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 effects of the bombing on future athletic 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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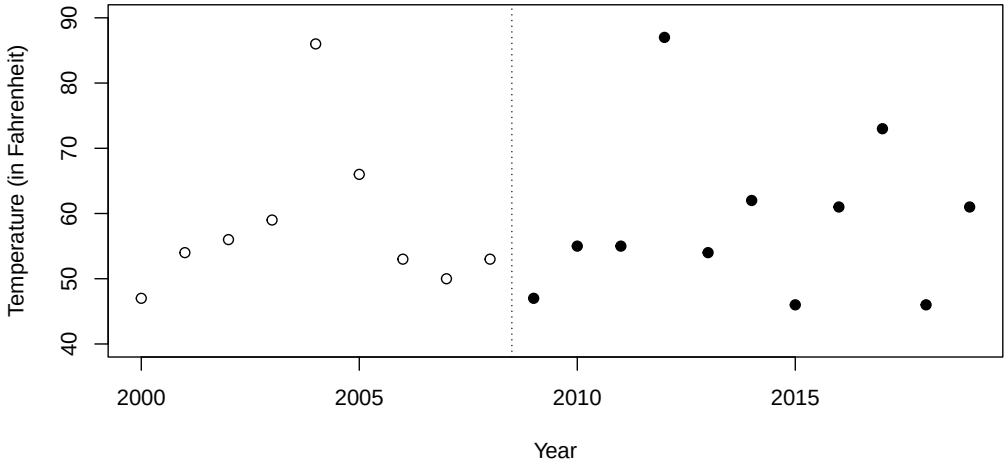
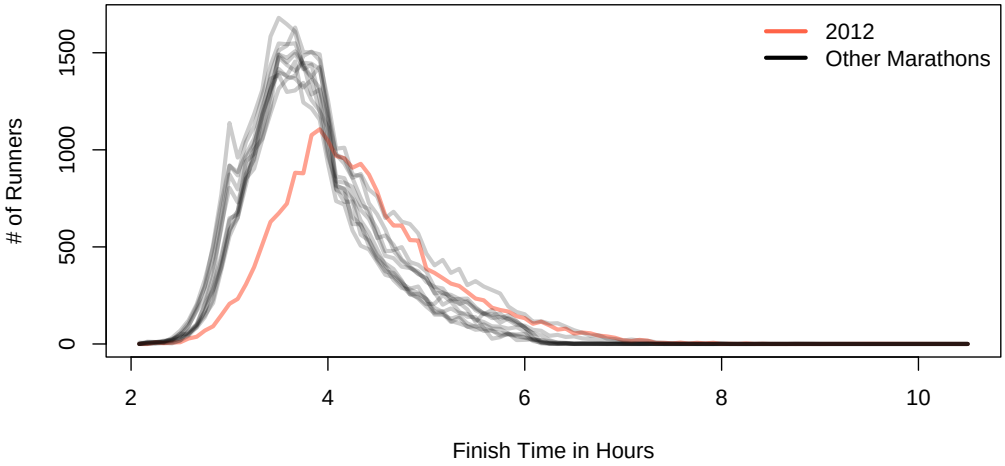
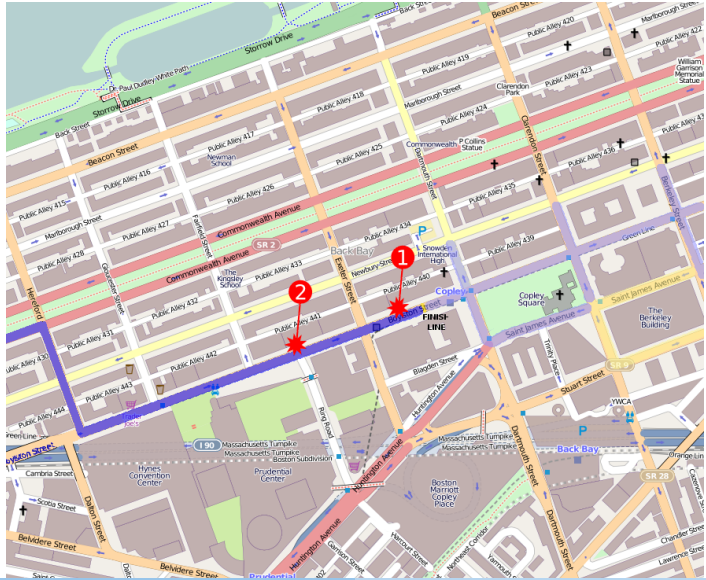
2012 Boston Marathon



