Effects of Trauma on Work Performance

Evidence From The Boston Marathon Bombing

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Research Setting

The Boston Marathon is the world's oldest annual marathon (est. 1897) and one of the most prestigious.

- Athletes must qualify for the Boston Marathon
- Qualifying times are relative to age and gender
- Organized into two to four waves (2011-2013 had three)
- The final wave contains "charity" runners

The 2013 Boston Marathon was disrupted by a terrorist attack, diverting approximately a quarter of the runners.

We ask: what are the long term traumatic effects of the bombing, if any, on future performance?

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Marathon Data

We collect finishing times from marathons between 2009 (5k splits from 2010) and 2019.

- 2013 contains **projected** finish times for those diverted.
- Other variables include name, age, gender, bib number, and residency information.
- The 2012 Marathon was particularly hot...

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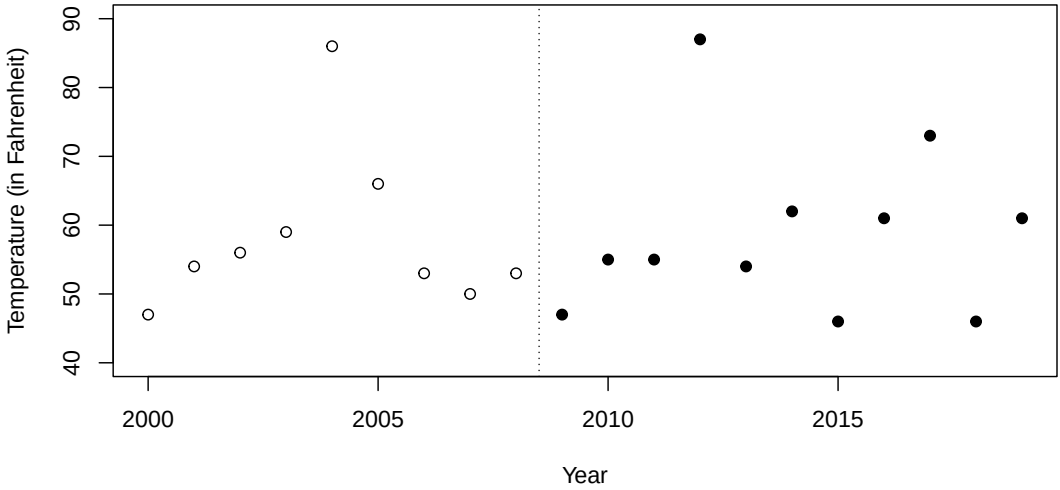
2012 Boston Marathon



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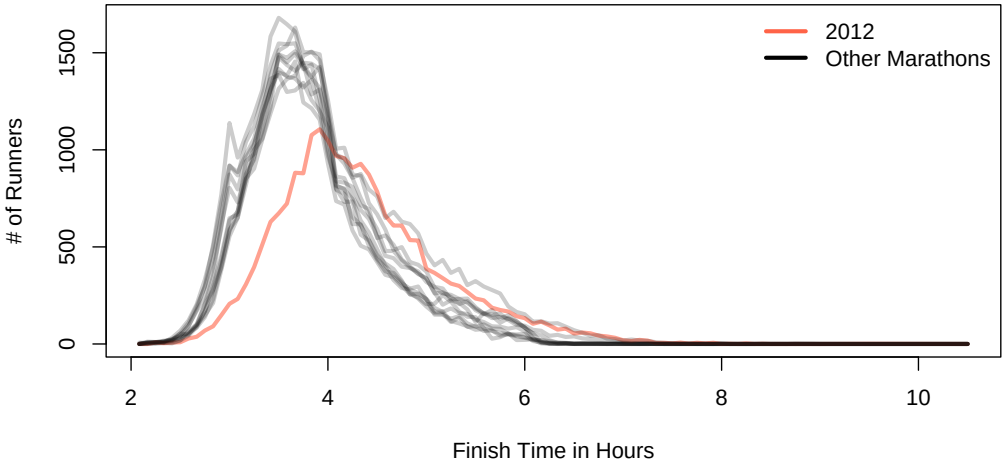
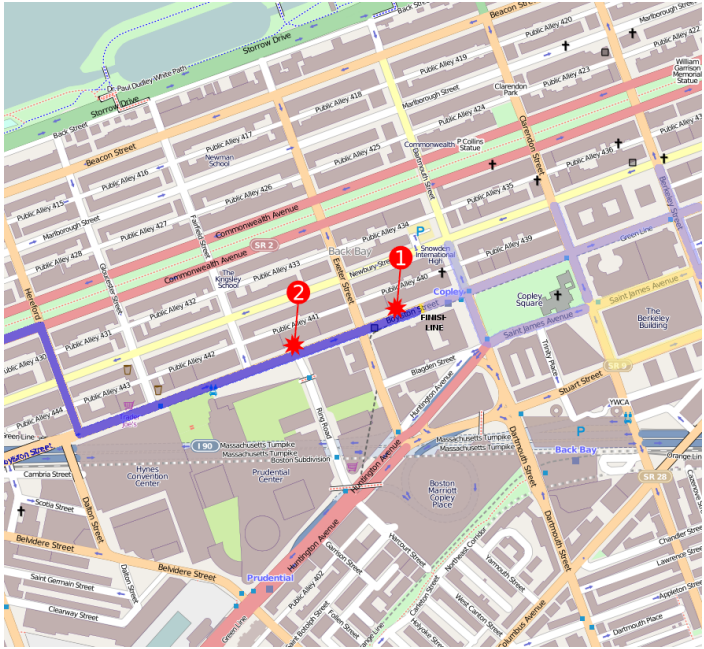
2012 Boston Marathon




