Winter 12-5-2004

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ABSTRACT

Online auctions have demonstrated how e-commerce can transform business, and not merely transplanting conventional processes to a new medium. The resulting emergence and growth of diverse markets pose the intriguing question of what 'shape' a given market is in at a particular moment of development. The approach of Topological Analysis, which is based on the Star Plot method in data visualization, provides such a model using only operational data, without any expert knowledge of the specific auction market, or financial details from the transactions. Using extensive analysis of data available on eBay.com, the foremost online auction platform to date, a global comparative study of four markets in eight countries is conducted. The results shed light on the evolution of electronic markets, as well as their regional and cultural variations.

Keywords: online auctions, market topology, data mining, data visualization

1. DATA VISUALIZATION AND THE SHAPE OF ONLINE AUCTION MARKETS

The Internet is a new medium of communication connecting potential partners in e-business worldwide. The initial frenzy over its promises led to grossly exaggerated valuations of business models that were mere transplantations of existing processes to the alternative channel. Now that the bubble has burst [8], more sensible and critical thoughts can be turned to true transformations that are creating and nurturing markets of the future, and shaping business strategies in a networked world. Online auction is one of the very few cases that has held a steady course ([5], [6], [7], [10]), as evidenced in the success to date of eBay.com. Founded in September 1995, eBay has become a global trading platform where on any given day, there are more than 16 million items listed across 27,000 categories. In 2003, at least 30 million people will buy and sell well over $20 billion in merchandise, so that the entire culture it engenders is now being described as the eBay economy [3]. It is also the richest source of data for online auction markets, as records of all its transactions are available to the public (on a 2-week rolling basis). In (Ho 2004) the intriguing question of what 'shape' a given market is in at a particular moment of development was posed. Using the Star Plot method of high-dimensional data visualization [4], a topological model was developed, based only on operational data, without any expert knowledge of the specific auction market, or financial details from the transactions. The dimensions in this model are reviewed in the next section. Applications of this Topological Analysis include the study of market evolution over time, market design and simulation in experimental economics, as well as inter-brand or international comparative studies of online auction markets. As a full-scaled example of the latter, the results for four markets (digital cameras, classical CDs, diamond rings, Star Wars play-figures) in eight countries/regions (US, Canada, Australia, United Kingdom, France, Italy, Spain, Taiwan) are presented.

2. TOPOLOGICAL ANALYSIS OF ONLINE AUCTION MARKETS

In [2], a topological model for an online auction market is defined to be a simultaneous graphical display of all the dimensions of its relevant data base, which provides a geometrical shape as a descriptive, visual statistics of the market. In particular, various dimensions were identified from available data for constructing a specific topological model that can help discern market efficiency. Such a model provides a visual cue for whether a market is favorable to buyers or sellers, without expert knowledge of the items involved or the prices attained. The dimensions in this model are briefly reviewed below.

Gross Activity
The absolute size of a market is indicated by the average number of auctions being offered per day.

Net Activity
As a categorical measure of the effective activity in an auction market, the proportion of listings that ended with at least one bid is used. In cases where a reserve price is in effect, the listing is counted whether the reserve is eventually met or not.

Participation
For those auctions that resulted in at least one bid, an aggregate measure of activity is the average number of bids. Multiple regular bids from the same buyer are counted separately.

Seller Diversity
For a sense of whether a market is dominated by relatively few sellers, or there is diverse sources of supply, the number of auctions in the data collection offered by each individual seller is tracked and the distribution is used as an indicator of seller diversity

Seller Experience
At the completion of any auction on eBay, the buyer and seller have the opportunity to post feedback to the system. The net feedback rating is used as a surrogate measure of an eBayer's experience. The distribution of four levels of seller experience—from 'Beginners' to 'Veterans' is compiled for each market.

Buyer Diversity
For a sense of the distribution of buyer participation over the auctions in the data set, the number of auctions in which each user placed a bid is tracked. Typically, each identified user participated only in a small percentage of the total number of auctions. Therefore the absolute number, rather than the percentage, is used. Again, four ranges are arbitrarily chosen: [1], [2 – 5], [6 – 10], [>10]. The proportions of buyers falling within these ranges are recorded.

