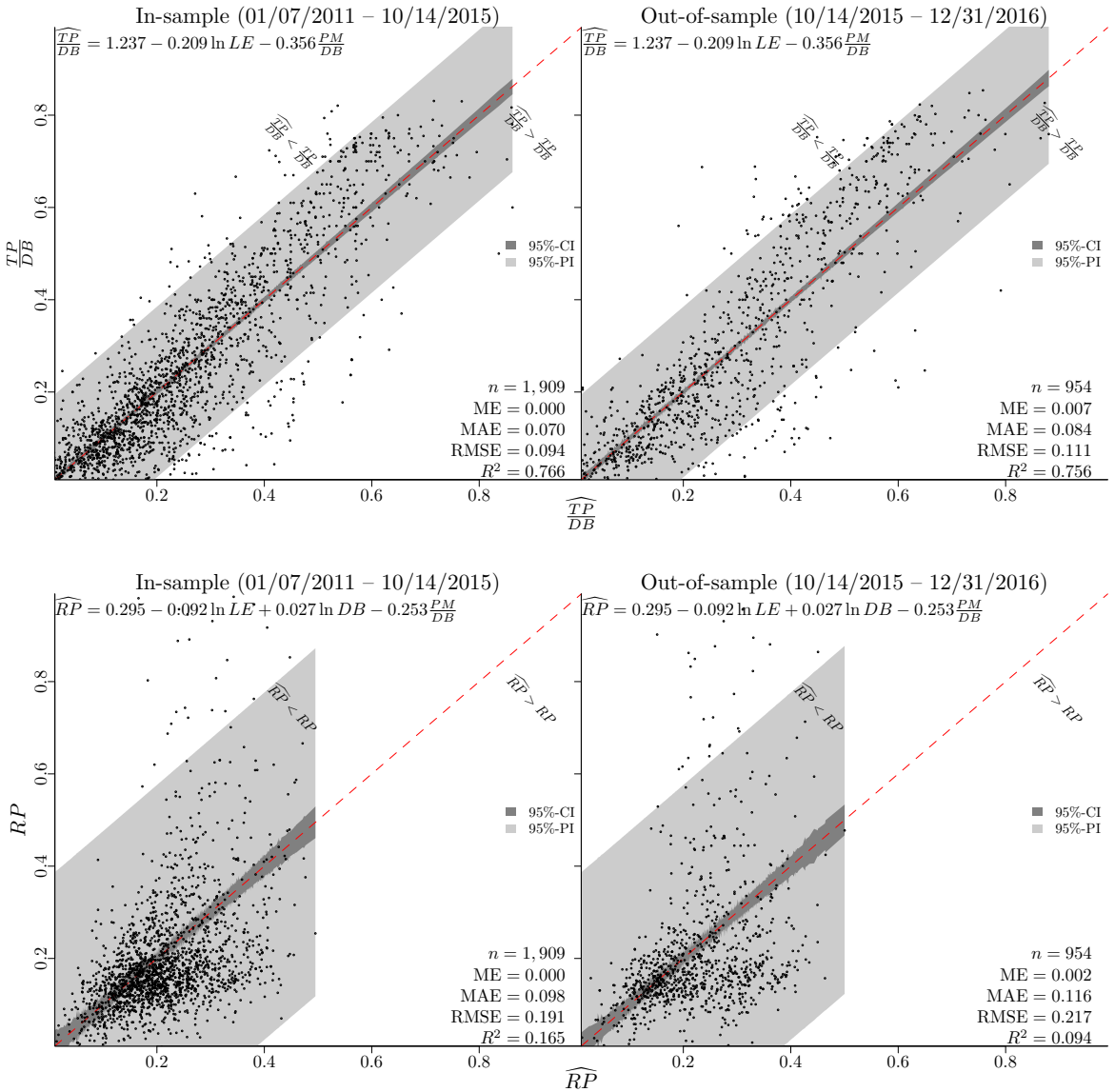
$\frac{TP}{DB}$ well modelled, RP not

$\widehat{\frac{TP}{DB}}$ estimated with regression result for $\frac{TP}{DB}$

good performance in in-sample estimation & out-of sample prediction

$\widehat{RP}$ estimated with regression result for RP