1
2
FINISH LINE
Storrow Drive
Commonwealth Avenue
Beacon Street
Marlborough Street
Back Bay
Copley
Boylston Street
Stuart Street
Huntington Avenue
Dartmouth Street
Belvidere Street
Prudential
Saint James Avenue
Massachusetts Turnpike
Hynes Convention Center
Prudential Center
Boston Marriott Copley Place
Copley Square
The Berkeley Building
YWCA
Newman School
The Kingsley School
Snowdon International High
Dr. Paul Dudley White Path
Public Alley 417
Public Alley 418
Public Alley 419
Public Alley 420
Public Alley 423
Public Alley 424
Public Alley 425
Public Alley 426
Public Alley 427
Public Alley 428
Public Alley 431
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Public Alley 435
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Public Alley 440
Public Alley 441
Public Alley 442
Public Alley 443
Public Alley 444
Public Alley 402
Cambria Street
Scotia Street
Dalton Street
Saint Germain Street
Cleanway Street
Newbury Street
Blagden Street
Green Line
Orange Line
SR 2
SR 28
I 90

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2013 Boston Marathon

The terrorist attack in 2013 occurred towards the end of the race, and immediately before the finish line.

- 1.5% of athletes in wave one DNF.
- 4.1% of athletes in wave two DNF.
- 64% of athletes in wave three DNF.
  - 8,110 total in wave three
  - 1,185 out of 2,667 (44.4%) non-charity runners DNF.
  - 4,002 out of 5,443 (73.5%) charity runners DNF.

We focus on runners in wave three, and observe their performance in other races.

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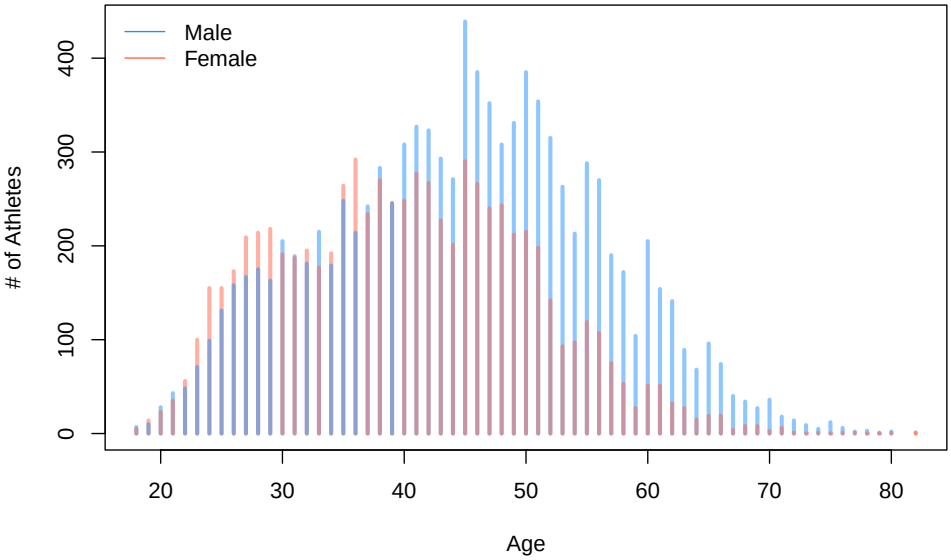
Age/Gender Distribution of All Runners in 2013