2012 Boston Marathon



2013 Boston Marathon



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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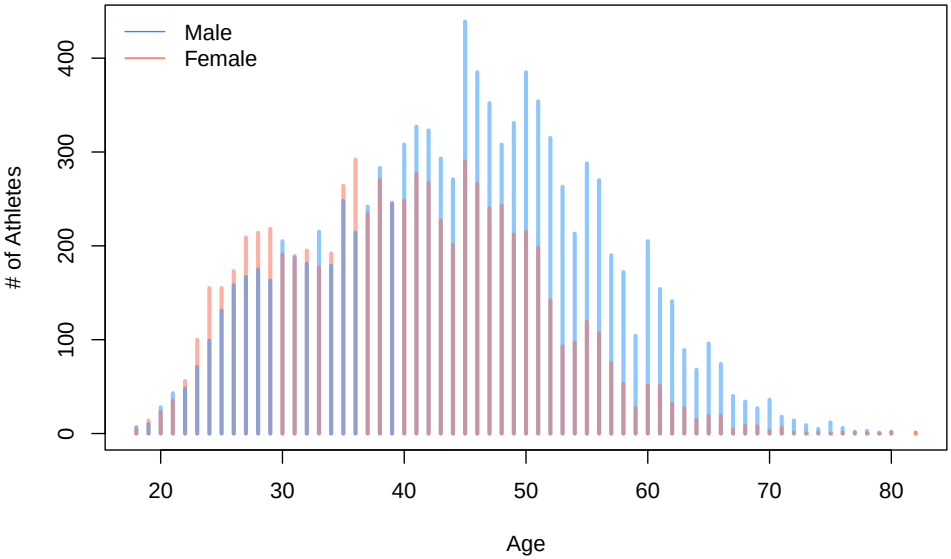
Age/Gender Distribution of All Runners in 2013



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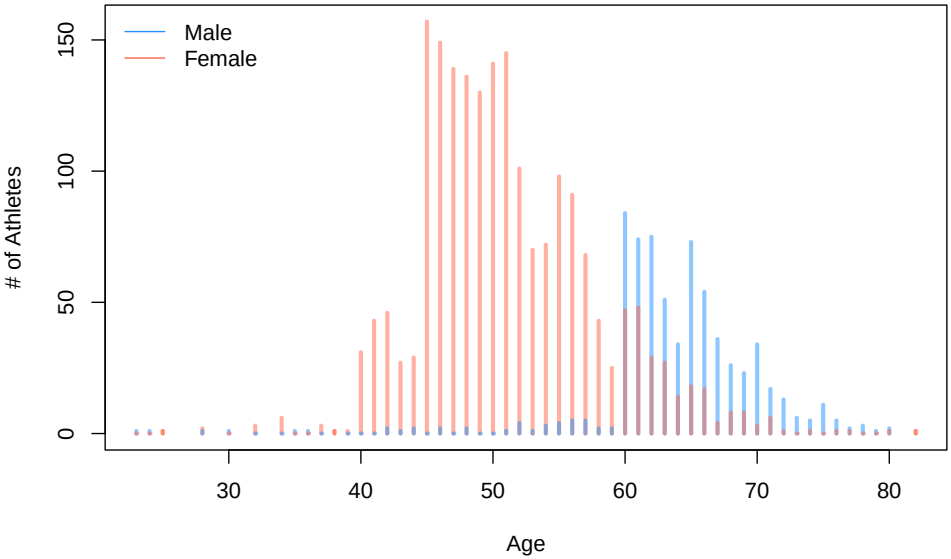
Age/Gender Distribution of Wave 3 Runners



