The Rebudgeting Algorithm

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How can we maximize the return on investment of acquisition marketing?

Strategic Context

- Netflix spends a lot of money on programmatic marketing to acquire new subscribers.
- We have many geographies and advertising platforms that we could spend any given dollar on.
- Two problems:
  - How do we spend our money to maximize our return on investment (ROI), given a budget?
  - How much money should we spend on advertising?

Strategic Context

- Solution: The rebudgeting algorithm!
  - Aggregates everything we know about past performance of advertising spend to predict future ROI.
- Algorithm consists of several components:
  - Data ingestion from advertising platforms
  - Computing **lift** (i.e. number of people converted) by country and platform
  - Revenue-weighting of predicted lift
  - Optimizing allocation given predicted result

The Rebudgeting Workflow

- How did this project come to be?
  - The Data Scientist designed the model, validated via A/B test that this was better than the rules-based approach we had before
  - Implementation required a collaboration with data engineers, product managers and campaign managers to make sure everything ran as intended
  - Stakeholder relationship was key for adoption

Measuring the Impact of Ads

- **Incremental lift (IL):** Number of people who became Netflix subscribers **because** they saw an ad
- At Netflix, programmatic campaigns are run as **experiments**
  - People are randomized into treatment and control at the very last point of the ad stack (after being targeted, and the auction is won)
  - We use ghost ads or counterfactual logging to causally measure the impact of our ads

The incremental value of spend

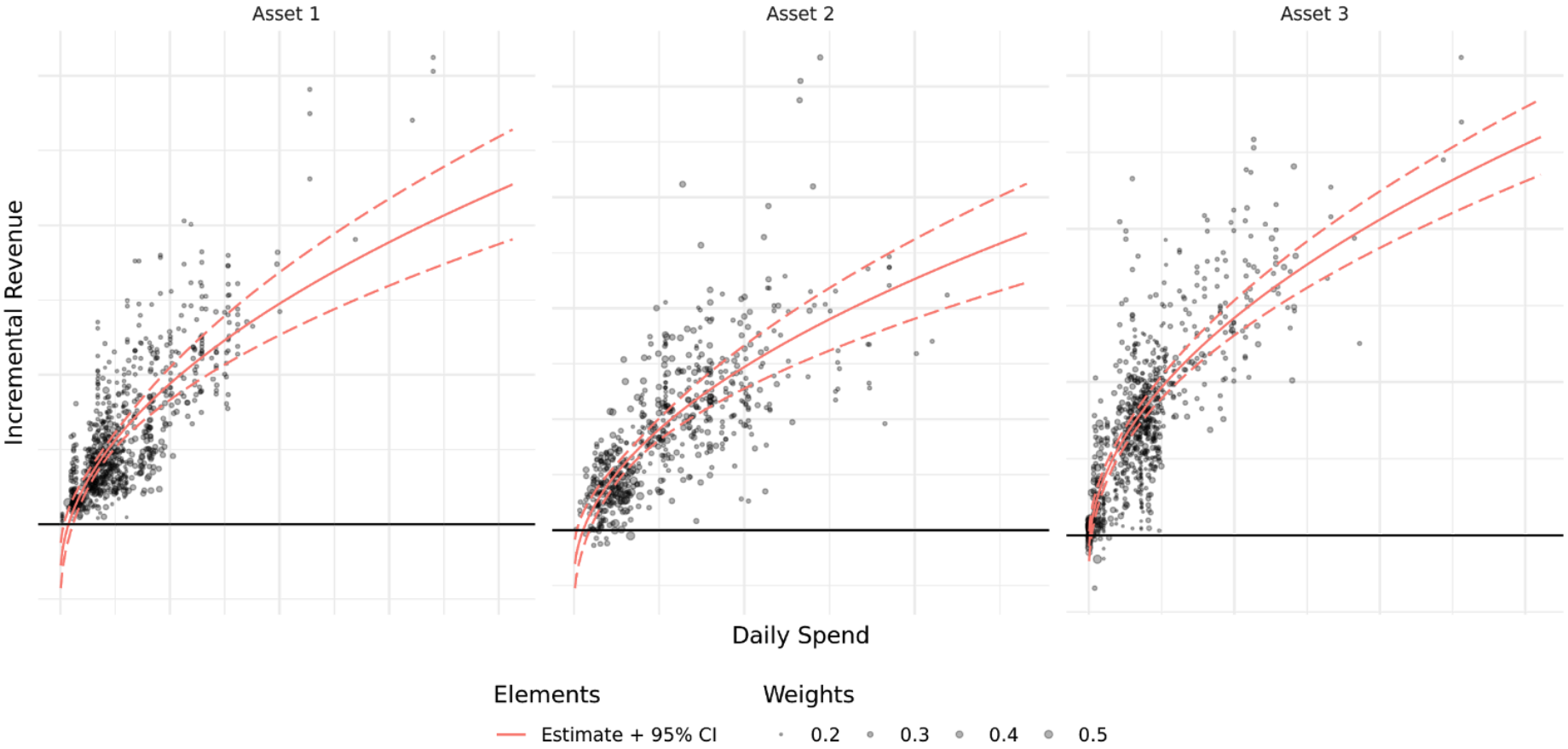
- Incremental lift doesn't capture the value of ad spend
  - Retention probabilities differ wildly between geographies
  - Solution: In-house model for average subscriber value (ASV)
- Platforms have measurement blind spots and can undercount subscribers in different ways, we use exchange rates (ER) between platforms to correct this
- Expected Incremental revenue:

$$E[\mathrm{IR}_{p,g}|spend_{p,g}] = E[\mathrm{IL}_{p,g}|spend_{p,g}] \cdot ASV_g \cdot ER_p$$

Modeling Incremental Revenue

- Generally, the more we spend, the more incremental revenue we see
  - Returns are diminishing
  - Every country has its own independent curve
- As new data comes in, it is upweighted relative to old data
- Data kept fresh via always-on thompson sampling

Predicted Incremental Revenue and Daily Spend



Optimizing the Portfolio

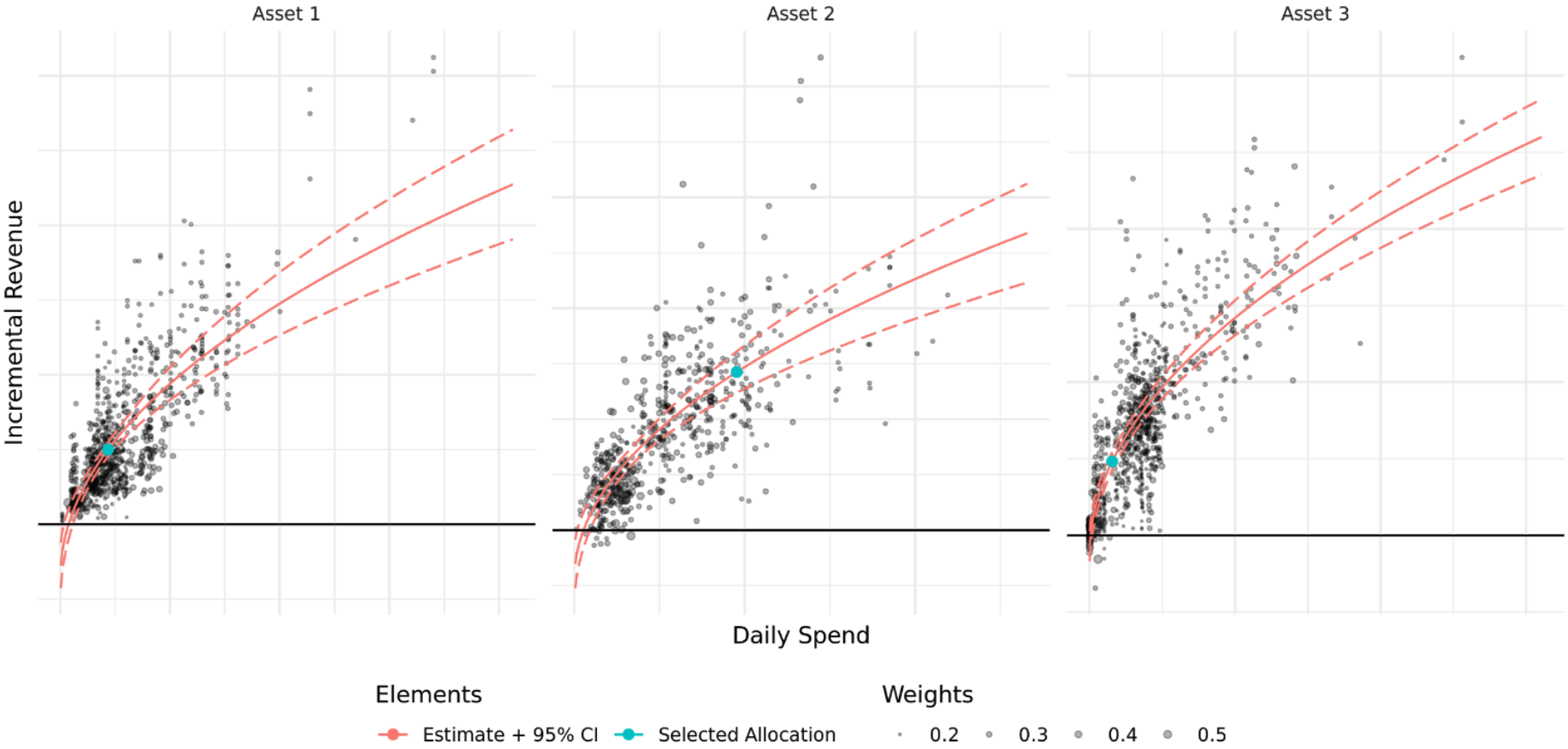
- Take model parameter estimates and find a spend level to:
- Maximize expected revenue
- ...given a daily budget
- ...and inventory constraints