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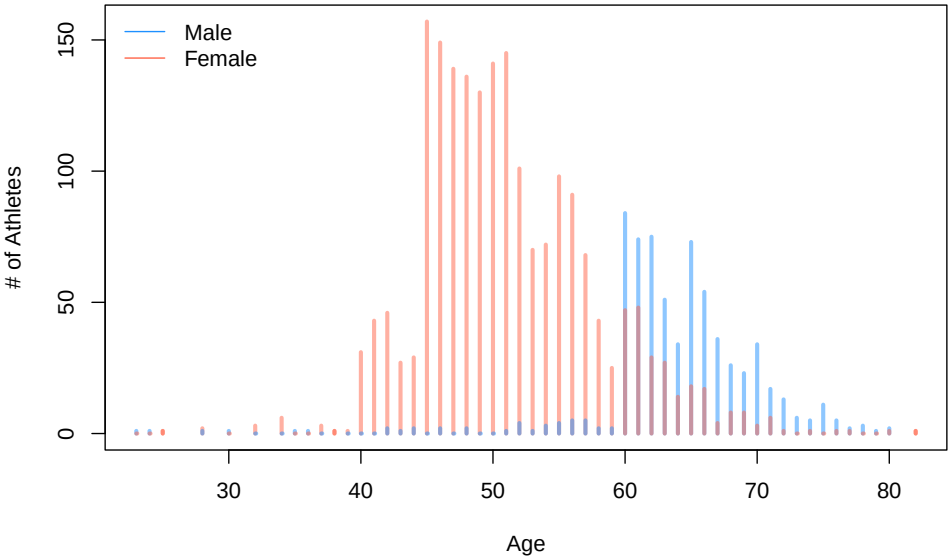
Age/Gender Distribution of Wave 3 Runners



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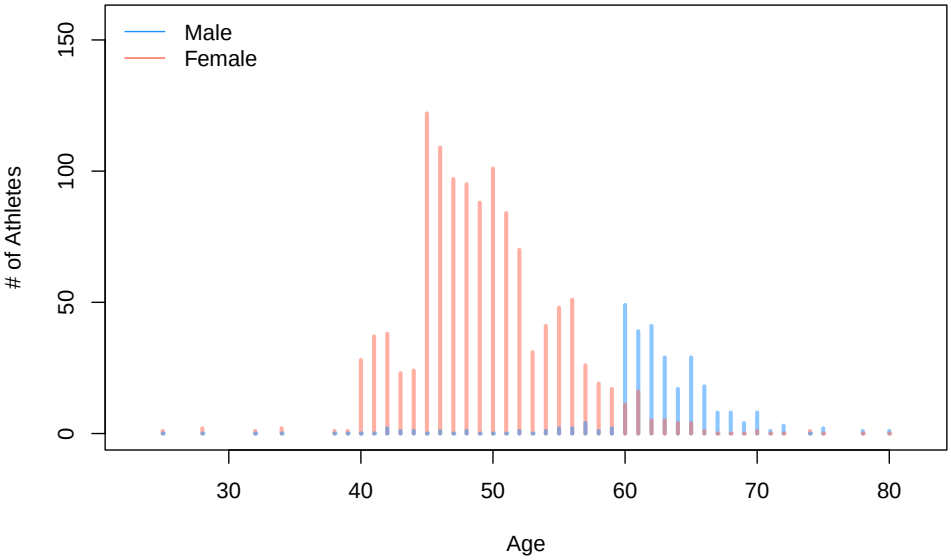
Age/Gender Distribution of Finishing Wave 3 Runners



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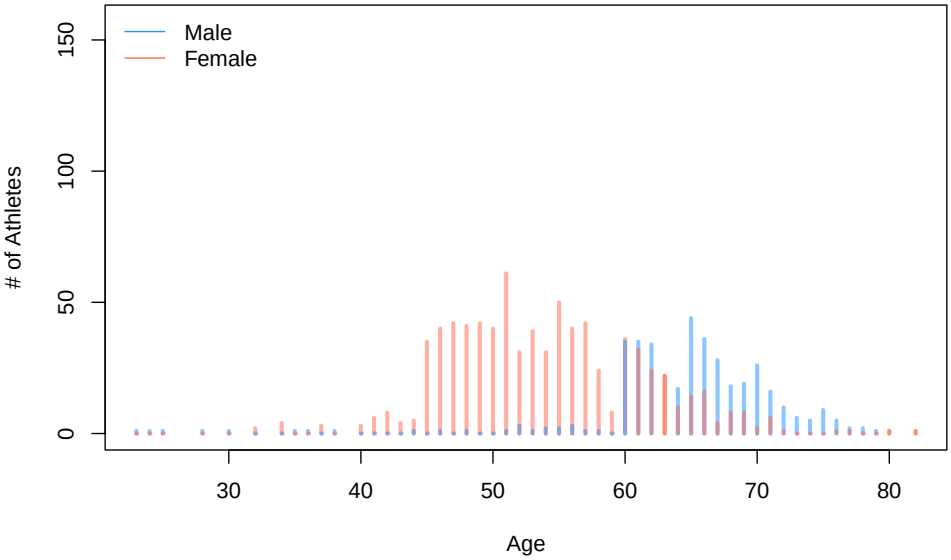
Age/Gender Distribution of DNF Wave 3 Runners



