

# BAS Sixth Annual Case Competition

---

Presented by Joan Dai, Annie Chen, Daniel He, Roy Kim

# Background

---

# Background

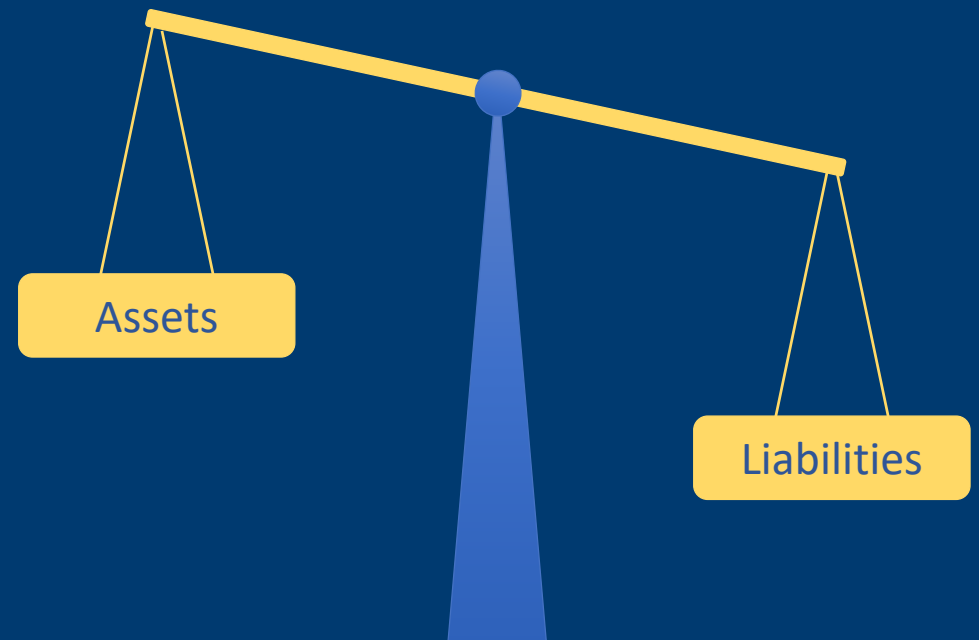
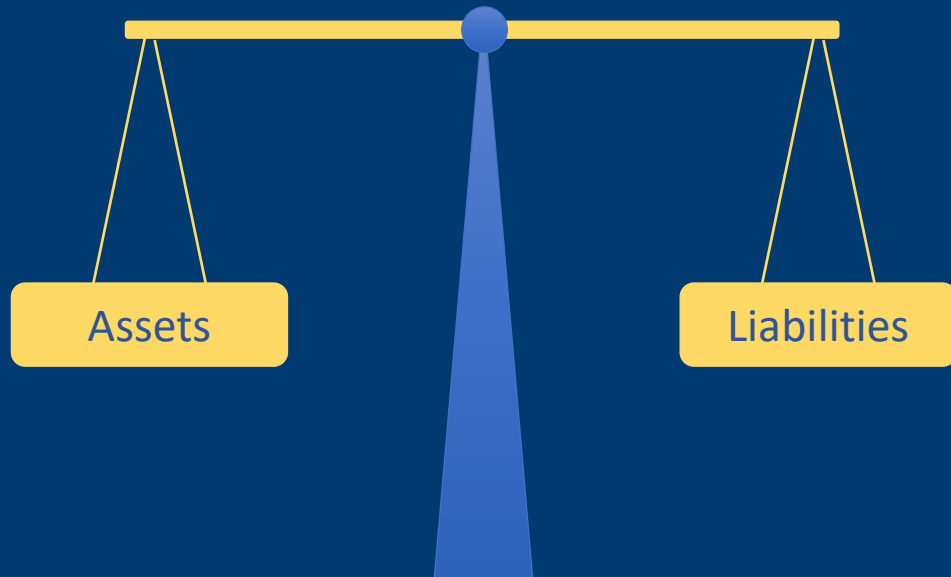
---

## Unexpected demographic shifts in pension plan

- Retirement Increase
  - Early retirement
  - Postponed retirement
- Creeping Active Termination