poor performance in in-sample estimation & out-of sample prediction



Model performance

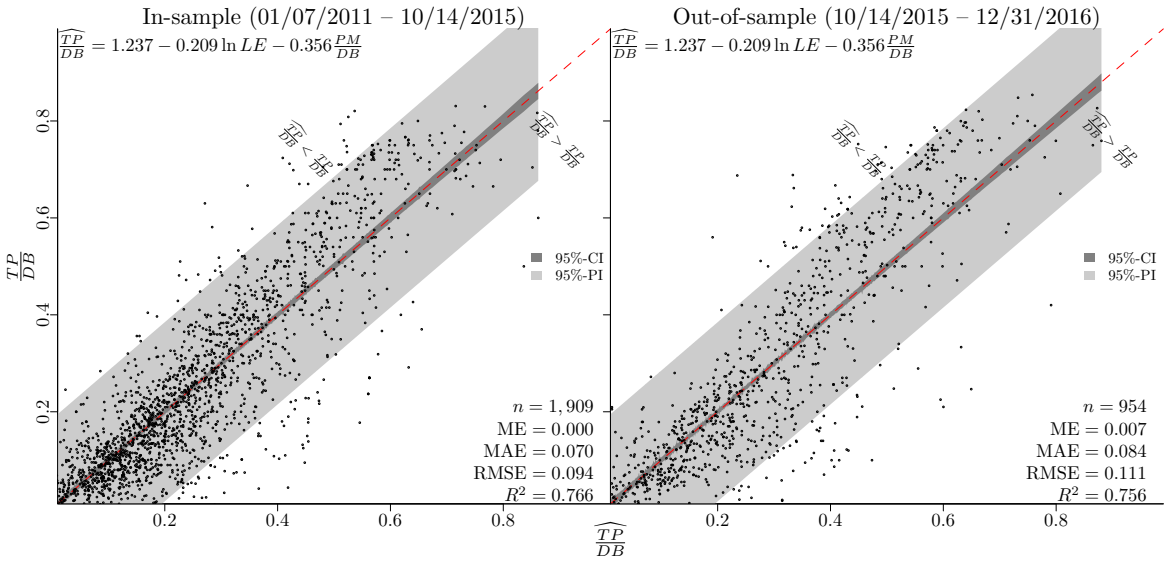
More efficient and effective to model $\frac{TP}{DB}$ directly

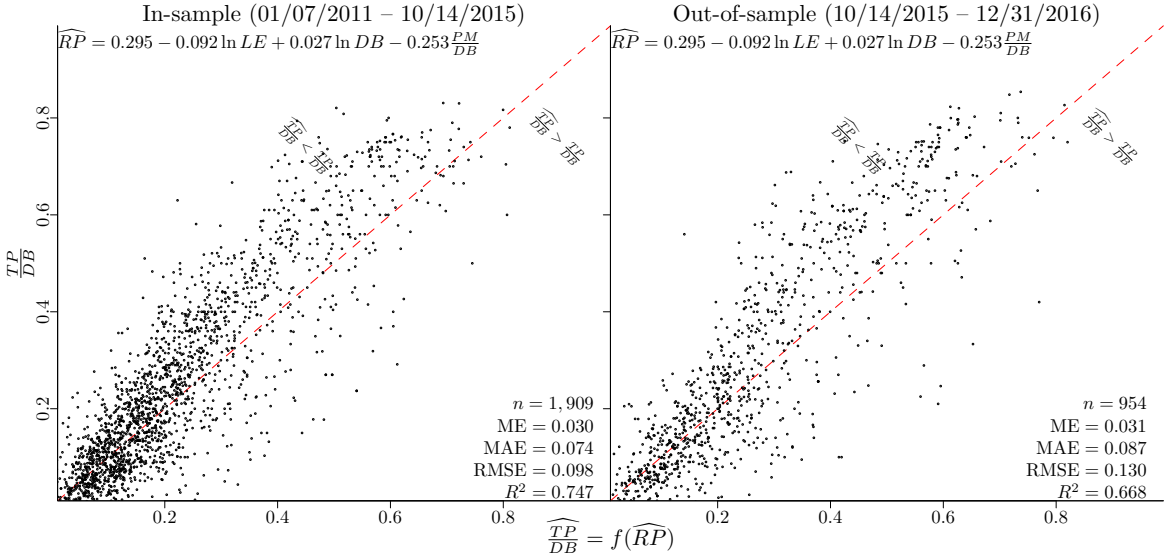
$\widehat{\frac{TP}{DB}}$ estimated with regression result for $\frac{TP}{DB}$

