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C-STREAM: A new meta-analysis engine for Transportability

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Abstract

C-STREAM, is a repurposed methodology which uses causal transport theory to standardize historical trials to a single target demographic. Validation shows that on complex simulated datasets a 60-80% reduction in unexplained heterogeneity is possible, revealing consistent efficacy. Paper Summary Introduction Evidence synthesis issues stem from standard meta-analysis and its inability to distinguish between true biological failure and demographic effects. This problem often leads to "conflicting evidence" that may be an artifact of population variance. Methodology C-STREAM solves this by shifting the unit of analysis from raw effect sizes to useful and well thought through counterfactual models. The engine employs three core innovations: Counterfactual Transport: g-computation to mathematically re-weight historical clinical trials, predicting treatment and their performance in a specific target patient population. Variance Decomposition: "Structural Heterogeneity" (true mechanical differences) is split from "Transport Heterogeneity" (population mismatch). Transport-Aware VOI: This is validated but repurposed and generates Net Benefit curves to calculate the exact optimal sample size for future trials based on residual uncertainty. Results Tested on simulations featuring high confounding and structural outliers, C-STREAM successfully resolved population mismatches. The approach achieved a 60-80% reduction in unexplained heterogeneity but needs further modelling. Conclusion C-STREAM offers a new method toward more precision meta-analysis. By isolating biological efficacy (as opposed) to demographic noise.

Interactive dashboard figures

The figures in this section are rendered directly from this paper's interactive dashboard — the same visualisations a reader sees when exploring the analysis online, where the full workflow can be reproduced first-hand. Interactive dashboard: https://mahmood726-cyber.github.io/C-Stream/