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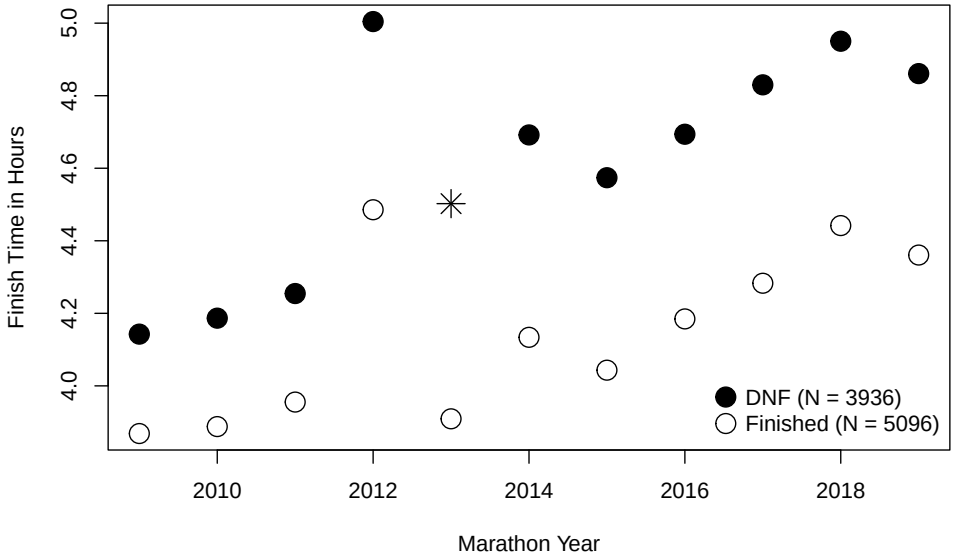
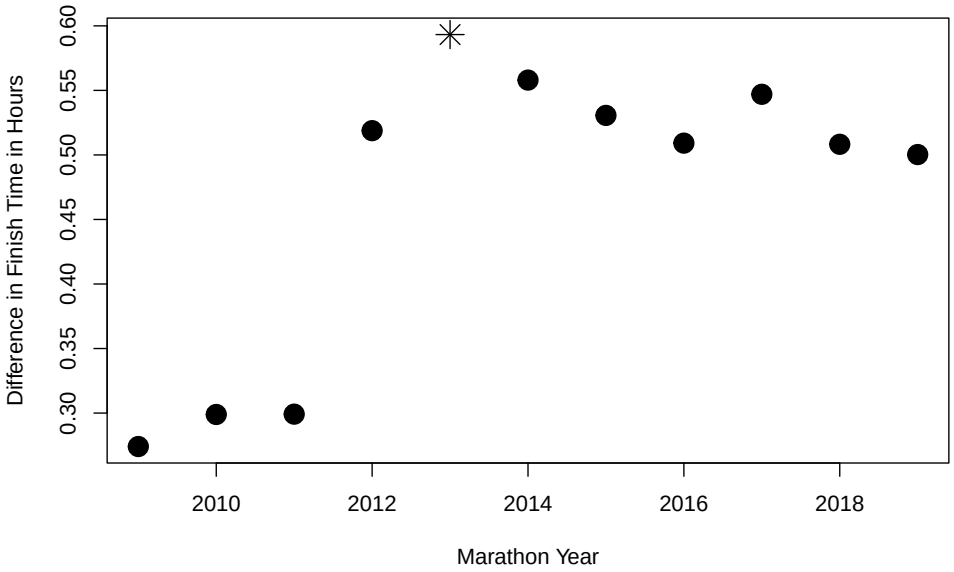
Finish Times in Other Races