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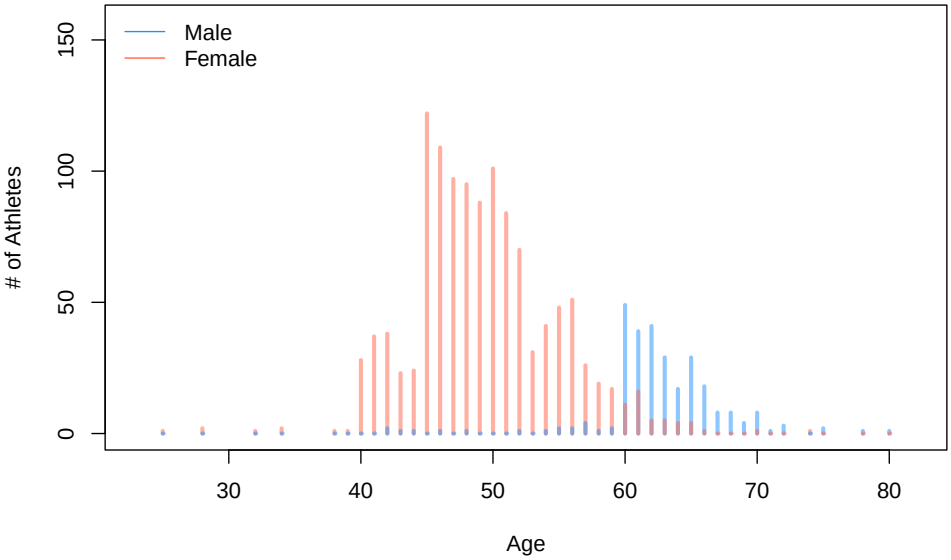
Age/Gender Distribution of Finishing Wave 3 Runners



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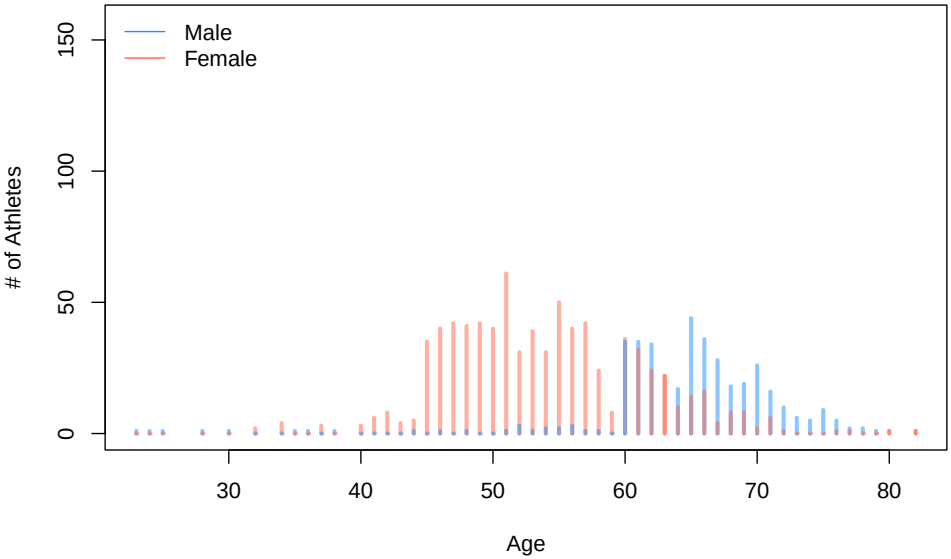
Age/Gender Distribution of DNF Wave 3 Runners