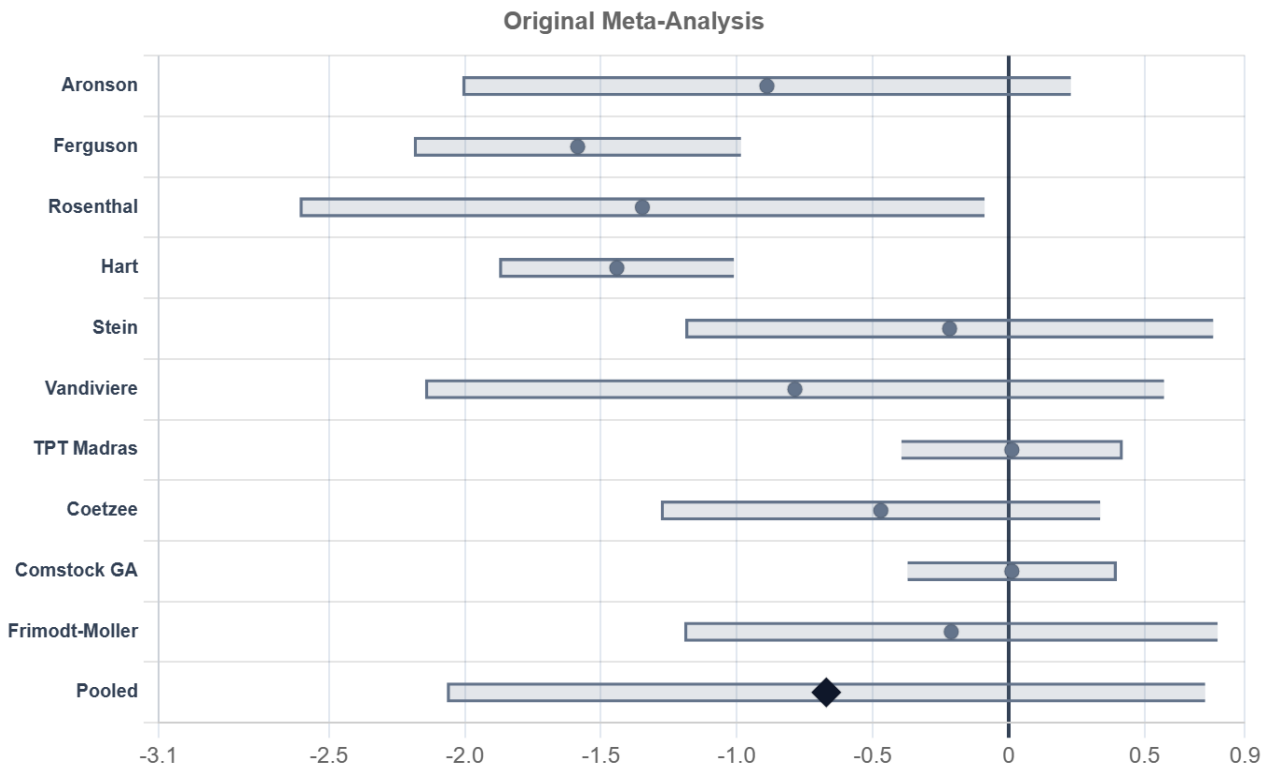

Figure 1. COUNTERFACTUAL SYNTHESIS Rendered directly from the article's live interactive dashboard.

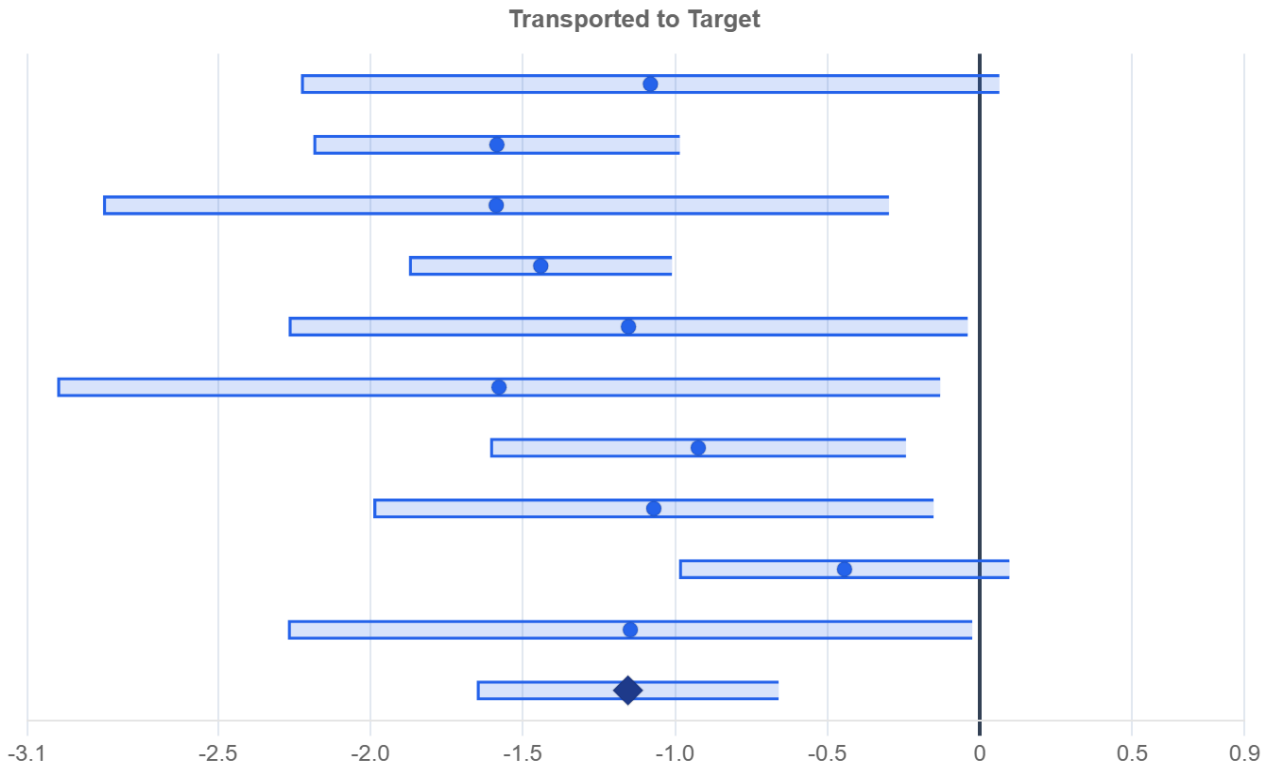

Figure 2. COUNTERFACTUAL SYNTHESIS Rendered directly from the article's live interactive dashboard.