# Problem

## Asset and liability mismatch



# Agenda

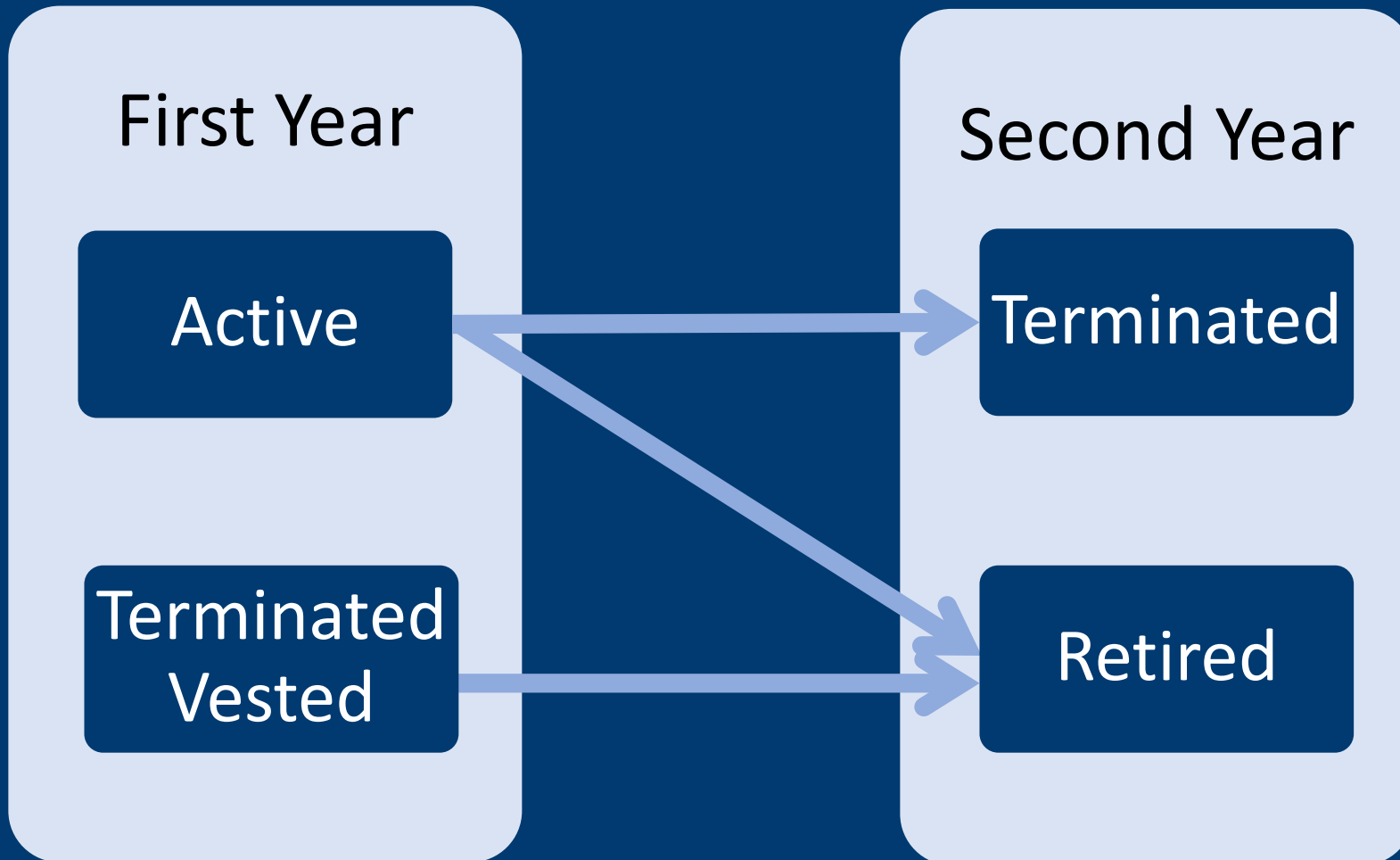
---

- Binomial Confidence Intervals
- Bootstrap Estimates
- Exponential Moving Average
  