Buyer Experience
This is completely analogues to the measure of seller experience. The feedback ratings of buyers identified in the data set are classified into the same four categories, and the proportions of buyers at each level are compiled for each market.

Matching
Since the intent of auction markets is for competing bidders to arrive at a fair value for the item offered, an auction that ended with a single, winning bid does not make for an interesting or typical case. However, it does signal a unique match in supply and demand.

Dueling
In contrast to single-bid matching, dueling is an indication of keen competition. While the actual dynamics of such bidding patterns, in terms of who is challenging and who is responding, can get quite complex and combinatorial, a tractable criterion can be defined for the occurrence of 'dueling' between two preeminent bidders. Dueling is recognized when the two bidders with the highest number of bids together account for the majority (or some other pre-set level) of the bids, provided the total number of bids exceeds some pre-set threshold (6 is used throughout this study). The last provision is to exclude trivial cases, for example when there are only two bidders with one bid each. Note that the two most active bidders may not actually have encouraged in head-to-head dueling, and neither of them needs to be the eventual winner.

Stashing
In markets for items whose value will increase with scarcity, such as collectibles, certain buyers may set out—to whatever extent—to 'corner' the market. They hope to build up a stock and profit from higher valuations in the future. Or there may be professional dealers with brick-and-mortar sales outlets who have managed to arbitrage actual price differentials between eBay and the conventional marketplace. In either case, 'stashing' activities would be reflected in frequent purchases of the same or similar items within the time frame of the dataset by such buyers. As an indicator of stashing, the highest percentage of the auctions in the dataset won by any single buyer is used.

Sniping
The specific design of online auction will affect the participants' behavior, and hence the topological shape of the market. Three parameters for the eBay online auction system (second price, fixed deadline, and public) lead to an interesting and significant phenomenon known as "sniping" [9]. This is the strategy of placing a first bid at the very end of the auction. In this work, we consider an auction to be won by sniping if the winning bid was placed within one minute from termination, and it was the first and only bid placed by the bidder.

Retailing
On eBay, sellers are provided with an option to offer the item at a fixed price. This is known as Buy-It-Now (BIN). While this option clearly detracts from the true spirit of online auctions, its viability is certainly self-regulating, and its effectiveness affords us another glimpse of the shape of the market.

Proxy
On eBay, a user can submit a maximum bid of what he or she is willing to pay for the item. Then, as necessary, the system will place the appropriate incremental bid for the user against other incoming bids, until the maximum is reached. Auctions won by proxy bids are indicated by winning bids that are not the last ones placed chronologically.

3. A BUYER-SELLER DICHOTOMY FOR ONLINE AUCTION MARKETS

Our topological model is based on the star plot for displaying multivariate data with an arbitrary number of dimensions [1]. Each data point is represented as a star-shaped figure (or glyph) with one ray for each dimension. As the resulting shapes depend on the configuration of the dimensions, we further analyze the observations along the dimensions identified above in an effort to present a visual model (see a generic example in Figure 1) of the shape of online auction markets. This is done by partitioning the dimensions into a buyer-seller dichotomy.

Gross and net activities are significant for inter- market comparisons, and neutral to buyers and sellers. We map gross activities, on some relative scale for all online auction markets, on the upper vertical axis, and use it as the radius of a circle to frame the visual model. Net activities, as percentage of auctions with bids, are mapped on the same vertical axis. Participation, expressed as the average numbers of bids per auctions, is mapped on the lower vertical axis. This way, the size of the circle represents the size of the market relative to

all others, whereas the span between the net activity and participation indicates its vibrancy.

Figure 1 . Topology of Online Auction Market

3.1 Buyer dimensions

The seller profiles, in terms of diversity and experience, are buyer dimensions. For diversity, we make the assumption that dominance in market share by relatively few sellers does not provide as much sourcing opportunities for buyers as when there are more different sellers. Analysis of data from over thirty markets led us to propose the use of the proportion of sellers offering 1 per cent or less of the auctions as the metric for diversity. For experience among sellers, the rationale is that an even distribution is favorable to buyers. The skewness of any observed distribution can then be normalized against the even distribution, which is top of the scale. In particular, the maximum of 0.25^4 which equals 0.0039 is normalized to 1.0 so that a distribution of, say, (0.4, 0.3, 0.2, 0.1) will be normalized to 0.61 on this scale. The two seller profile dimensions are mapped radially in the top-right quadrant in Figure 1.

