Universität St.Gallen

Life Settlement Pricing
An Econometric Approach

Prof. Dr. Alexander Braun

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Introduction

Background

- IRFS 13 and AIFMD are in force since 2014 and demand that assets are held at fair value
- Empirical study in 2014 reveals differences between market prices and fund valuations
- Some misconceptions seem to persist in the life settlement industry:
  - A standardized model cannot capture the unique character of each policy
  - Due to unobservable inputs, model parameter values need to be chosen arbitrarily

Motivation for this research

- Need for a reliable pricing approach that can also facilitate fund portfolio valuations
- Is it possible to employ market data in order to identify "unusual" valuations?

AA-Partners transaction data

Multi-provider dataset

- The transaction data was collected by AA-Partners Ltd. from multiple providers
- Secondary and tertiary market transactions on a monthly basis
- Prices and important deal characteristics (e.g., life expectancy, face amount, etc.)
- The following life settlement providers were transparent at the end of November 2014:

  Abacus Settlements, Berkshire Settlements, Habersham Funding, Institutional Life Services, Legacy Benefits, Life Equity, The Lifeline Program, Life Settlement Solutions, LifeTrust LLC, Magna Life Settlements/Vida Capital, Q Capital Strategies, RiverRock Partners and Settlement Group (GWG Life left the data collection in August 2011)

- In addition, Carlisle and SL Investment Management Ltd. provide transaction data

What factors affect the transaction price in percent of face value?

Hypotheses

- H_1: The shorter the life expectancy (LE) of the insured, the higher the transaction price
- H_2: The higher the cash surrender value of the policy, the higher the transaction price
- H_3: The higher the sum of projected premiums, the lower the transaction price
- H_4: The prices for tertiary market deals are lower than those for secondary market deals
- H_5: Universal life policies sell at higher prices than other contract types
- H_6: Premium-financed policies sell at lower prices
- H_7: The transaction price is lower if the insurer exhibits a high yield rating
- H_8: Life settlement prices decrease for increasing treasury yields

How can we test these determinants?

Data and methodology

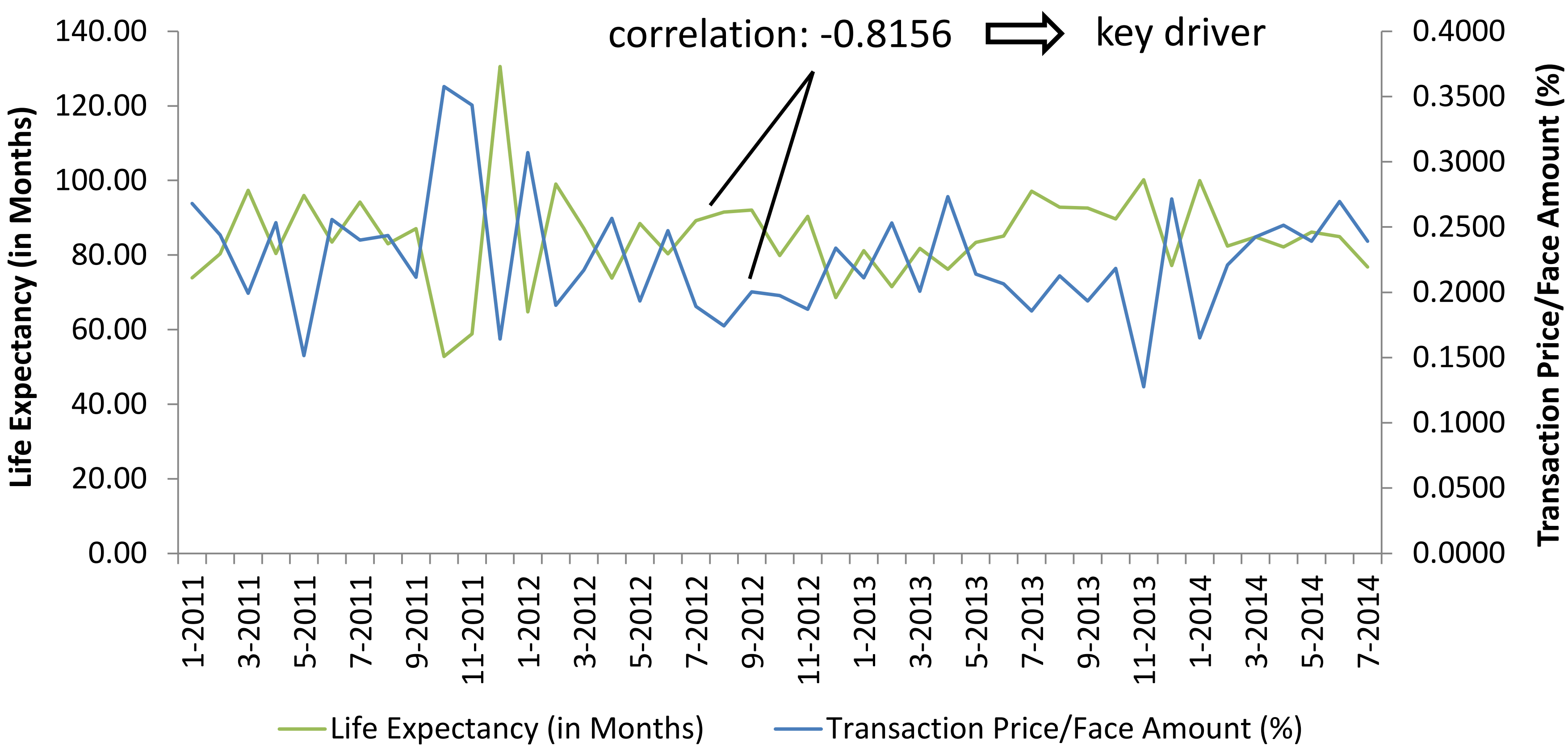
- Methodology: cross-sectional OLS regressions (unit: individual transactions)
- Dataset: 1358 life settlement transactions that occurred between 01/2011 and 11/2014
- Split sample: for in-sample (897 trades) and out-of-sample (461 trades) analysis
- Outliers: elimination of 87 cases by means of externally studentized residuals/Cook's D