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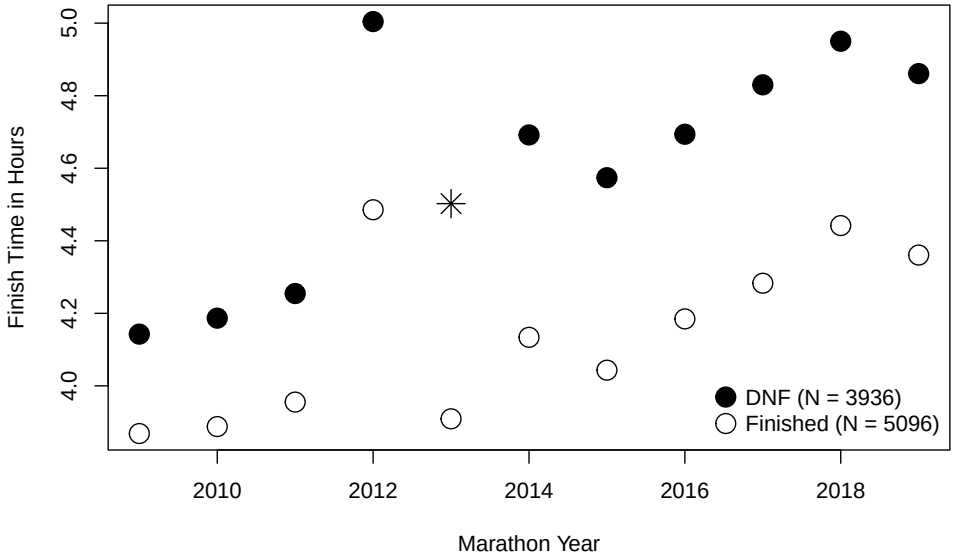
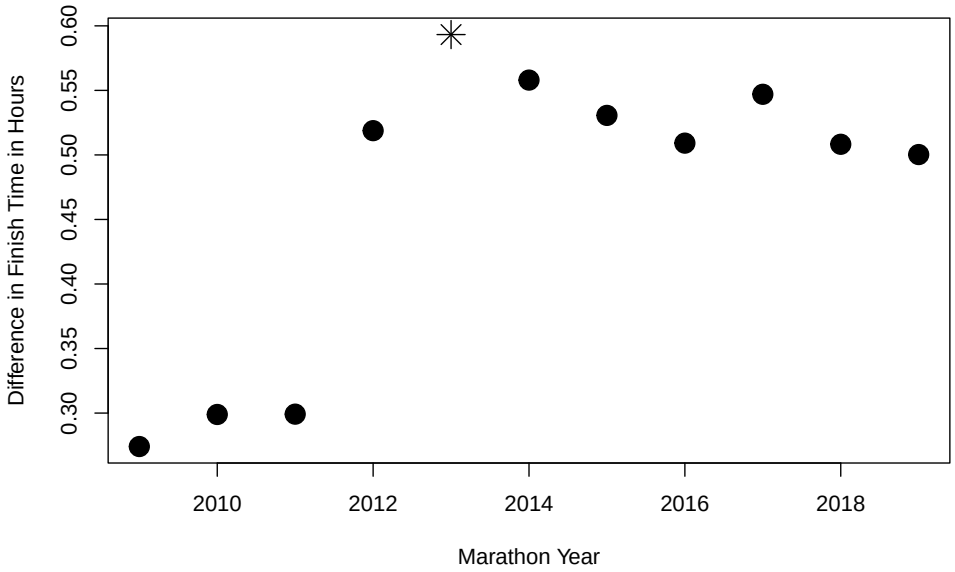
Finish Times in Other Races



Differences in Finish Times in Other Races



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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.