$$spend^* = \arg\max_{spend} \sum_{g \in \mathcal{G}, p \in \mathcal{P}} \hat{E}[lift^*_{g,p} | spend_{g,p}, \hat{\beta}_{g,p}]$$

$$\text{s.t.} \sum_{g \in \mathcal{G}, p \in \mathcal{P}} spend_{g,p} = \overline{budget}$$

$$\underline{spend}_{g,p} \leq spend_{g,p} \leq \overline{spend}_{g,p} \; \forall \; g \in \mathcal{G}, p \in \mathcal{P}$$

Predicted Incremental Revenue, Daily Spend and Optimal Allocation



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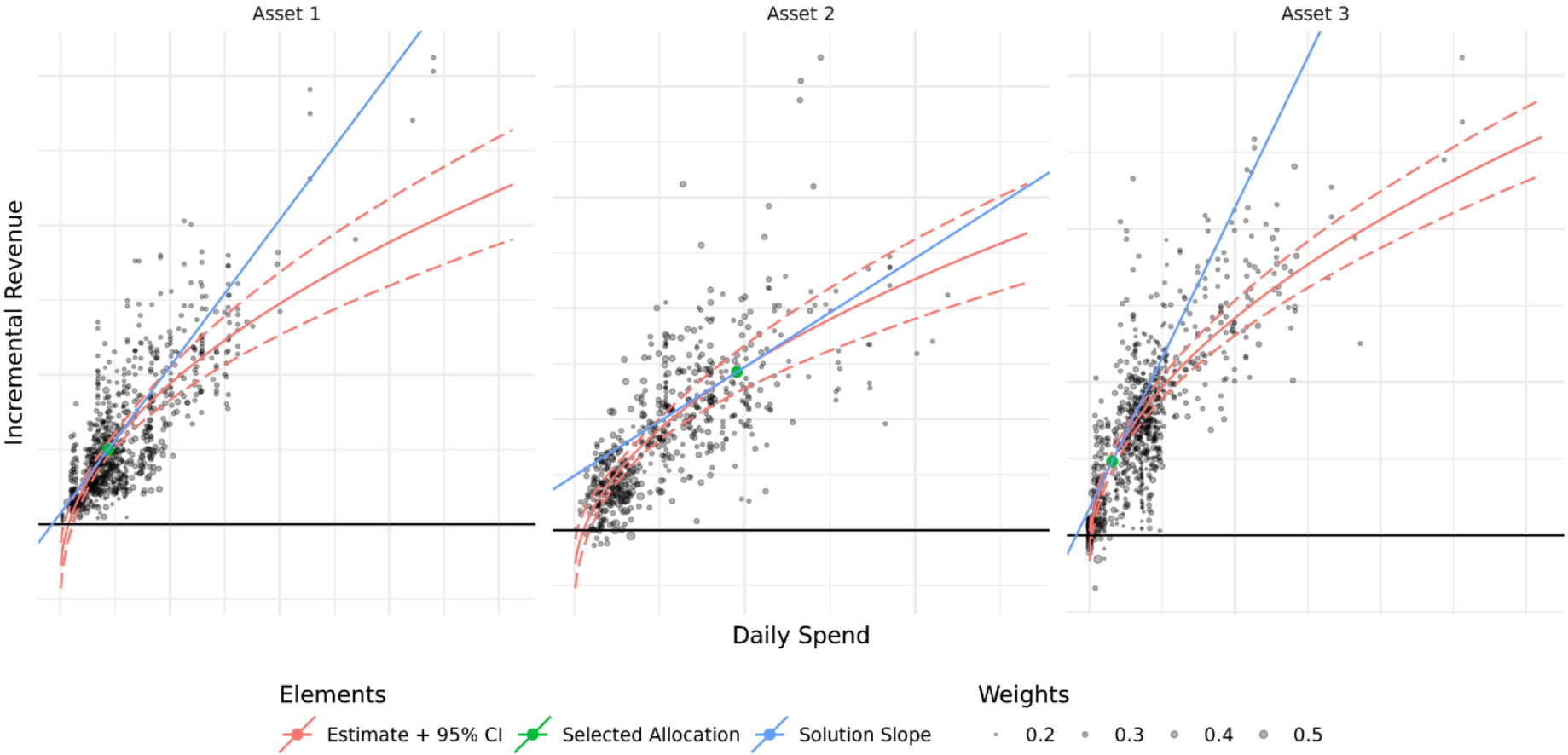