- Final Funding Status Report

# Rate Analysis

---

# Rate Analysis



# Rate Analysis

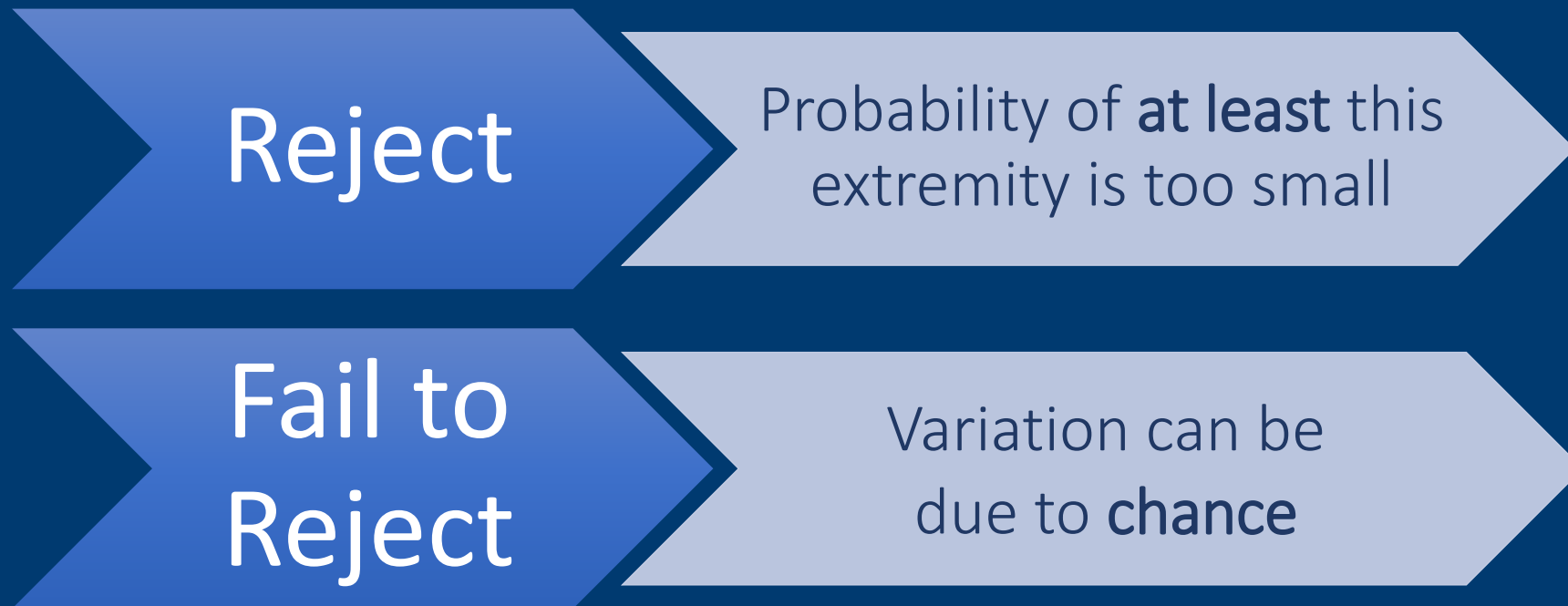
- Hypothesis tests of previous assumption rates
- Graphically shown with standard 95% confidence intervals

Active Retirement Rate	
Age	Current
55	0.05
56	0.05
57	0.05
58	0.05
59	0.05
60	0.10
61	0.10
62	0.20
63	0.30
64	0.40
65	1.00