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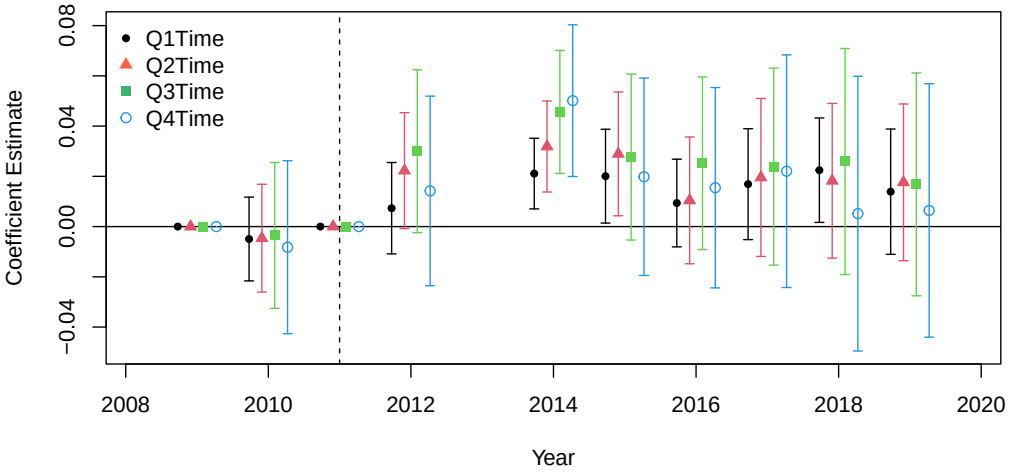
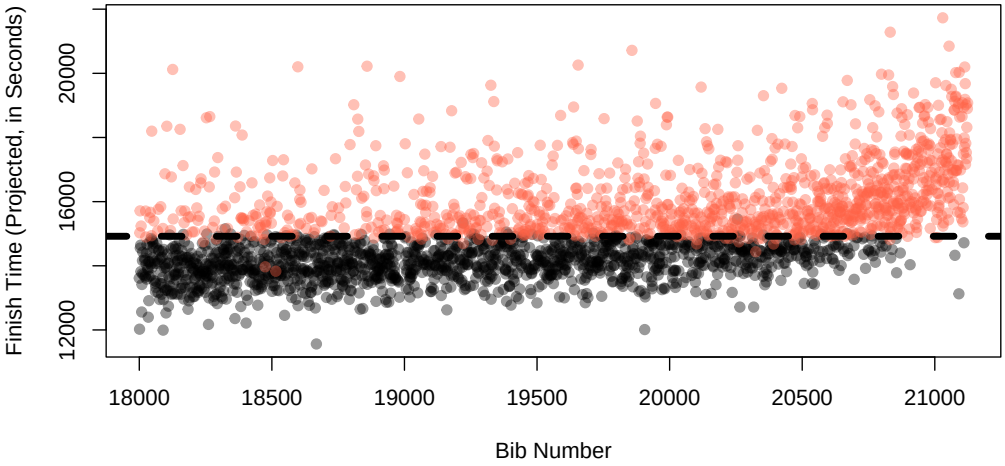
Race Times – Runner FEs



Bib Number vs Finish Time in 2013 (Time to Event)



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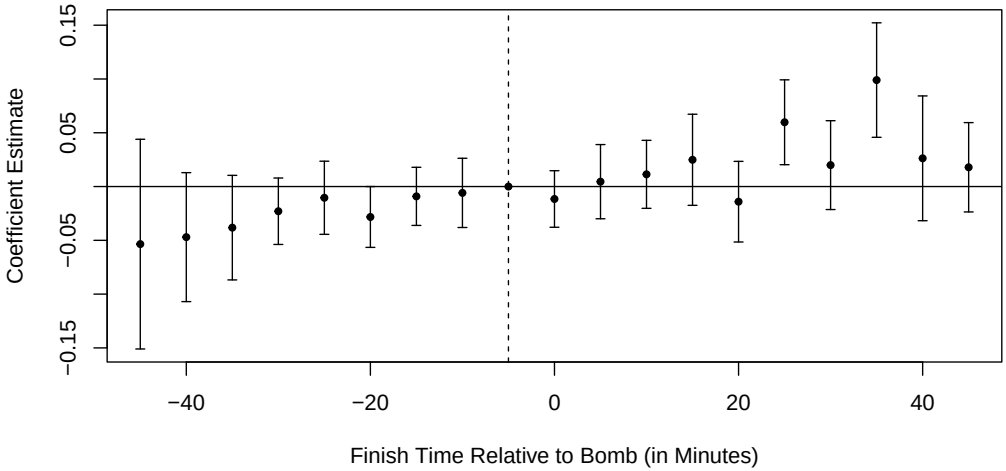
Race Times – Time to Event



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Controlling for "Bibs"

Runners line up based on their qualifying time (and division).

- Conditioning on gender and age leaves "ability" or "deterioration" as a confounding factor.
- Conditioning on bib number controls for race expectations, so the remaining variation ought to be random.

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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.