Differences in Finish Times in Other Races



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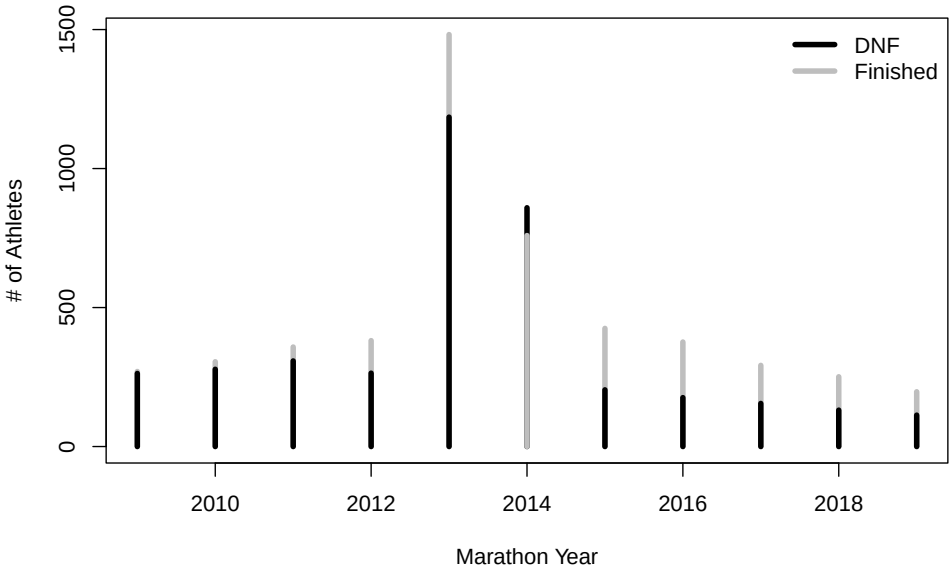
Number of Wave 3 2013 Athletes by Race



Runner FEs Model

$$T_{it} = \delta \times \text{DNF}_i \times \text{Post}_t + \mu_i + \tau_{a(i)g(i)t} + \epsilon_{it}$$

- T_{it} represents runner i's split time in race t.
  - We use the following splits: 0-10km, 10-21km, 21-30km, and 30-42km.
- μ_i, or runner FEs, should control for time invariant characteristics of athlete i such as height, grit, etc.
- $\tau_{a(i)g(i)t}$ controls for the average performance of runners in the same age-gender cohort by race.

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Runner FEs Model – Assumptions

To interpret δ as the causal effect of the 2013 bombing on race times:

- We assume that in the absence of treatment, the times of runners who finished after the bomb would have evolved in parallel to the times of runners who finished before the bomb within the same age-gender cohort.
- We assume that we have controlled for all variables correlated with both the treatment and race outcomes.*