Proceeding

- Test all factors, then remove those which are statistically and substantively insignificant
- Standard errors: based on Newey-West HAC covariance matrix

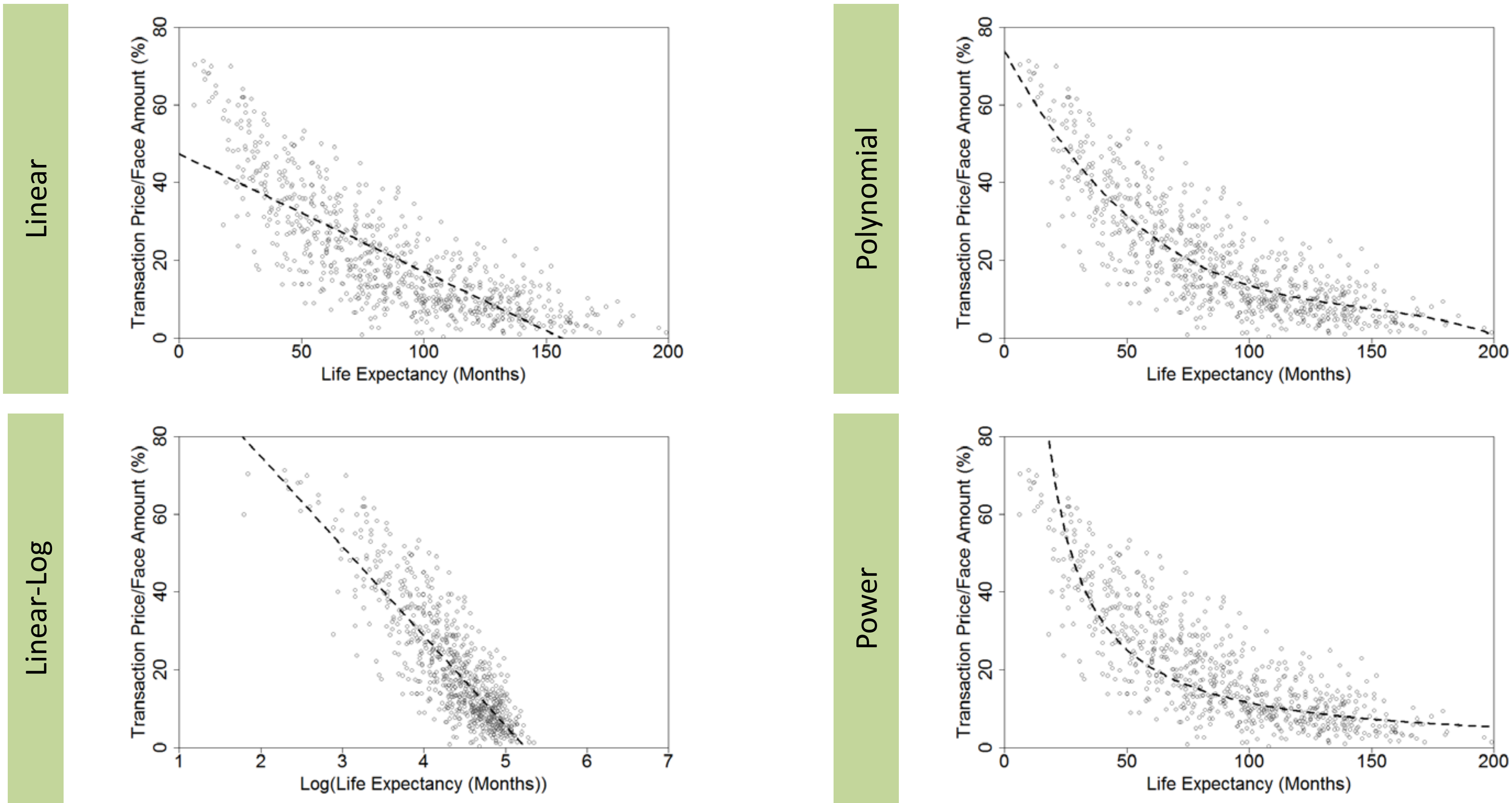
The LE of the insured is highly negatively correlated with prices