- This compares diverted runner i to runners who were absent from 2013, but had a similar qualifying time as runner i.

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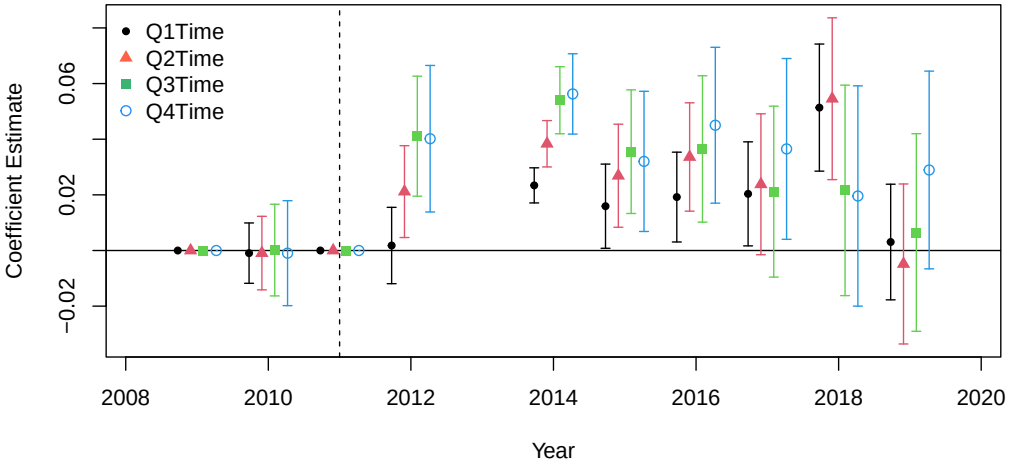
Race Times – Matched Sample



Controlling for "Bibs"

If the "treatment" of diversion impacts qualifying times, this can bias the results.

- Instead, we merge the runner FE model with the matching model.
- We control for bib-bin in 2013.

We estimate:

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

where $\tau_{b(i)g(i)t}$ controls for the average performance of athletes of gender g in bin b.

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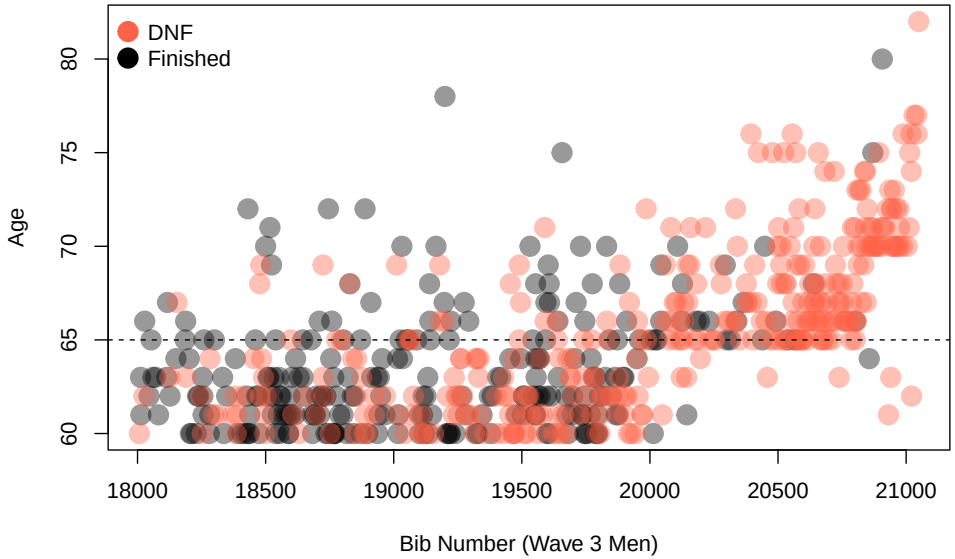
Age by Bib Number (Wave 3 Men in 2013)



