The benefits of Randomization Mechanisms in Counter-Strike: Global Offensive

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Topic

- Many video games have chosen to sell cosmetic alterations to their games using randomization mechanisms called “loot boxes”
- Economic Literature tells us that there is no benefit to randomization for risk-neutral consumers, so the benefit must come from risk-loving consumers.
- How much more revenue-generating is this compared to traditional selling mechanisms?

What is Counter Strike?

- Popular First-Person Shooter video game first created in 1999, current version has existed since 2012
- Weapon Skins are items that change how your weapon looks within the game
- Skins can be opened from boxes for $\$2.50$ or bought and sold at a secondary market
- The contents are each box are public, as are the probabilities of obtaining each of the contents.
- The boxes or their contents are able to be sold at a secondary market where Valve then takes 15% as a tax.

Why do we care?

- We are interested in discovering what drives this market to feature randomization mechanisms.
- Are consumers inherently more risk-loving when they play video games?
- Is this driven by consumers over-weighting tiny probabilities as cumulative prospect theory suggests?
- Are consumers weighing benefits and losses differently?
- What is the magnitude of these gains from randomization?

What do the weapon skins look like?

The Data

- Contains complete market history for all items sold in the Steam Community Market for *Counter-Strike: Global Offensive*
- Market history is specific to the hour for the last 30 days, specific to the day for the remaining time the item has existed.
- Contains all active buy and sell orders for each of these items as of June 7^{th} 2018.
- Note that this not the only way to obtain the item, as it can also be obtained by opening the box.

Roadmap

- Want to estimate the demand of the consumers for each of the weapons contained in the game.
- Compute the distribution of the risk-neutral price that consumers would be willing to pay for a loot-box.
- Compute the risk-preference of consumers by using the demand for the loot boxes and the demand for the contents.
- Calculate the benefit of randomization by the difference between the valuation distribution for the boxes, and the risk-neutral distribution.

Discrete Choice

- There are many weapons available in the game, but discrete choice requires that we only ever buy a single item.
- Assume that there are distinct markets for each weapon "role" that is decided by domain knowledge.
- For example, a person would only consider buying a single AK47 skin, as he only ever have one equipped at a time.
- This assumes that no substitution occurs between weapon roles (AK47 never substituted for M4)

Agents

- Want to use the Random Coefficients Logit Demand Model. (BLP 1995)

$$u_{ij} = \alpha_i p_j + \boldsymbol{x}_j' \boldsymbol{\beta}_i + \xi_j + \epsilon_{ij}$$

- α_i, β_i individual specific parameters, x_j is the observed characteristics of good j, ξ_j is unobserved characteristics (but the consumers and producers observe them).
- ϵ_{ij} is distributed type 1 extreme value distribution with mean 0.
- Logit demand with heterogeneity between consumers

BLP Continued

- Consumer i's demand for good j is given by:

$$\Pr(i \to j) = \frac{\exp(\alpha_i p_j + x_j' \beta_i + \xi_j)}{\sum_{k \in \mathcal{F}_t} \exp(\alpha_i p_k + x_k' \beta_i + \xi_k)}$$

- Equilibrium Market share π_j is given by:

$$\hat{s}_j \approx \pi_j = \mathbb{E}\left[\Pr(i \to j)\right]$$

Instruments

- Need instruments for both price and market share
- Price Instruments: The price of other contents in the same loot box. By our separate market assumption, this is exogenous.
- Instrument relevance: Supply shocks (changes to the amount of boxes being opened) must affect the other contents as well as this one.
- Market Share instruments: BLP Instruments
- Use the sum of the characteristics of the other products in the market.

Risk Preferences

- Assume that consumers are homogeneous about risk-preferences and the market for the loot boxes and their contents are in equilibrium.
- This assumption implies that there are no differences between the consumers that purchase the loot boxes and those that do not.
- This allows our estimates of demand from the secondary market to be applied to the loot boxes.

Risk Neutral Pricing

- From the distribution of valuations for the weapon skins, the risk-neutral valuations of the loot box are a convex combination.
- By assuming normality on the valuations, this is computationally tractable.
- This risk-neutral pricing is the value that could be made by selling these items using traditional price-discovery mechanisms.

Risk Estimation

- Want to estimate the risk primitives (Cumulative Prospect Theory)
- However market price is censored data of valuations.
- Existing buy orders however are valuations. Reporting your actual valuation is a dominant strategy when you pay the seller's ask.
- Can estimate the risk-primitives using some functional form and Censored Maximum Likelihood Estimation

Results

- Once we have computed the risk primitives, we can compute the benefit of randomization
- For some good j with consumer i's valuation V_{ij}, Let $F(V_i)$ be the risk-transformed valuation.
- Benefit to Valve for this randomization is given by:

$$\Pi = \int \sum \left[F(V_{ij}) - V_{ij} \right] d\theta$$