

Producing Death

A Bayesian Hierarchical Model of Casualties

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Empirical Models of Battles

Two issues in the literature:

1. Bad data
2. Bad models

Empirical Models of Battles

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1. Bad data
2. **Bad models**

Empirical Models of Battles II

To be explained:

1. Outcome (Victory / defeat) (w)
2. Casualties (c_1, c_2)
3. Duration (d)

with,

1. Coherent models
2. Strategic behavior

Empirical Model of Battles

- military effectiveness: ability to incur and avoid casualties
- resolve: probability of quitting as a function of casualties
- duration is endogenous to resolve and military effectiveness

Something like,

$$p(w, c_1, c_2, d|.) = p_w(w|c_1, c_2, .) \\ \cdot p_d(d|c_1, c_2, .) \\ \cdot p_c(c_1, c_2|.)$$

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Military Effectiveness

$$E \frac{C_a}{t} = \alpha_a \chi_d^{\rho_a} \chi_a^{\beta_a} \quad (1)$$

$$E \frac{C_d}{t} = \alpha_d \chi_a^{\rho_d} \chi_d^{\beta_d} \quad (2)$$

Derived Quantities

Quantity/Quality

“Quantity” < “Quality” when $\lambda_a < 1$, where

$$\lambda_a = \rho_d - \beta_a + 1 \quad (3)$$

Defensive Advantage

$$\log \alpha_a - \log \alpha_d = \zeta_a - \zeta_d = \Delta\zeta_a \quad (4)$$

Statistical Model

$$y_i = \zeta_i + \rho_i \text{stro}_i + \beta_i \text{str}_i + \tau_i \text{duration}_i + \epsilon_i \quad (5)$$

Hierarchical model with levels

- attacker
- war
- battle
- war \times attacker

For example,

$$\zeta_i = \zeta_d + \Delta\zeta_{\text{war}_i}^w + \Delta\zeta_{\text{battle}_i}^b + (\Delta\zeta_a + \Delta\zeta_{\text{war:attacker}_i}^{w:a}) \times \text{attacker}_i \quad (6)$$

Innovation

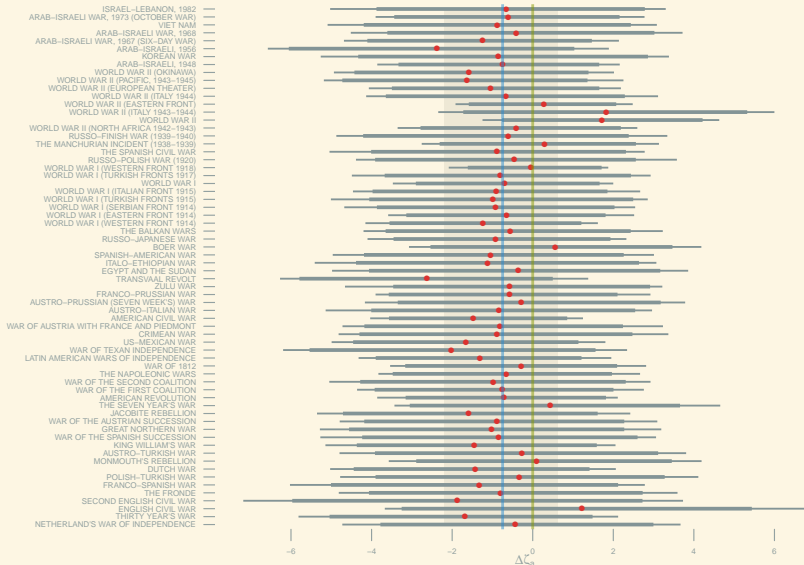
War-level estimates

1. How has offense defense balance changed over time?
2. How has quality / quantity trade-off changed over time?
3. Mitigates some selection bias in battle data

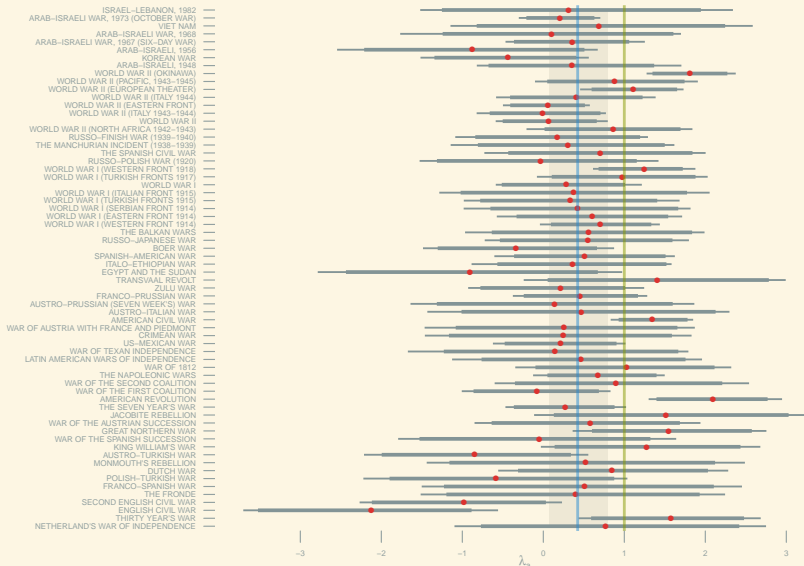
Data

- CDB-90 dataset of battles
- 66 “Wars”
 - War of Dutch Independence (1600) to
 - 1982 Lebanon War
- 620 Battles
- Number of battles per war
 - Median = 5
 - Max = 49 (“American Civil War”)
- 1238 belligerents

Defensive Advantage



Quality vs. Quantity



Conclusion

Towards theory based, empirically estimable models of battles and wars