good performance in in-sample estimation & out-of sample prediction

$\widehat{\frac{TP}{DB}} = f(\widehat{RP})$, $\widehat{RP}$ estimated with regression result for RP

worse performance in in-sample estimation & out-of sample prediction





Model performance

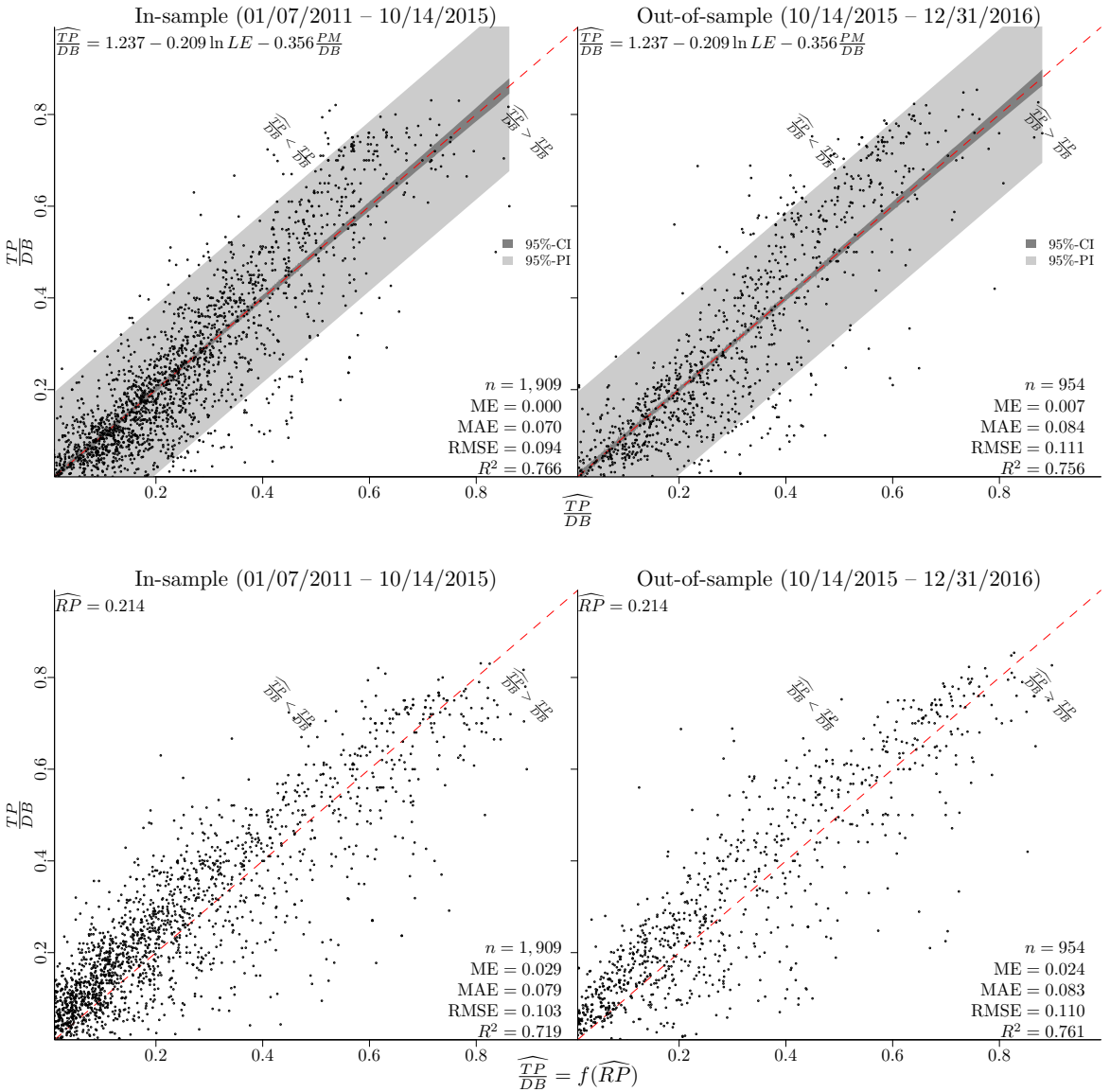
$\frac{TP}{DB}$ can be well described simply through LE and premiums

