Spaceships are Serious Business: Econophysics of EVE Online

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Econophysics Presentation
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Overview of Talk

- What is EVE Online?
- Datasets used
- Power Laws
- Correlations
- Market Shocks
- Further Research
What is EVE Online?

• Classified as a MMO
• Started in 2003
• “Sandbox” Gameplay
• Rich & Emergent Markets
  • Localized emergent market hubs
  • >10k individual items
  • 1-2M daily transactions
  • Commodities Market
Geography of EVE Online

- Dodixie
- Amarr
- Jita
- Hek
- Rens
 Mechanics of Trading

- Two Positions: “Asks” and “Bids”
- Asks: offer money and wait for players to sell to you.
- Bids: offer items and wait for players to buy from you.
- Any item is always sold/bought with the best bidder.
- Transaction Tax:
  - 0.75% to place an order
  - 0.80% to complete a transaction (for both parties)
- Money: ISK (InterStellar Kredit OR Icelandic Krona)
Data Used

• Publicly Available data from Third-Party Website:
  • https://eve-central.com/

• Cache Scraping to collect data from players who offer to help
  • Incomplete data set!

• Data from 2006 – Present
  • Stored as a data dump; highly uncompressed
  • ~300 Mb/day, or 110 GB/year

• First thing: Download & Compress data
  • Select only orders from 5 main trade hubs
  • Select only top ~1,000 most popular items
  • Compress data from all orders to the Best order, and the total order volume

• Compressed to ~1.5GB for 300 days of data
Data Used (Continued)

• Data points are independent vectors of:
  (ItemID, Location, Buy Price, Buy Volume, Sell Price, Sell Volume)

• Convert data into a time series:
  • Create time boxes, fill all empty boxes with nearest left filled neighbor
  • Multiple points per box are averaged.
Example Data

- Hourly-Averaged data for “Mexallon” (Equivalent to Steel or similar; a basic building material)
- 54,773 Data points in Jita (7.6 per Hour)
First Result!

- Prices tend to settle to round Numbers, aka 810,000,000.00
- Insight on mentality of players?
- Market Inefficiencies!
Further Exemplified: “PLEX Inflation”

- December 2014: the PLEX speculation bubble
- Prices rose from 500m in 2012 to >800m in 2014
- Sell Prices touched 1,000m, which caused the bubble to burst, just because of the number.
Is this system similar to real Markets?

• Power Law Returns?
• Efficient Market Hypothesis?
• Cross-Market Correlations?
• Trade-Hub Emergence?
• Cross-Item Correlations?
• Market Shocks?
• How can I make a profit?
Power Law Returns

• Looking at 24h returns for different items
• On right: “Basic Minerals” market group; Equivalent to basic commodity prices (steel, wheat, etc)
• Recover a power law as is expected
• “Tritanium” had an anomalous event in 12/14 which messed up normalization
• Less active items are anomalous around 0 returns
Efficient Market Hypothesis

• “There are no chances for Arbitrage in the system”
  • All autocorrelations are zero for non-zero time shifts
  • Inter-item correlations are the same, or small
Autocorrelations of Returns

- 48 Hour returns with 1 hour shift means there is some “blurring”
- Daily timescales are “Natural” for this system; the market is normally slow.
Does this violate the Efficient Market Hypothesis?

- **NO:** there is a Transaction Tax which allows for small correlations!
- Suppose you knew that an item was going to increase in value in the next 48h. How do you profit?

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase at Low Value</td>
<td>-$800,000,000.00</td>
</tr>
<tr>
<td>Transaction Tax (1.7%)</td>
<td>-$13,600,000.00</td>
</tr>
<tr>
<td>Sell 48h later (+2.0%)</td>
<td>+$816,000,000.00</td>
</tr>
<tr>
<td>Transaction Tax (1.7%)</td>
<td>-$13,872,000.00</td>
</tr>
<tr>
<td><strong>Total Profit</strong></td>
<td><strong>-$11,472,000.00</strong></td>
</tr>
</tbody>
</table>

- Most fast Fluctuations are below transaction tax threshold: Not scale free!
Cross-Market Correlations

- Are there “Leader” and “Follower” markets?
  - 5 main trade hubs! Cross-correlate returns for time series!
- Jita (the largest trade hub) is consistently the leader of price changes
Market Shocks and Speculation

- Sometimes the game developers announce changes to the game
  - Equivalent to the Federal reserve changing interest rates, or companies announcing new products.
  - Announcements range from balancing ship classes to modifying mineral manufacturing ratios.
- Prices can rapidly change to settle on a new optimal value, on timescales of hours!
- Markets can be small enough to allow for manipulation by players
Market shocks are common

- “Invention” Changes on 11/1/2014 (Some results below)
- Proposed Mineral changes on 4/1/2015: Some prices **double**
- Anti-Botting Mechanism late 2014: Partially responsible for PLEX crash
Market Manipulation

• The basics are simple:
  • Buy a large volume of an item to push up the price
  • Re-list all purchased items at the higher price
  • Sell all items at a higher price for a profit
  • Hope you sell everything before prices return to normal!

• How does a Transaction Tax effect Manipulation?
• How can I use this information to make a profit?
Some Basics...

- Volume Response
- Time Response
- Definitions:

\( \gamma \) – Price-Volume relationship [ Percent per Item ]
\( \tau \) – Characteristic System Time [ Time ]
\( V \) – Volume – [ Items per Time ]
\( T \) – Transaction Tax [ Percent ]
More things to explore!

• Trade Hub Emergence
• System response to shocks
• Price-Impact Function
• Market Manipulation
• Material-Product Correlations
• More impacts of taxation
• Exploiting Market Inefficiencies!

• How can I make a profit?
Thank You!

• Eðvald I. Gíslason, Analyst CCP Games
• Antonio, Chester & Dr. Stanley
• http://www.eve-central.com
• http://www.eve-markets.com
• http://imgur.com/gallery/jOfk1
• All art used is from CCP Games