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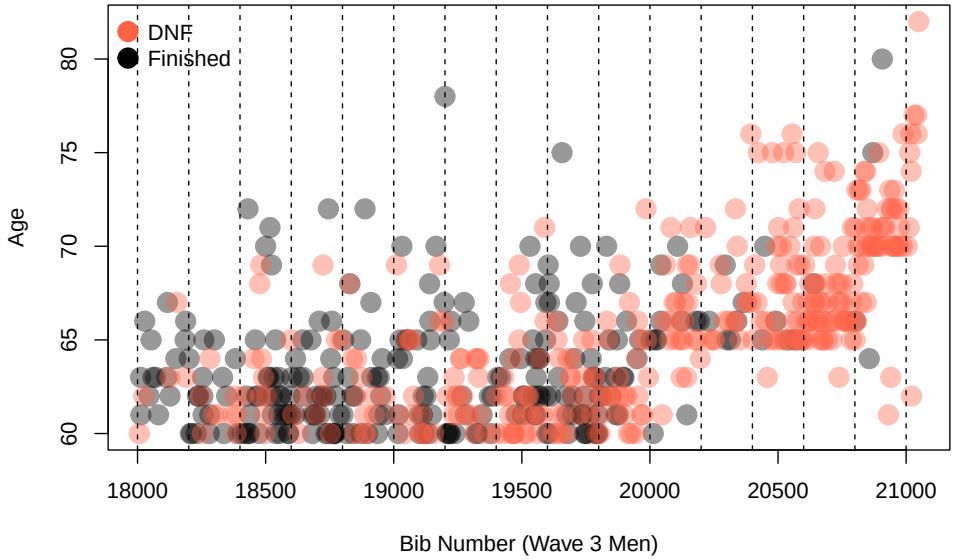
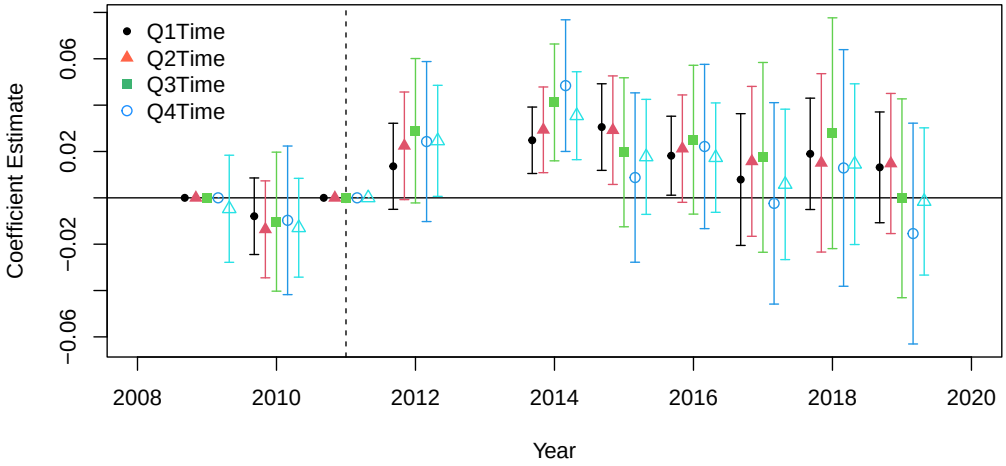
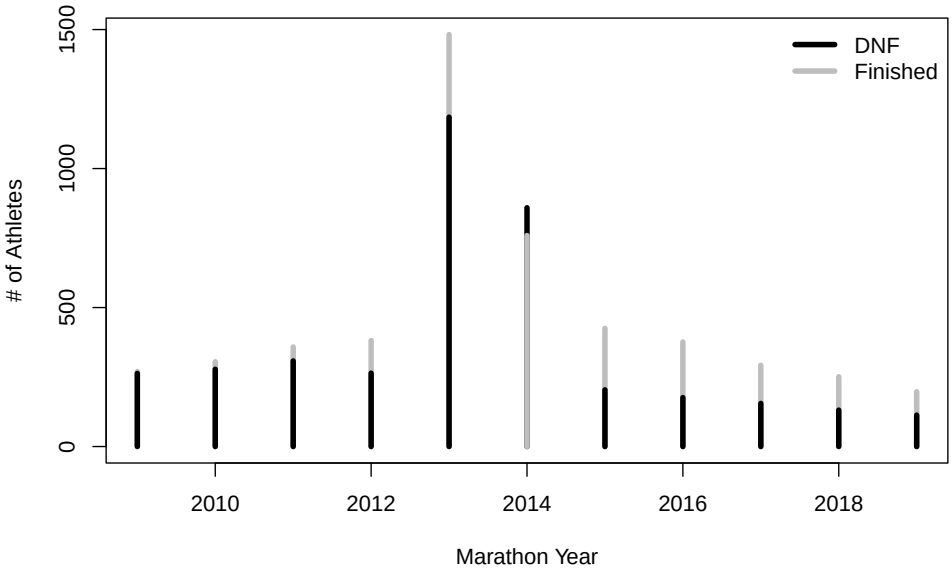
Age by Bib Number (Wave 3 Men in 2013)