$\widehat{\frac{TP}{DB}}$ estimated with regression result for $\frac{TP}{DB}$

good performance in in-sample estimation & out-of sample prediction

$\widehat{\frac{TP}{DB}} = f(\widehat{RP}) = f(0.214)$, 0.214 as mean RP from in-sample data

worse performance in in-sample estimation, better in out-of sample prediction



Robustness test

Robustness test of different policy types

Policy type	Universal life			Term life			Whole life		
	Coeff.	p	sig.	Coeff.	p	sig.	Coeff.	p	sig.
c	1.20	0.000	***	1.23	0.000	***	1.44	0.000	***
$\ln LE$	-0.20	0.000	***	-0.19	0.000	***	-0.24	0.000	***
$\frac{PM}{DB}$	-0.34	0.000	***	-0.53	0.001	***	-0.87	0.001	***
BP test	192.100	0.000	***	0.419	0.811		1.477	0.478	
Performance	In-s.	Out-of-s.		In-s.	Out-of-s.		In-s.	Out-of-s.	
n	1,645	762		72	89		23	25	
ME	0.000	0.001		0.000	0.012		0.000	0.010	
MAE	0.066	0.078		0.080	0.103		0.080	0.130	
RMSE	0.090	0.104		0.097	0.129		0.098	0.190	
R^2	0.716	0.714		0.737	0.646		0.803	0.366	

Disregarding policy type "Whole life" which contains very few observations, the model stays robust.

Robustness test

Robustness test of different rating classes

Rating	A-rated			B-rated			No rating		
	Coeff.	p	sig.	Coeff.	p	sig.	Coeff.	p	sig.
c	1.24	0.000	***	1.02	0.000	***	1.25	0.000	***
$\ln LE$	-0.21	0.000	***	-0.17	0.000	***	-0.23	0.000	***
$\frac{PM}{DB}$	-0.36	0.000	***	-0.34	0.007	**	-0.05	0.803	
BP test	166.645	0.000	***	5.075	0.079		1.787	0.409	
Performance	In-s.	Out-of-s.		In-s.	Out-of-s.		In-s.	Out-of-s.	
n	1,865	895		31	34		13	25	
ME	0.000	0.009		0.000	0.046		0.000	-0.050	
MAE	0.069	0.084		0.079	0.095		0.060	0.124	
RMSE	0.094	0.110		0.099	0.119		0.075	0.146	
R^2	0.767	0.760		0.669	0.762		0.858	0.496	

Disregarding rating class "No rating" which contains very few observations, the model stays robust.

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Interpretations of the findings

Why *RP* can hardly be modelled

- Risk behavior:
  - policy purchases do not reflect a significant level of risk-aversion

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- Risk behavior:
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- Risk premium proxy:
  - applied vs. implied risk premiums

Interpretations of the findings

Why *RP* can hardly be modelled

- Risk behavior:
  - policy purchases do not reflect a significant level of risk-aversion

- Risk premium proxy:
  - applied vs. implied risk premiums

- inherent property of IRR:
  - non-injectivity on return to price (multiroot)
  - decresing elasticity of price on return

Thank you!

Contact

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