Time series of monthly averages



What is an adequate functional relationship between price and LE?

A graphical illustration



The polynomial and linear-log functions provide a good fit

Estimation results

Linear model $P_i = \alpha + \beta \, \mathrm{LE}_i + \epsilon_i$

Polynomial model $P_i = \alpha + \beta \, \mathrm{LE}_i + \gamma \, \mathrm{LE}_i{}^2 + \delta \, \mathrm{LE}_i{}^3 + \epsilon_i$

Power model $P_i = \alpha \, \mathrm{LE}_i{}^{\beta} + \epsilon_i$

Linear-log model $P_i = \alpha + \beta \ln(\mathrm{LE}_i) + \epsilon_i$

	Linear			Polynomial			Power			Linear-Log		
	coeff.	p-val.	sig.	coeff.	p-val.	sig.	coeff.	p-val.	sig.	coeff.	p-val.	sig.
α	0.4733	0.0000	***	0.7385	0.0000	***	20.4252	0.0000	***	1.2088	0.0000	***
β	-0.0030	0.0000	***	-0.0118	0.0000	***	-1.1239	0.0000	***	-0.2304	0.0000	***
γ				0.0001	0.0000	***						
δ				0.0000	0.0000	***						
df	808.00			806.00			808.00			808.00		
SEE	0.09			0.08			0.15			0.08		
Adj. R^2	0.62			0.72			0.56			0.72		
White's Test	104.57	0.0000	***	71.15	0.0000	***	4.23	0.1204		77.62	0.0000	***
BP Test	104.57	0.0000	***	89.65	0.0000	***	4.23	0.0396	**	77.62	0.0000	***

Notes: Standard errors based on Newey-West Heteroskedasticity- and Autocorrelation-Consistent (HAC) Covariance Matrix
Significance levels: ****=0.01, **=0.05, *=0.10*

What happens if we add other potential drivers of the price?