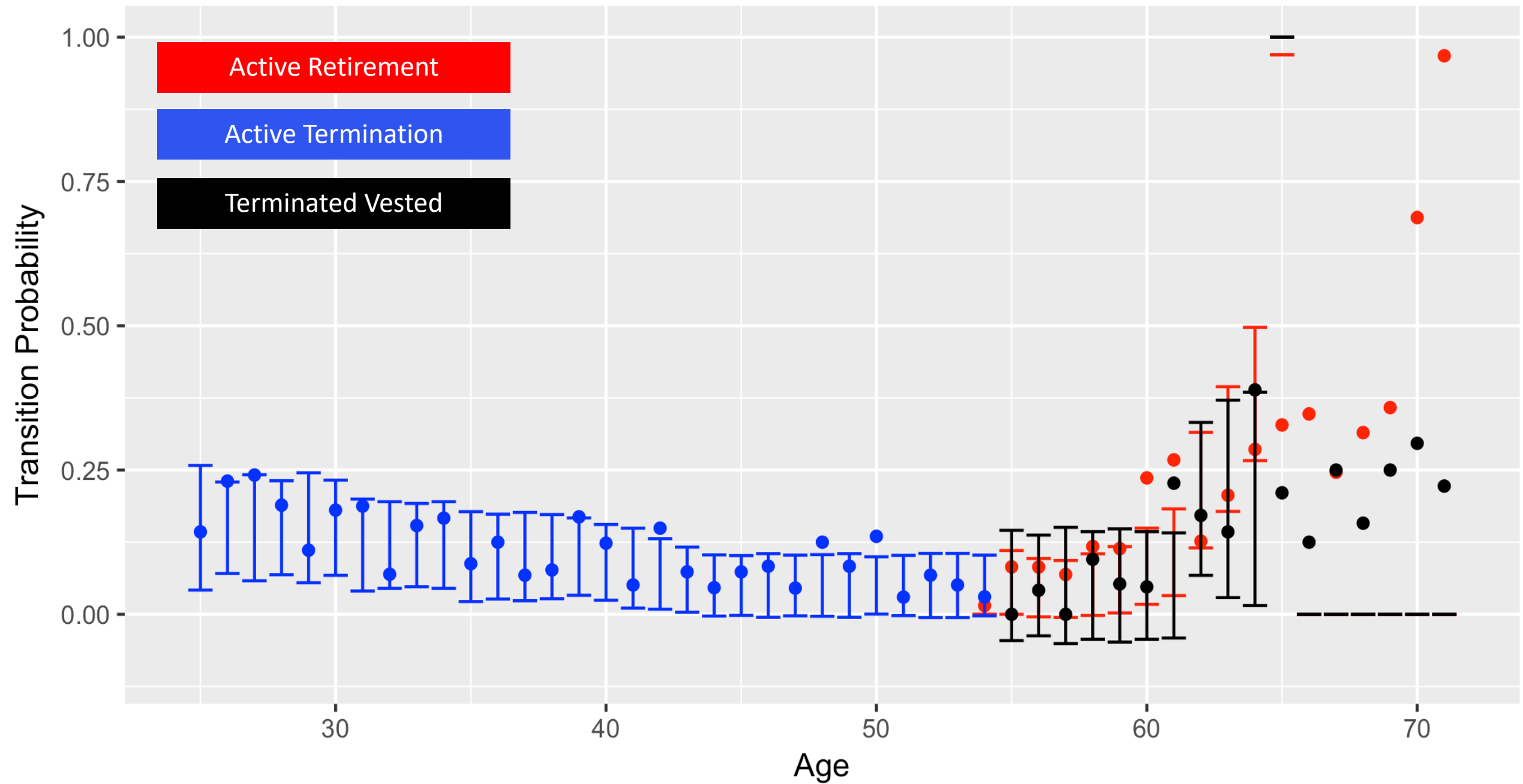


# Rate Analysis

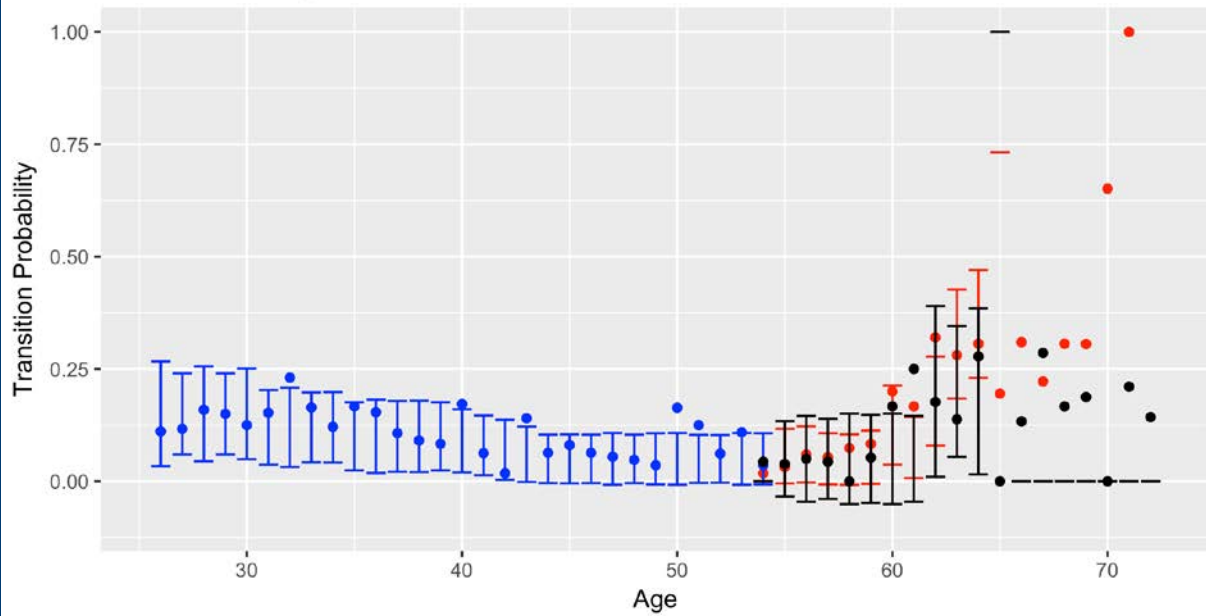
- Hypothesis testing each age level with **assumption rates** as null