Single-bid matching, though not an indicator of the vitality of a true auction market, does work in the favor of buyers. It meets their demand at opening bid prices, which are likely to be bargains. The success of winning bids by sniping also put buyers at an advantage. As demonstrated in [9], the winning bid prices can be expected to be undervalued. Buy-It-Now options, if acceptable to buyers, necessarily reflect favorable prices, and so can be ruled a buyer dimension. These three buyer dimensions, all expressed as percentage of total auctions, are mapped in the lower right quadrant in Figure 1.

3.2 Seller Dimensions

The buyer profiles, in terms of diversity and experience, are seller dimensions. Analogues to the buyer dimensions we make the assumption that diversity in participation and an even distribution in experience among buyers are favorable to sellers. For diversity, we use the proportion of buyers participating in a single auction as the metric. For experience, the skewness of the distribution is normalized against the even distribution as described above. These two dimensions are mapped in the top right quadrant in Figure 1.

Dueling, which signals competitive bidding to raise the winning price is obviously to the advantage of sellers. Stashing by buyers with ulterior motives, which are not necessarily rational in the actual market, is also a seller dimension. Finally, proxy bidding can both attract bidders who would otherwise be too busy to monitor an auction, as well as elicit true valuations from potential buyers to help maximize the final price, and hence a seller dimension. These three seller dimensions, all expressed as percentage of total auctions, are mapped in the lower left quadrant in Figure 1.

4. A GLOBAL COMPARATIVE STUDY

The graphical display of the topological model of online auction markets provides a visual aid in describing the ‘shape’ of a market at any particularly stage of its development. The dimensions (or attributes) deemed advantageous to buyers and sellers are mapped on the right and left sides of a circle, respectively. With proper normalization and harmonization of the scales, the relative areas of the two sides of the star glyph provide a visual cue to market efficiency: a larger right side favors buyers, and vice versa. By themselves, such snapshots encapsulate market characteristics, especially when large numbers of markets are to be studied. As a full-scaled example, a global comparative study is conducted.

4.1 The Countries/Regions

By August 2004, eBay has expanded globally to 23 country/region-specific sites along with its main, US-focused home site. Some of these operate on the same technical platform as the main site. Others, being partnerships or “buy-outs” of local ventures, typically in Latin America and Asia, do not. To date, only sizable sites using the home platform offer recent historical data on completed auctions on an approximately two-week rolling basis. After eliminating sites where activities are not yet high enough to provide any significant data collection, eight are chosen: United States (US), Canada (CA), Australia (AU), United Kingdom (UK), France (FR), Italy (IT), Spain (ES), and Taiwan (TW).

As further evidence of how e-business blurs conventional geo-political distinctions, the scope of the auction markets under any country-specific site is not strictly defined. In general, they offer listings in the local language submitted to the local site, from sellers with items that are located within the specific country. However, it is a seller’s option whether to deliver outside of the country or region, and there is no

restriction on where a seller can post a listing. For instance, we might find a German supplier of musical CDs listing offers on, say, the Taiwan site. Ultimately, the relative scope of various markets will be determined by market forces in the form of shipping costs, ease of payment, and language preferences.

4.2 The Markets

Since eBay provides over 27,000 categories of auction items, it may seem trivial to define a market a priori, e.g. digital cameras, and expect to collect data for such a specific item. Actually, the underlying database is keyword driven so that substantial cross-listing can result for items which may only be remotely related. Even with progressively refined drilling to filter extraneous selections, it is impossible, short of item by item scrutiny, to ascertain exact pertinence of the collected data to the prescribed market. For example, even if the search for digital cameras were restricted to a specific brand and model, it would still fail to preclude accessory items such as carrying cases. If a filter is used to block out carrying cases, then it may exclude cameras with carrying cases. With this in mind, the choice of markets for this study is made in part to minimize such fuzziness, as well as to contrast items with common versus subjective values, practical use versus amusement, technology versus craftsmanship. Moreover, they have to be sufficiently active on most of the chosen sites to provide significant data. Even with these criteria, the options are enormous and the decision is arbitrary.