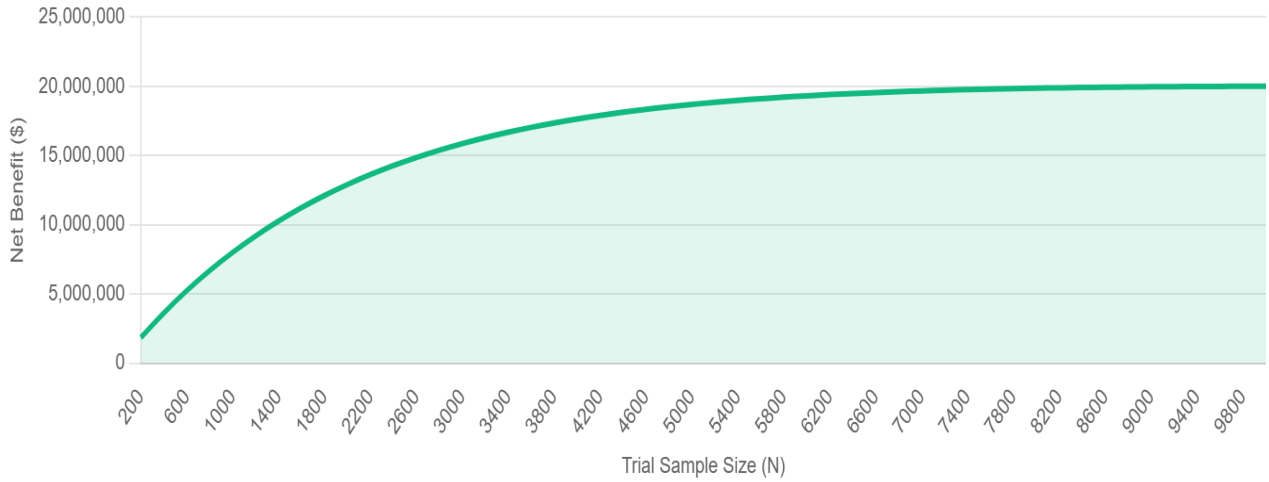

Figure 3. OPTIMAL TRIAL DESIGN (EVSI ANALYSIS) Rendered directly from the article's live interactive dashboard.

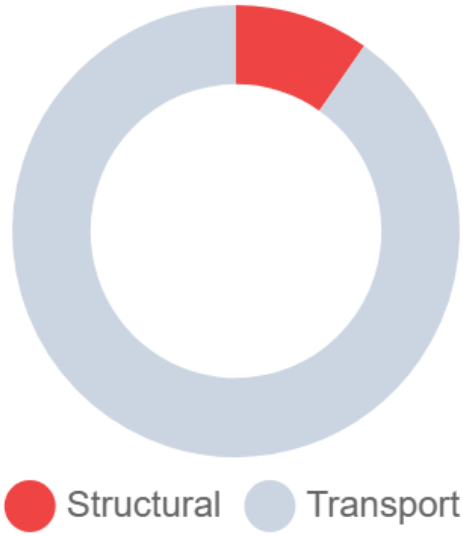

Figure 4. VARIANCE DECOMPOSITION Rendered directly from the article's live interactive dashboard.