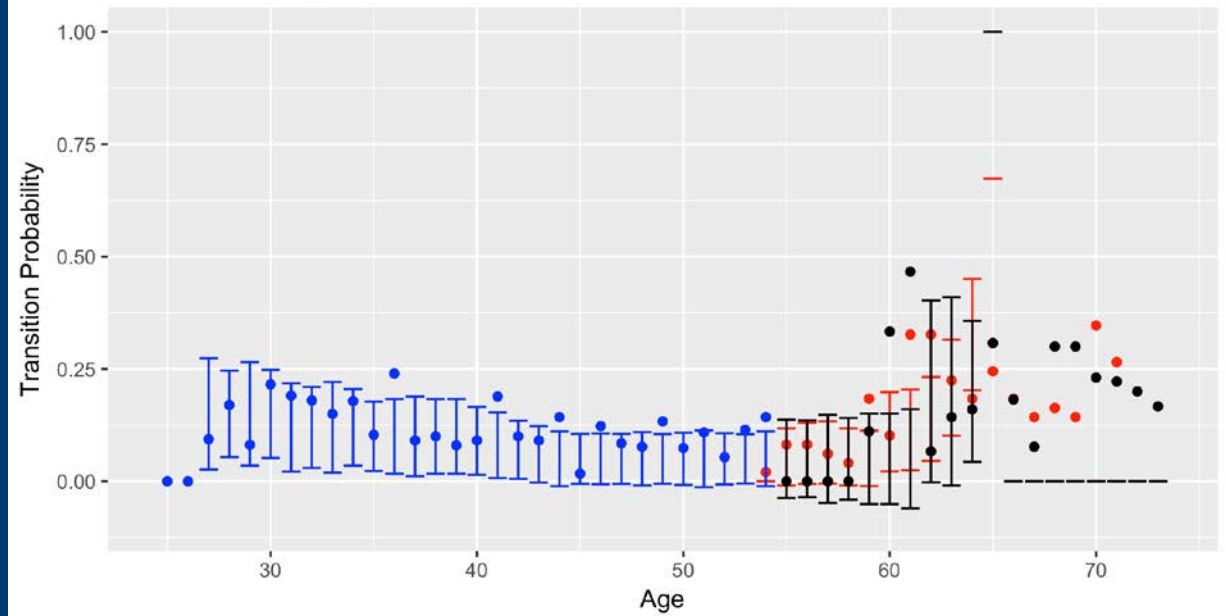
# 2012 - 2013 Experience



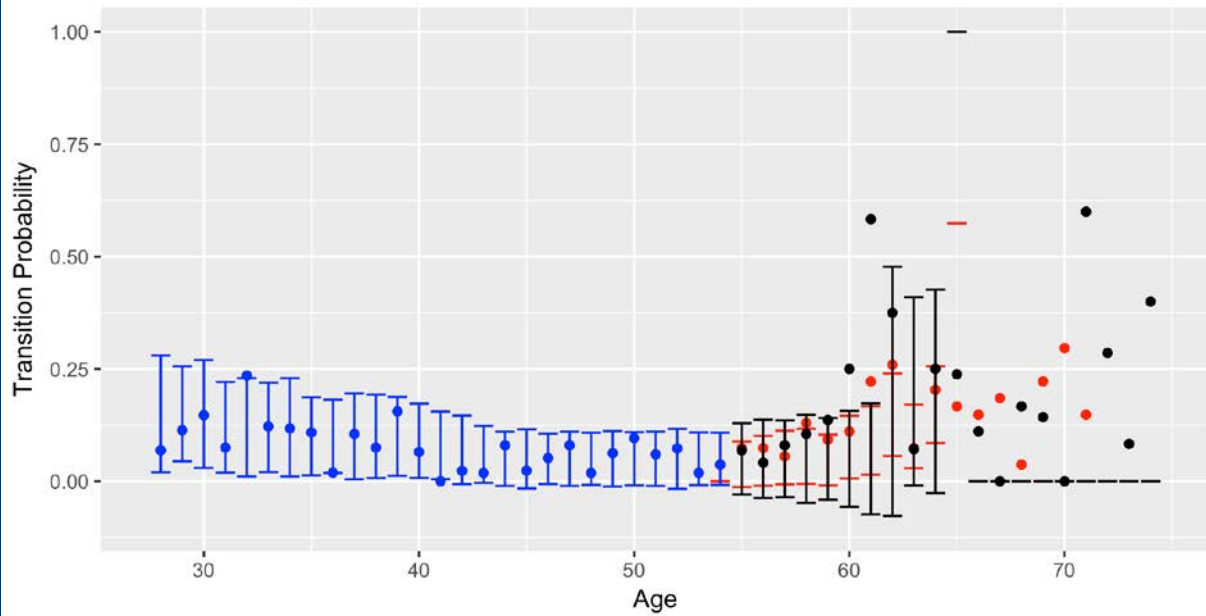
2013 - 2014 Experience



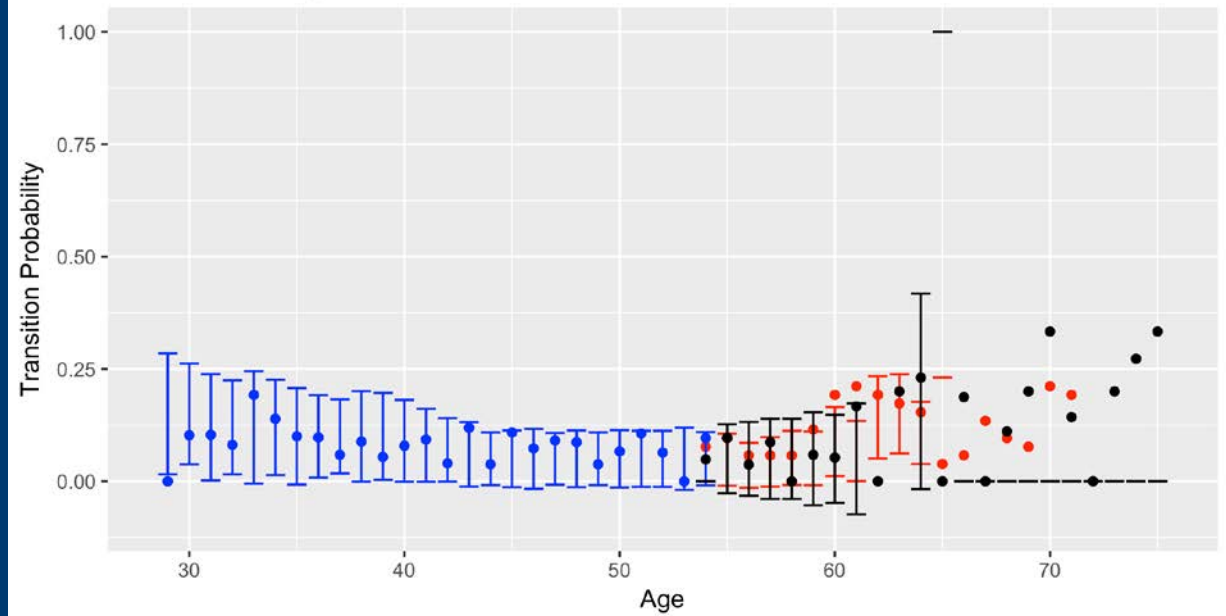
2014 - 2015 Experience



2015 - 2016 Experience



2016 - 2017 Experience



Active Retirement

Active Termination

Terminated Vested

# Rate Derivation

---

# Rate Derivation

---

- Assume original assumption is not credible
- Based only on participants' behavior

# Rate Derivation

---

- Method: Bootstrap simulation
- Sample Size: 750 from designated population
- Resampling: 500 times
- All Three Categories:
  - Termination Rate
  - Active Retirement Rate
  - Terminated Vested Retirement Rate

# Rate Derivation

Bootstrap Trials (Active Retirement Rate 2012 to 2013)					