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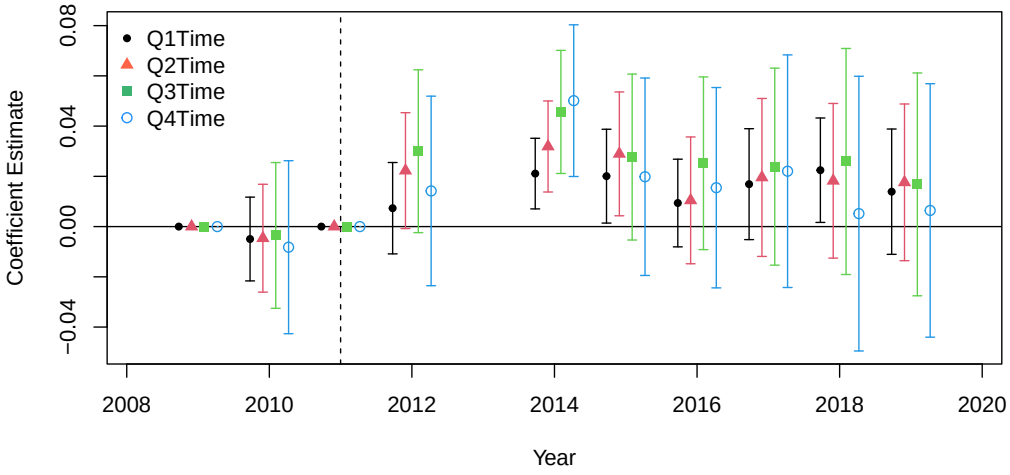
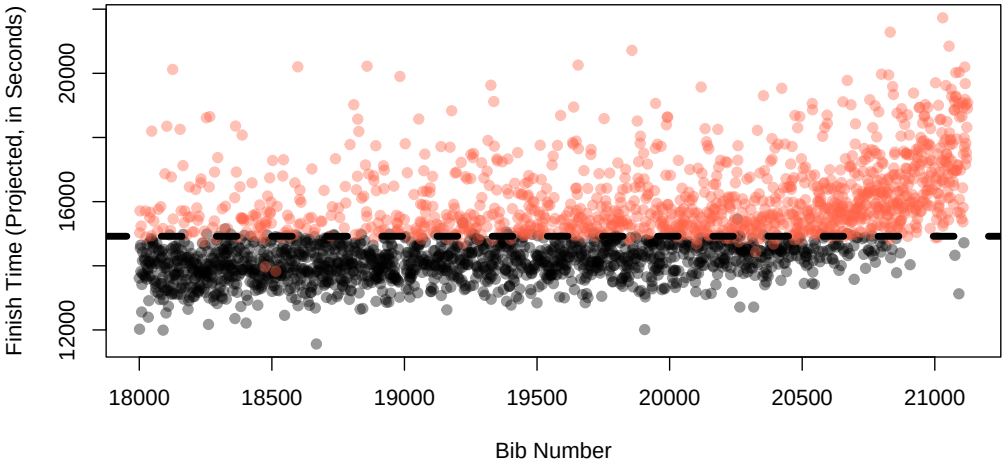
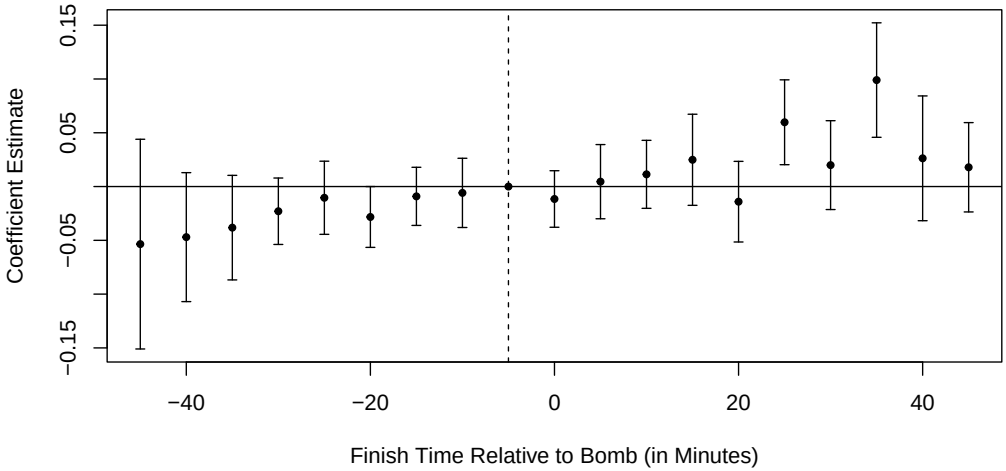
Race Times – Runner FEs



Bib Number vs Finish Time in 2013



Race Times – Time to Event



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We estimate the following:

$$T_{it} = \delta \times \text{DNF}_i \times \text{Post}_t + \tau_{a(i)g(i)t} + \epsilon_{it}$$

after preforming a matching algorithm that finds the runner with the closest bib number in the same age-gender cohort.

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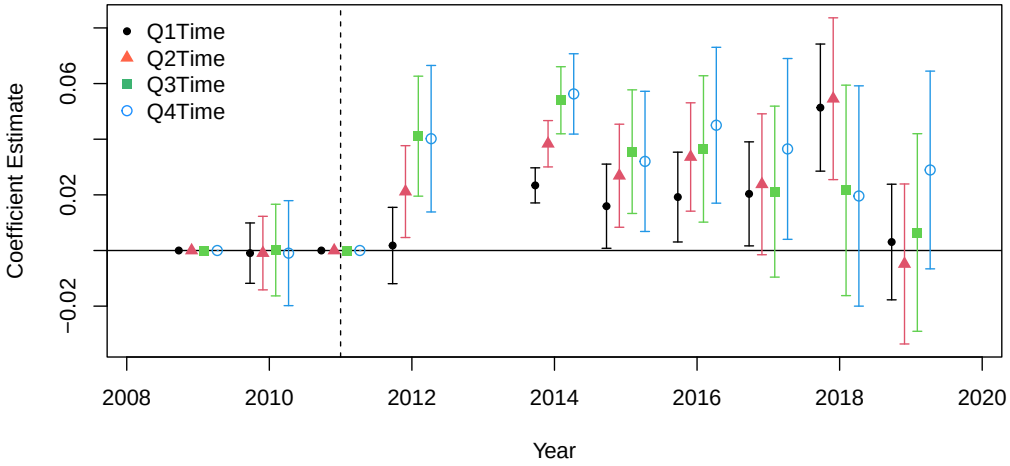
Race Times – Matched Sample



Finally, we estimate the following:

$$R_{it} = \delta \times \text{DNF}_i \times \text{Post}_t + \mu_i + \tau_{a(i)g(i)t} + \epsilon_{it}$$

where R_{it} measures whether runner i completes the Marathon in year t.[1]