Binned-Bib FE Results



Number of Wave 3 2013 Athletes by Race



Boston Marathon Participation Model

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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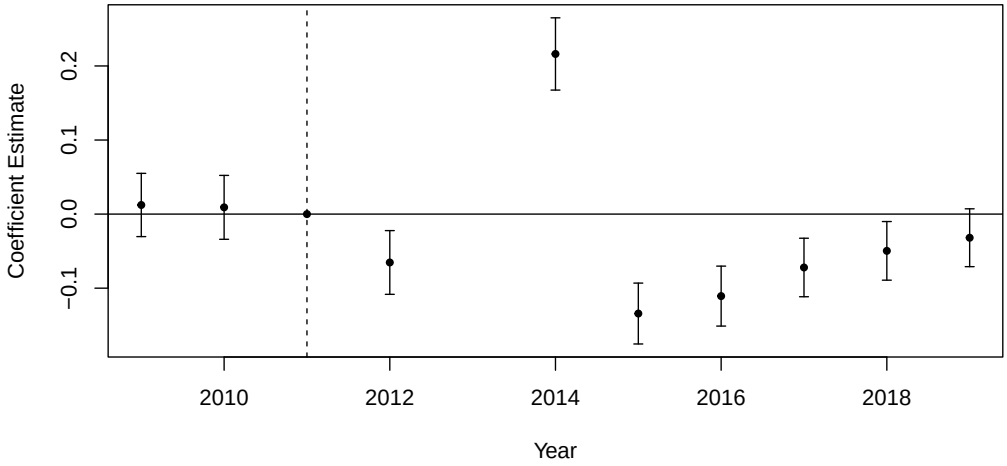
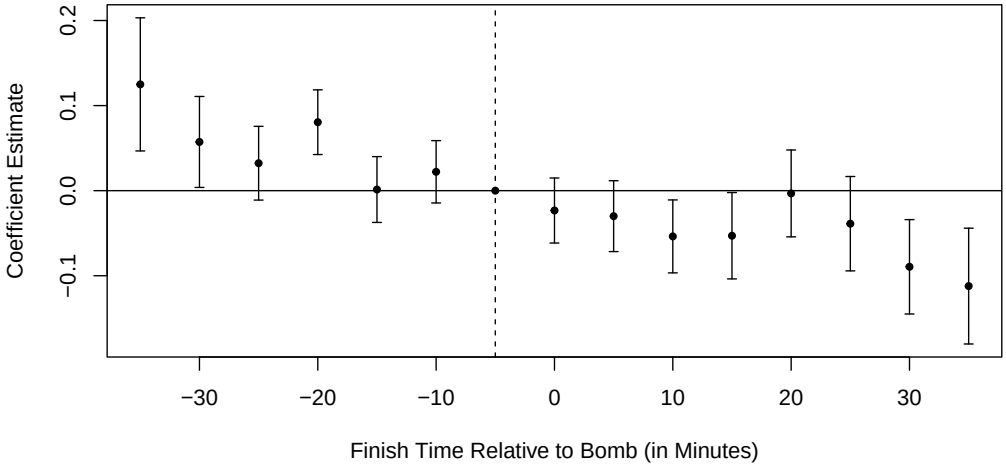
Boston Marathon Participation Results



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.

Maybe there's nothing to learn here, and I need to stop torturing this data...

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