Age	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
54	0.00	0.02	0.10	0.00	0.05
55	0.00	0.00	0.05	0.05	0.15
56	0.05	0.16	0.00	0.02	0.1
57	0.13	0.00	0.00	0.00	0.00
58	0.00	0.00	0.25	0.00	0.00
59	0.14	0.00	0.00	0.4	0.25
60	0.11	0.09	0.16	0.2	0.00
61	0.50	0.16	0.00	0.20	0.00
62	0.10	0.75	0.20	0.00	0.25
63	0.25	0.20	0.17	0.50	0.29
64	0.50	0.25	0.00	0.33	0.00
65	0.00	0.25	0.00	0.25	0.67
66	0.66	0.50	0.22	1.00	0.00
67	0.17	0.00	0.20	0.00	0.00
68	0.16	0.50	0.43	0.16	0.50
69	0.67	0.00	0.50	0.00	0.67
70	1.00	1.00	0.60	1.00	0.75
71	1.00	1.00	0.00	1.00	1.00

• • •

Bootstrap Result	
Age	Mean
54	0.02
55	0.03
56	0.06
57	0.05
58	0.11
59	0.11
60	0.24
61	0.26
62	0.32
63	0.28
64	0.31
65	0.33
66	0.36
67	0.26
68	0.33
69	0.35
70	0.69
71	0.97