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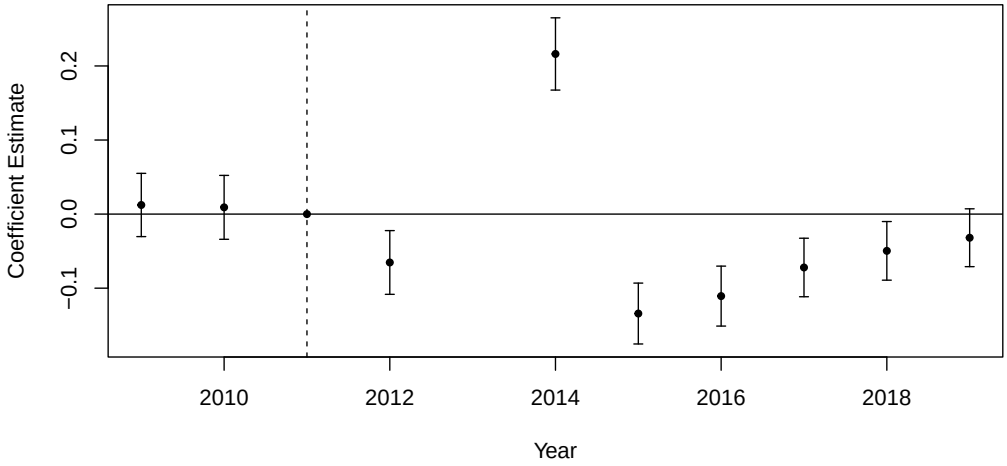
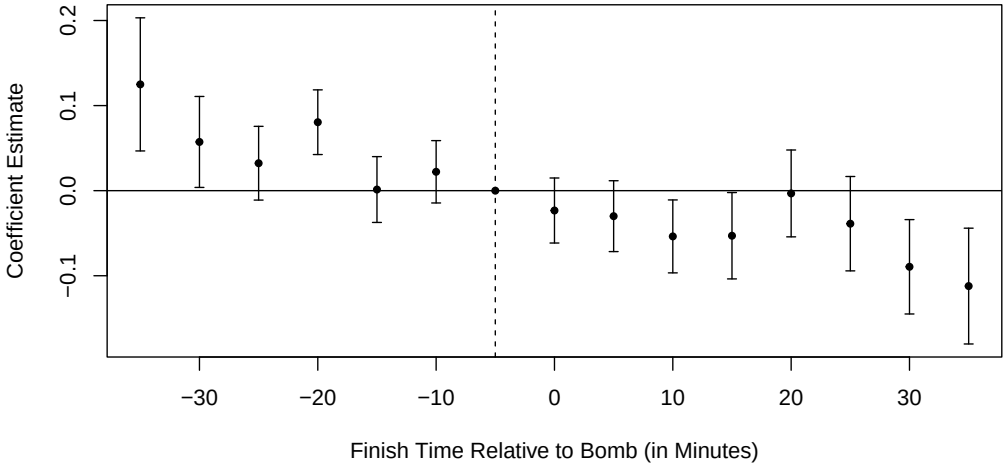
Boston Marathon Participation Results



Returning – Time to Event



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Future Steps?

What is going on with 2012?

- Our current hunch is that whatever caused runners to "select"/"sort" into treatment in 2013 (run slower) also made them more sensitive to extreme weather in 2012.
- Put differently, maybe these runners have higher rates of physical deterioration relative to others in their same gender-age cohorts.

Leveraging bib numbers

- Runners are lined up depending on their qualifying time and division.
- Conditioning on gender and age leaves "ability" as a confounding factor.
- Conditioning on bib number controls for race expectations, so the remaining variation ought to be random.
  - Results are identical, though.

We are open to (and in need of) suggestions!