Full model

$$P_i = \alpha + \beta_{\mathrm{LE1}}\mathrm{LE}_i + \beta_{\mathrm{LE2}}\mathrm{LE}_i{}^2 + \beta_{\mathrm{LE3}}\mathrm{LE}_i{}^3$$

$$+ \beta_{\mathrm{CSV}}\mathrm{CSV}_i + \beta_{\mathrm{PREM}}\mathrm{PREM}_i + \beta_{\mathrm{TERT}}\mathrm{TERT}_i + \beta_{\mathrm{UL}}\mathrm{UL}_i + \beta_{\mathrm{PREFIN}}\mathrm{PREFIN}_i + \beta_{\mathrm{HY}}\mathrm{HY}_i + \beta_{\mathrm{USTY}}\mathrm{USTY}_i + \epsilon_i$$

- P_i: transaction price / face value (in percentage points)
- LE_i: life expectancy (in months)
- CSV_i: cash surrender value (in USD million)
- PREM_i: sum of projected premium payments (in USD million)
- TERT_i: dummy variable that equals one for tertiary market transactions and zero otherwise
- UL_i: dummy variable that equals one for universal life policies and zero otherwise
- PREFIN_i: dummy variable that equals one for premium-financed policies and zero otherwise
- HY_i: dummy variable that equals one if the insurer exhibits a high-yield rating and zero otherwise
- USTY_i: ten-year US treasury bond yield on the transaction date (in percentage points)

Statistically and substantively insignificant factors can be removed!

Estimation results

	Model 1				Model 2				Model 3			
	coeff.	stand.	p-val.	sig.	coeff.	stand.	p-val.	sig.	coeff.	stand.	p-val.	sig.
(Intercept)	73.7319		0.0000	***	75.4639		0.0000	***	74.8477		0.0000	***
LE	-1.1483	-0.6285	0.0000	***	-1.1548	-0.6764	0.0000	***	-1.0982	-0.6951	0.0000	***
LE^2	0.0073	0.2718	0.0000	***	0.0074	0.1551	0.0000	***	0.0068	0.1503	0.0000	***
LE^3	-0.0000	-0.0646	0.0000	***	-0.0000	-0.0364	0.0000	***	-0.0000	-0.0303	0.0000	***
CSV	19.2353	0.0810	0.0003	***	19.1540	0.0795	0.0003	***				
PREM	-0.3790	-0.1175	0.0000	***	-0.3769	-0.1232	0.0000	***	-0.3865	-0.1242	0.0000	***
HY	-0.2479	-0.0093	0.8621									
TERT	3.3451	0.0940	0.0000	***	3.3010	0.0885	0.0000	***				
UL	-3.5347	-0.0692	0.0043	***	-3.5707	-0.1003	0.0040	***	-2.7389	-0.0861	0.0275	**
PREFIN	-2.5465	-0.0176	0.0666	**	-2.7699	-0.0032	0.0513	**				
UST	0.6765	-0.0988	0.1008									
df	799.00				801.00				804.00			
SEE	0.07				0.07				0.08			
Adj. R^2	0.75				0.75				0.74			
White's Test	77.45		0.0000	***	76.07		0.0000	***	64.06		0.0000	***
BP Test	109.10		0.0000	***	103.80		0.0000	***	88.44		0.0000	***

Notes: Standard errors based on Newey-West Heteroskedasticity- and Autocorrelation-Consistent (HAC) Covariance Matrix
Significance levels: ****=0.01, **=0.05, *=0.10*

The in-sample model fit is robust for different time periods

Subsamples for different time periods

	01/2011-12/2013			2011			2012			2013		
	coeff.	p-val.	sig.	coeff.	p-val.	sig.	coeff.	p-val.	sig.	coeff.	p-val.	sig.
(Intercept)	74.8477	0.0000	***	76.5509	0.0000	***	74.7519	0.0000	***	75.1955	0.0000	***
LE	-1.0982	0.0000	***	-0.9052	0.0000	***	-1.1095	0.0000	***	-1.1527	0.0000	***
LE^2	0.0068	0.0000	***	0.0052	0.0001	***	0.0070	0.0072	***	0.0072	0.0000	***
LE^3	0.0000	0.0000	***	0.0000	0.0028	***	0.0000	0.0548	*	0.0000	0.0001	***
PREM	-0.3865	0.0000	***	-0.3918	0.0018	***	-0.4475	0.0000	***	-0.3515	0.0017	***
UL	-2.7389	0.0039	***	-10.0329	0.0063	***	-2.2932	0.1806		-2.0810	0.2034	
df	805.00			181.00			297.00			314.00		
SEE	0.08			7.03			7.72			8.05		
Adj. R^2	0.73			0.75			0.72			0.75		
White's Test	73.63	0.0000	***	7.33	0.0255	**	38.21	0.0000	***	17.88	0.0001	***
BP Test	83.42	0.0000	***	19.79	0.0014	***	41.04	0.0000	***	37.69	0.0000	***