# Rate Derivation

## Putting it all together

- Assumption rates, fail-to-reject or reject
- Bootstrap rates

Derived Active Retirement Rates					
	2012	2013	2014	2015	2016
54	<b>0.02</b>	<b>0.02</b>	<b>0.02</b>	<b>0.04</b>	<b>0.08</b>
55	0.05	0.05	0.05	0.05	0.05
56	0.05	0.05	0.05	0.05	0.05
57	0.05	0.05	0.05	0.05	0.05
58	<b>0.11</b>	0.05	0.05	<b>0.12</b>	0.05
59	<b>0.11</b>	0.05	<b>0.19</b>	0.05	<b>0.12</b>
60	<b>0.24</b>	<b>0.20</b>	0.10	0.10	<b>0.22</b>
61	<b>0.26</b>	0.10	<b>0.28</b>	<b>0.25</b>	<b>0.32</b>
62	0.20	<b>0.32</b>	<b>0.47</b>	<b>0.35</b>	0.20
63	0.30	0.30	0.30	0.30	0.30
64	0.40	0.40	<b>0.22</b>	0.40	0.40
65	<b>0.33</b>	<b>0.19</b>	<b>0.37</b>	<b>0.29</b>	<b>0.16</b>
66	<b>0.36</b>	<b>0.31</b>	<b>0.27</b>	<b>0.38</b>	<b>0.14</b>
67	<b>0.26</b>	<b>0.22</b>	<b>0.24</b>	<b>0.42</b>	<b>0.56</b>
68	<b>0.33</b>	<b>0.31</b>	<b>0.23</b>	<b>0.10</b>	<b>0.36</b>
69	<b>0.35</b>	<b>0.30</b>	<b>0.22</b>	<b>0.45</b>	<b>0.21</b>
70	<b>0.69</b>	<b>0.65</b>	<b>0.69</b>	<b>0.61</b>	<b>0.73</b>
71	<b>0.97</b>	<b>0.99</b>	<b>0.92</b>	<b>0.97</b>	<b>0.99</b>



# Rate Synthesis

---

# Rate Synthesis

---

## Objectives

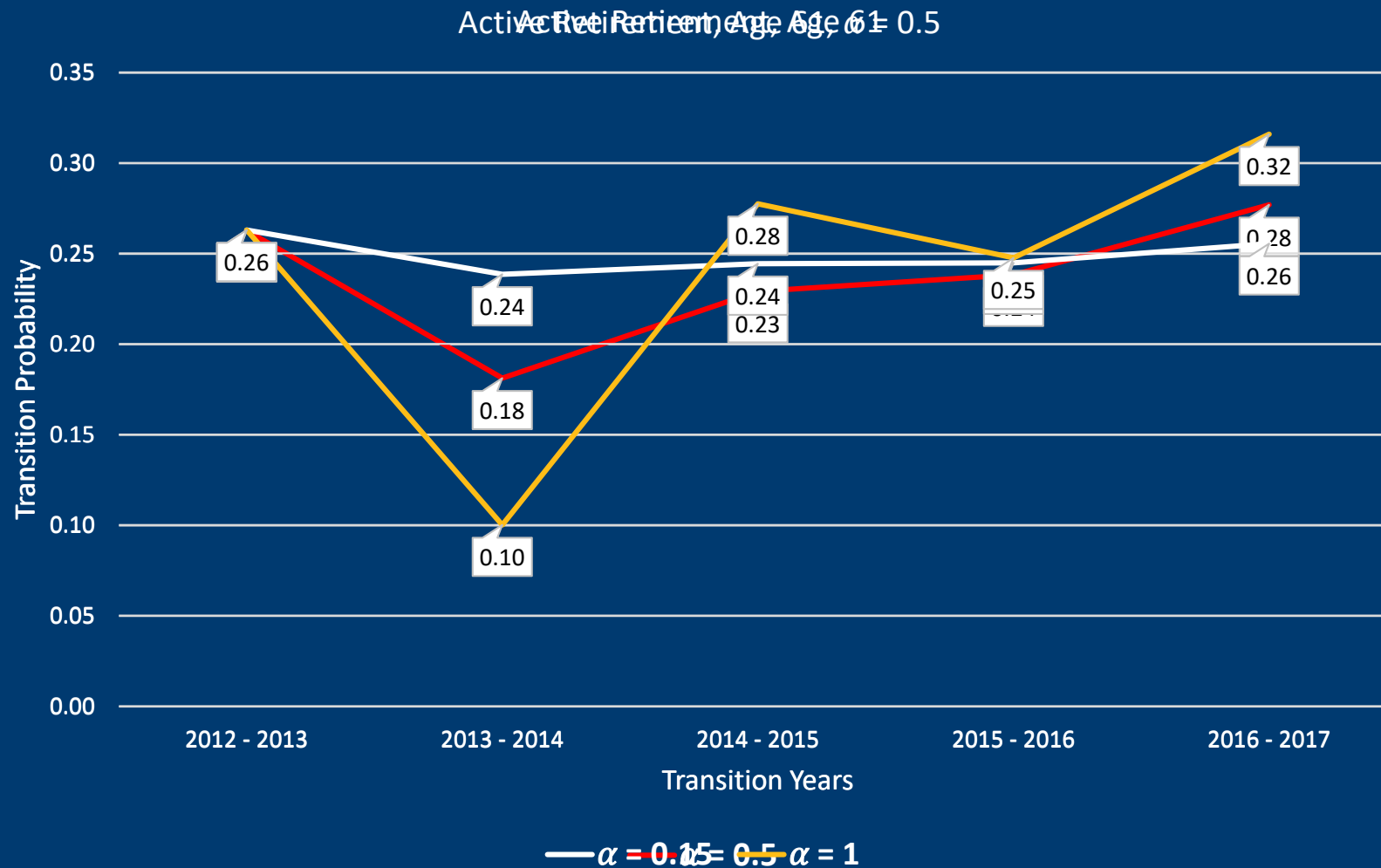
- Reduce **noise**
- Predict the **trend**