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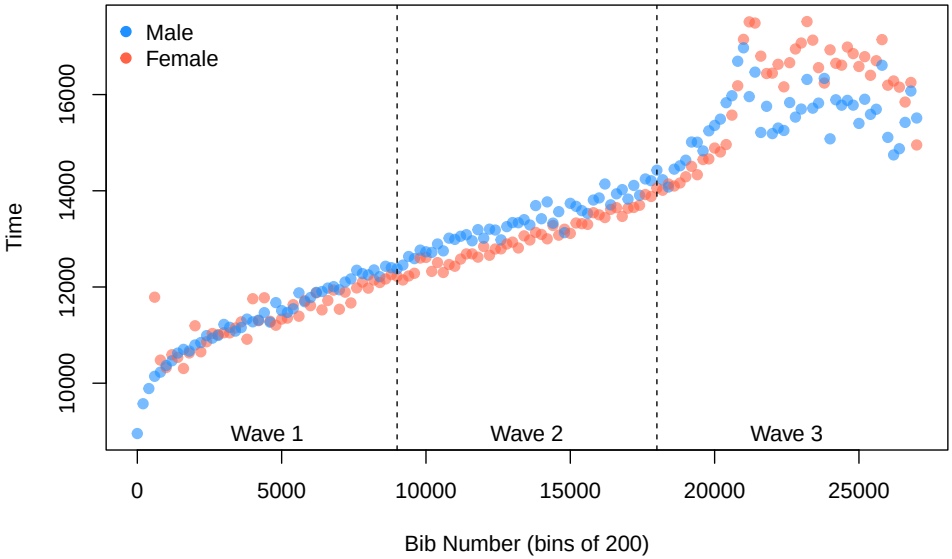
Time by Bib Number (2013)



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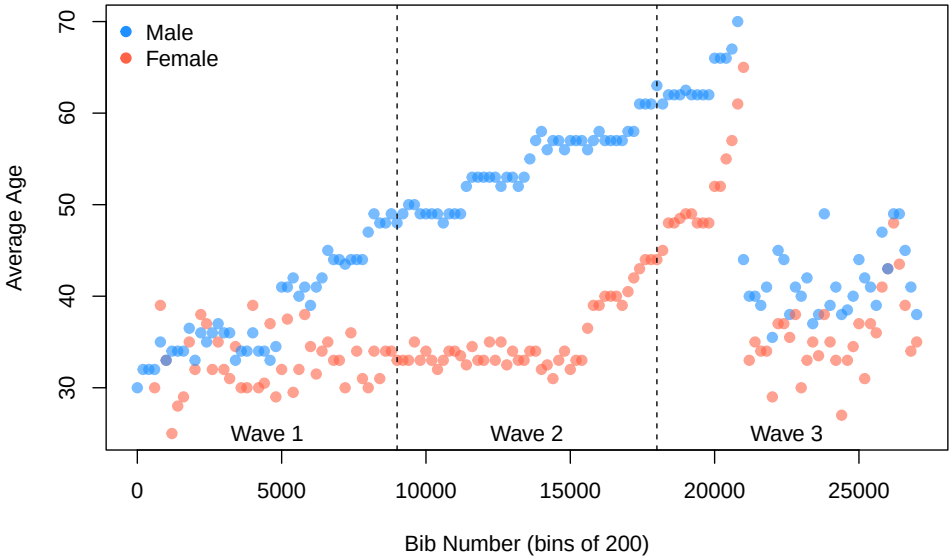
Age by Bib Number (2013)



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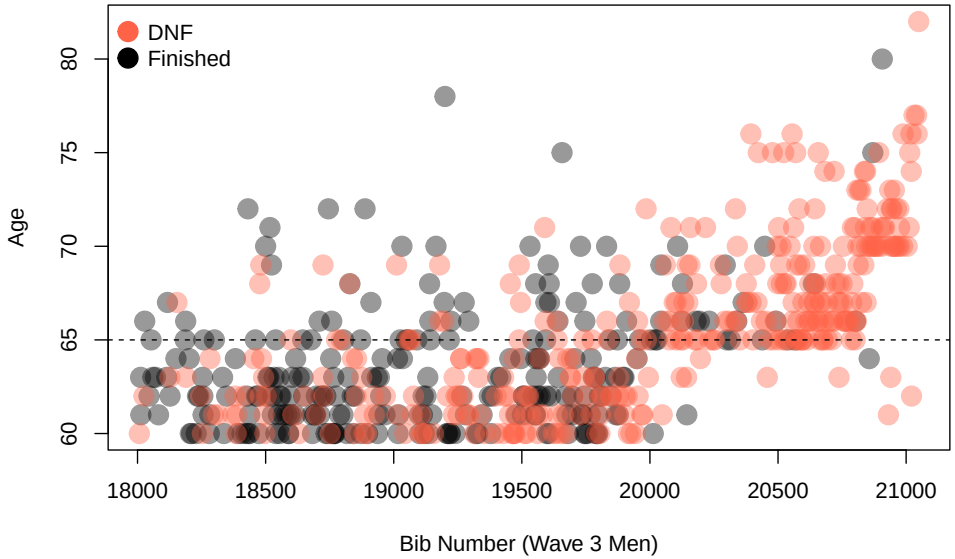
Age by Bib Number (Wave 3 Men in 2013)