Notes: Standard errors based on Newey-West Heteroskedasticity- and Autocorrelation-Consistent (HAC) Covariance Matrix
Significance levels: ****=0.01, **=0.05, *=0.10*

An out-of-sample analysis is a key indicator of the model's accuracy

Proceeding

- Fit each model to the calibration sample (e.g., 810 deals from 01/2011 to 12/2013)
- Apply the resulting parameter vectors to calculate predicted spreads for the test sample
- Combine with observed spreads in the test sample to determine measures of accuracy

Out-of-sample performance measures

Mean Error $$ME = \frac{1}{N'}\sum_{i=1}^{N'}\left(P_i - \hat{P}_i\right)$$

Root Mean Square Error $$RMSE = \sqrt{\frac{1}{N'}\sum_{i=1}^{N'}\left(P_i - \hat{P}_i\right)^2}$$

Mean Absolute Error $$MAE = \frac{1}{N'}\sum_{i=1}^{N'}\left|P_i - \hat{P}_i\right|$$

Out-of-Sample R^2 $$R_{OS}^2 = 1 - \frac{\sum_{i=1}^{N'}\left(P_i - \hat{P}_i\right)^2}{\sum_{i=1}^{N'}(P_i - \bar{P})^2}$$

P_i: observed price for transaction i $\hat{P}_i$: predicted price for transaction i $\bar{P}$: historical average price

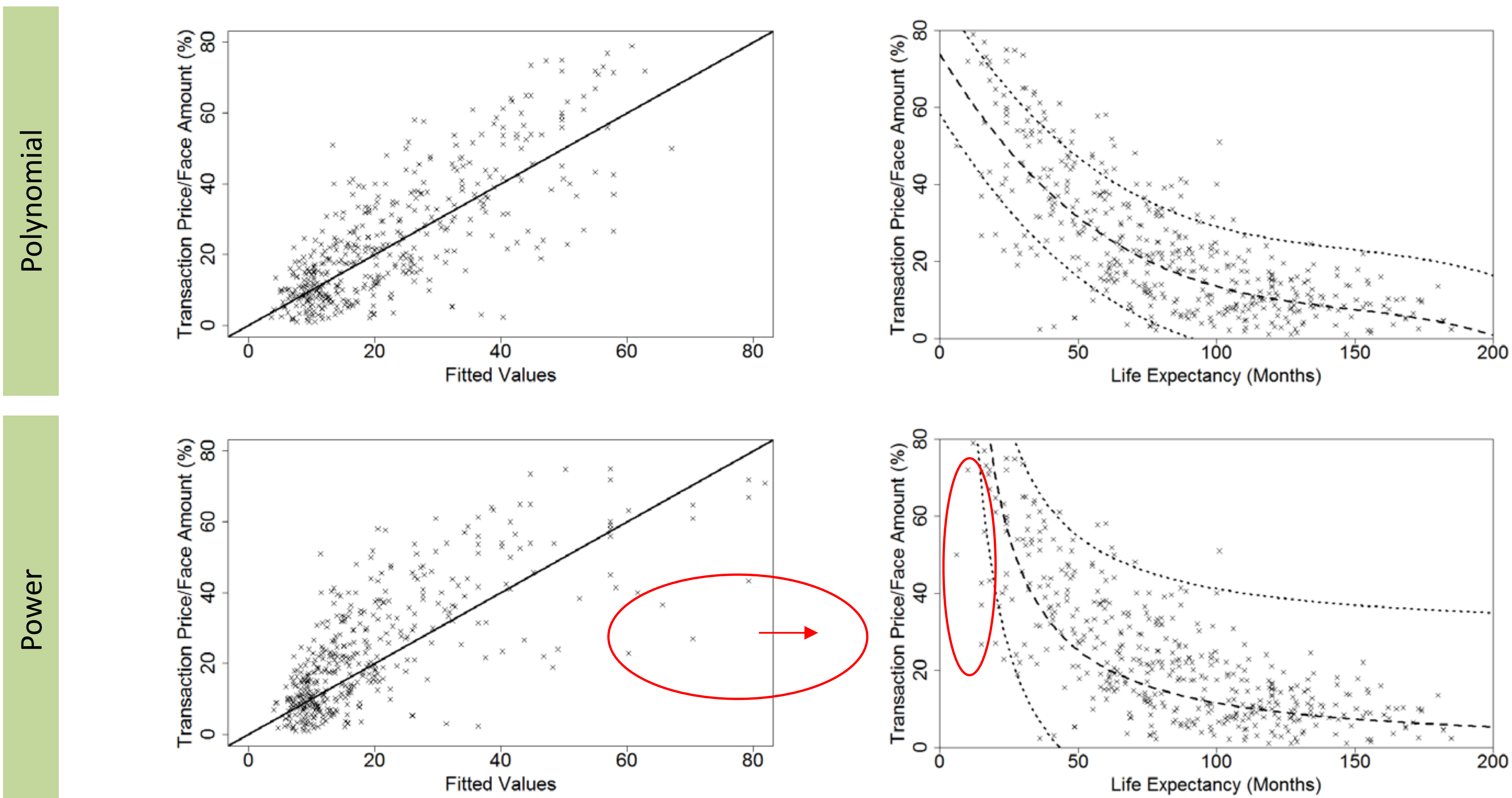
Multifactor, polynomial, and linear-log models perform similarly!