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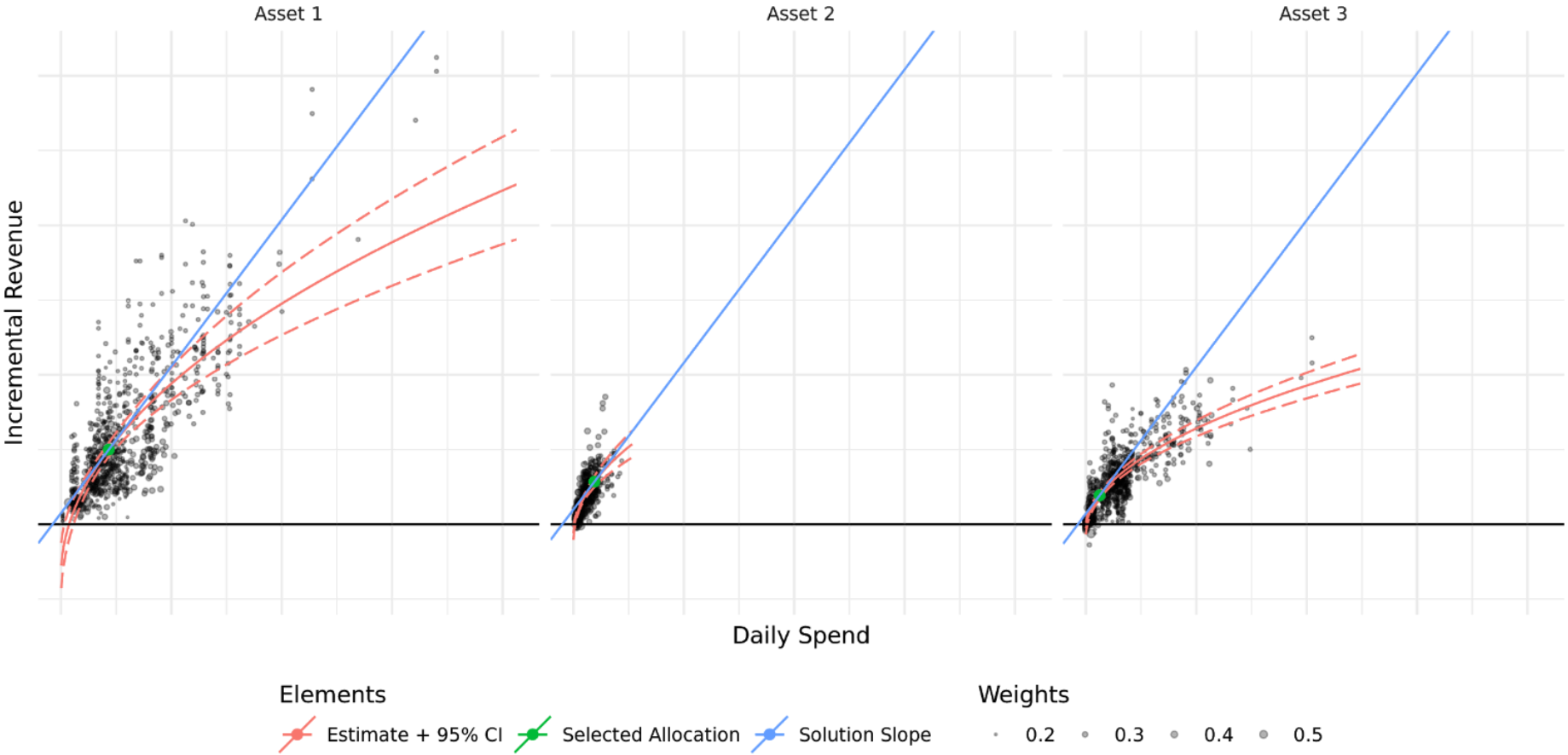
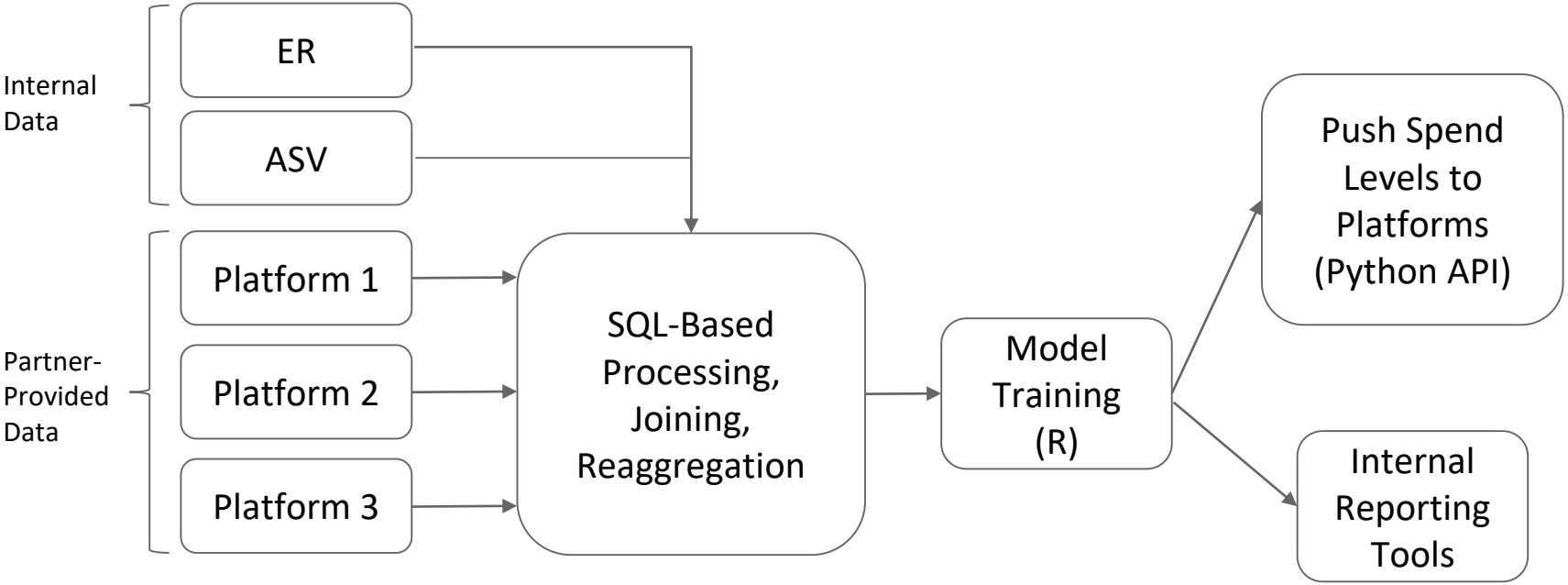
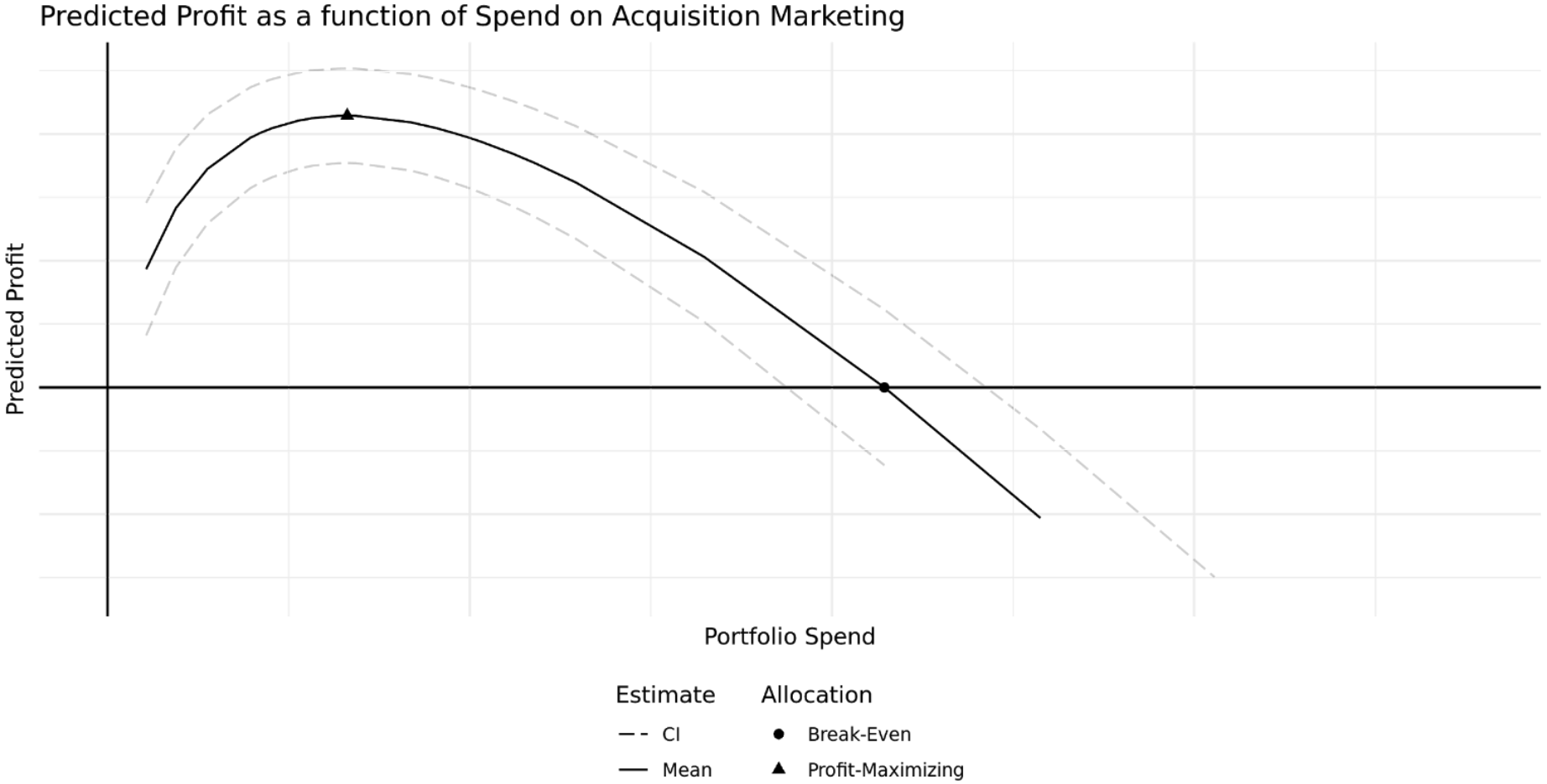


Data Engineering



The same model/optimizer can recommend top-level budgets

- The model outputs expected incremental revenue of the whole portfolio as a function of any intended spend level
- By making the model solve over a grid of total portfolio spend, we can find the profit-maximizing point and the break-even point


Predicted Profit as a function of Spend on Acquisition Marketing
Predicted Profit
Portfolio Spend
Estimate
CI
Mean
Allocation
Break-Even
Profit-Maximizing

Thank You.

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