## Techniques

- Exponential moving average

# Rate Synthesis

Age	2012 – 2013	2013 – 2014	2014 – 2015	2015 – 2016	2016 – 2017
61	<b>0.26</b>	0.10	<b>0.28</b>	<b>0.25</b>	<b>0.32</b>



# Rate Synthesis

**Table 1: Active  
Retirement Rates**

Age	Current	Proposed Rate
54	NA	<b>0.05</b>
55	0.05	0.05
56	0.05	0.05
57	0.05	0.05
58	0.05	<b>0.07</b>
59	0.05	<b>0.10</b>
60	0.10	<b>0.18</b>
61	0.10	<b>0.28</b>
62	0.20	<b>0.28</b>
63	0.30	0.30
64	0.40	<b>0.38</b>
65	1.00	<b>0.23</b>
66	NA	<b>0.24</b>
67	NA	<b>0.44</b>
68	NA	<b>0.27</b>
69	NA	<b>0.28</b>
70	NA	<b>0.69</b>
71	NA	<b>0.98</b>

**Table 2: Terminated-Vested  
Retirement Rates**

Age	Current	Proposed Rate
54	NA	<b>0.03</b>
55	0.05	0.05
56	0.05	0.05
57	0.05	0.05
58	0.05	0.05
59	0.05	<b>0.07</b>
60	0.10	<b>0.14</b>
61	0.10	<b>0.32</b>
62	0.20	0.20
63	0.30	<b>0.20</b>
64	0.40	<b>0.21</b>
65	1.00	<b>0.11</b>
66	NA	<b>0.16</b>
67	NA	<b>0.04</b>
68	NA	<b>0.16</b>
69	NA	<b>0.20</b>
70	NA	<b>0.21</b>
71	NA	<b>0.27</b>

# Rate Synthesis

Table 3: Active Termination Rates, 25 - 44

Age	Current	Proposed Rate
25 - 29	0.15	<b>NA</b>
30	0.15	0.15
31	0.12	0.12
32	0.12	<b>0.16</b>
33	0.12	0.12
34	0.12	0.12
35	0.10	0.10
36	0.10	<b>0.12</b>
37	0.10	0.10
38	0.10	0.10
39	0.10	0.10
40	0.09	<b>0.10</b>
41	0.08	<b>0.07</b>
42	0.07	0.07
43	0.06	<b>0.07</b>
44	0.05	<b>0.06</b>

Table 3: Active Termination Rates, 45 - 71

Age	Current	Proposed Rate
45	0.05	0.05
46	0.05	<b>0.06</b>
47	0.05	0.05
48	0.05	0.05
49	0.05	<b>0.06</b>
50	0.05	<b>0.06</b>
51	0.05	0.05
52	0.05	0.05
53	0.05	<b>0.06</b>
54	0.05	<b>0.06</b>
55 - 63	NA	<b>0.00</b>
64	NA	<b>0.01</b>
65 - 69	NA	<b>0.00</b>
70	NA	<b>0.01</b>
71	NA	<b>0.01</b>

# Rate Synthesis

---



# Rate Synthesis

## Funding Status



	Old Rates	New Rates	Net Difference
Normal Retirement Lump-Sum 2018	\$327K	\$798K	\$473K

# Index & Thank You

## Presenters



Joan Dai



Annie Chen



Daniel He



Roy Kim

## Index

- [Title Card](#)
- [Background: Title Card](#)
- [Background: Introduction](#)
- [Background: The Problem](#)
- [Background: Agenda](#)
- [Rate Analysis: Title Card](#)
- [Rate Analysis: Introduction](#)
- [Rate Analysis: Transition Pools](#)
- [Rate Analysis: Testing](#)
- [Rate Analysis: 2012 – 2013 Experience](#)
- [Rate Analysis 2013 – 2017 Experience](#)
- [Rate Derivation: Title Card](#)
- [Rate Derivation: Introduction](#)
- [Rate Derivation: Method](#)
- [Rate Derivation: Results](#)
- [Rate Derivation: Combination](#)
- [Rate Synthesis: Title Card](#)
- [Rate Synthesis: Method](#)
- [Rate Synthesis: Exponential Smoothing](#)
- [Rate Synthesis: Trends](#)
- [Rate Synthesis: Tables 1 & 2 Proposal](#)
- [Rate Synthesis: Table 3 Proposal](#)
- [Rate Synthesis: Funding Status](#)