Out-of-sample accuracy: numerical measures

	Multifactor	Linear	Polynomial	Power	Linear-Log
Panel A: Calibration Period: 01/2011 - 12/2013 (N = 810);		**Test Period: 01/2014 - 11/2014 (N'=461)**			
ME	0.0110	0.0221	0.0168	0.0205	0.0170
MAE	0.0858	0.1002	0.0882	0.1036	0.0897
$RMSE$	0.1130	0.1294	0.1155	0.1764	0.1163
R^2_{OS}	0.6170	0.4983	0.6000	0.0671	0.5945
Panel B: Calibration Period: 01/2011 - 03/2014 (N = 959);		**Test Period: 04/2014 - 11/2014 (N'=312)**			
ME	0.0165	0.0304	0.0228	0.0241	0.0240
MAE	0.0849	0.1010	0.0870	0.1038	0.0888
$RMSE$	0.1143	0.1333	0.1165	0.1882	0.1180
R^2_{OS}	0.6521	0.5272	0.6390	0.0575	0.6294
Panel C: Calibration Period: 01/2011 - 06/2014 (1051);		**Test Period: 07/2014 - 11/2014 (N'=220)**			
ME	0.0143	0.0276	0.0218	0.0310	0.0231
MAE	0.0820	0.0997	0.0817	0.0883	0.0836
$RMSE$	0.1076	0.1301	0.1078	0.1295	0.1092
R^2_{OS}	0.6889	0.5445	0.6874	0.5490	0.6794

The power function heavily overprices certain deals

Out-of-sample accuracy: visual inspection



An econometric model is very simple to calibrate and implement

A numerical pricing example

$$\hat{P} = 74.8477 - 1.0982\,LE + 0.0068\,LE^2 - 0.0000\,LE^3 - 0.3865\,PREM - 2.7389\,UL$$

		Deal 1		Deal 2		Deal 3	
Factor	**Unit**	**Value**	**Price/FA (%)**	**Value**	**Price/FA (%)**	**Value**	**Price/FA (%)**
Intercept	Price/FA	-	+74.85	-	+74.85	-	+74.85
LE	Months	50	-54.91	100	-109.82	150	-164.73
LE^2	$Months^2$	2,500	+16.91	10,000	+67.66	22,500	+152.23
LE^3	$Months^3$	125,000	-1.87	1,000,000	-14.96	3,375,000	-50.49
PREM	USD Million	10	-3.86	5	-1.93	1	-0.39
UL	Dummy	1	-2.74	0	-0.00	1	-2.74
		Total	28.38	Total	15.79	Total	8.73

Summary and conclusion

What value does an econometric model add for the industry?

- Clear differentiation of the relevant pricing determinants for life settlements
- Simple to implement; strong in-sample model fit and out-of-sample pricing accuracy
- Multiple factors not even necessary: 3rd-order polynomial model performs just as well
- Once calibrated, it can be used to generate market-consistent portfolio valuations!

Potential pitfalls

- Factor model: maintaining a good fit may require frequent recalibrations
- Highly dependent on LE estimates: need to keep this key input factor up to date!

Thank you for your attention!