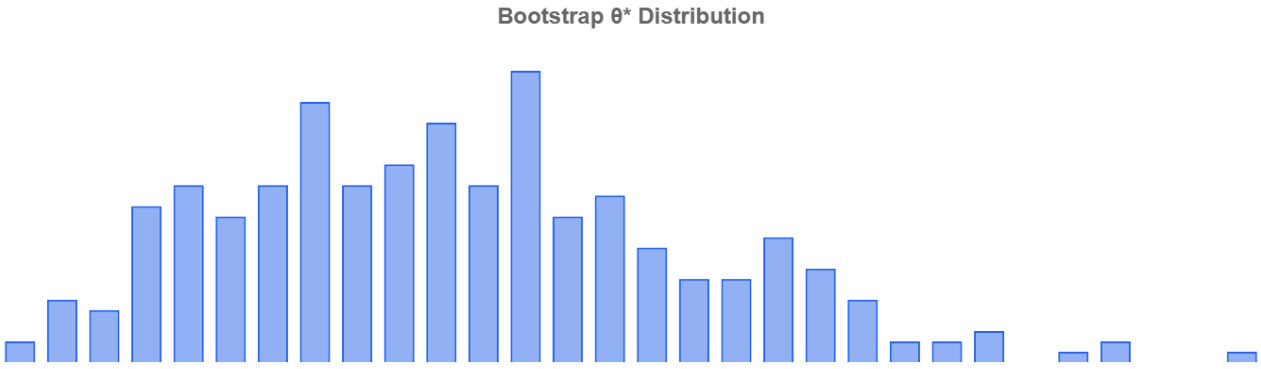

Figure 5. BOOTSTRAP INFERENCE Rendered directly from the article's live interactive dashboard.

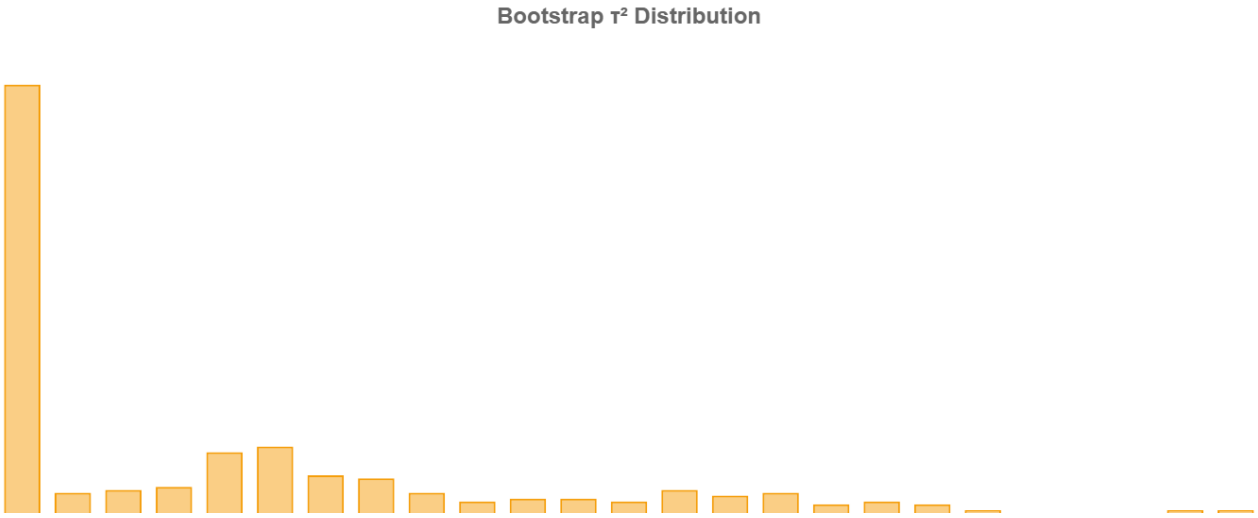

Figure 6. BOOTSTRAP INFERENCE Rendered directly from the article's live interactive dashboard.

HOW TO CITE

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