Digital Cameras:
To sharpen the market focus, models with medium pixel capacity is specified. On most sites, these are classified under 3.0–4.0 Megapixels. For ES and UK, 2.1-4.0 is used; 3.1 and over for FR. No subcategory is available for TW.

Diamond Rings:
These are under the category of "Jewelry & Watches" on all sites. While a specific subcategory is available on some sites, a keyword search on "Diamond" may be necessary under "Rings" on others.

CDs Classical:
These are listed under the category of "Music" or "Music and Instruments" and the subcategory of "CD" and genre of "Classical".

Star Wars Toys and Games:
These are mostly so-called action figures, memorabilia, and collectibles engendered by the Star Wars movies, under the "Toys and Games" category.

4.3 The Data Samples

As we intend to study auction markets at particular points in their development, the time span for the collected data should not be too long. However, to ensure accurate representation of the actual dynamics of the markets, enough data points should be included. From both logistical and statistical considerations, we chose a target size of 500 auctions over a period of from one to three weeks, in June and July 2004. Note that these are not random samples, but complete records taken over a contiguous interval of time. Not all the actual markets can support this sample size within the given time frame. In those cases, the size is limited to data availability. The sample sizes for this study are summarized in Table 1.

Table 1. Sample size of datasets

Sample Size	**US**	**AU**	**CA**	**UK**	**FR**	**IT**	**ES**	**TW**
Digicam	500	444	495	498	100	152	151	426
Diamond Ring	543	504	501	337	98	22	8	10
CDs Classical	501	301	402	500	159	66	-	36
Star Wars	500	587	502	506	602	13	174	20

4.4 The Results

The bidding history for completed auctions on the eBay sites are copied and stored in MS Excel spreadsheets. Macro programs are designed to perform the data mining and compile statistics for the dimensions in the topological model. To render meaning to the visual cue for the buyer-seller dichotomy, the statistics are normalized and harmonized by a transformation that maps (approximately) the first, second, and third quartiles for the entire collection of datasets on each dimension to the unit-free scale of [0.25, 0.5, 0.75], respectively on the unit interval. This way, we can visualize the relative advantages to buyers and sellers without knowledge of the economic details of the transactions.

The results for our datasets are presented by market in Figures 2-5. Since the primary purpose of this work is to illustrate the topological model as a data visualization tool, we will observe, compare, and discuss market characteristics from this perspective, rather than dwelling on the quantitative or statistical analysis. First we note that in terms of net activity (average number of auctions with bids per day), the US site dominates by orders of magnitude. This is indicated in the bar-chart at the center of each of Figures 2-5.

Markets do exhibit their characteristic shapes. As the US site is most developed, the shapes of the markets there provide useful frames of reference. Digicam has an "upright" shape. Diamond Ring is slanted, from top-left to bottom-right. CDs Classical suggests a shamrock leave. Star Wars is more spade like. For a given market, the resemblance across international sites can still be discernable. Significant variations may be attributed to operational factors, regional or cultural differences, but even more likely to market size and stage of development. For example, the Buy-It-Now option tends to be practicable only for large enough

markets. The one remarkable operational factor concerns the TW site. In its promotional period, which covered the data in this study, all listing and commission fees were waived. As a result, the ratio of total listings to those with bids was extremely high. This effect is likely to vanish as soon as regular fees are charged.

In terms of the buyer-seller dichotomy, there is no clear advantage for each side except for Star Wars, which appears to favor sellers in the larger markets. For the others, we can comment on the relative conditions of the markets just by examining the topological plots. Shoppers of digital cameras should find eBay auctions a reasonable source of supply. The only shortcoming based on our model seems to be a dominance of experienced sellers. For hi-tech new products, this is hardly a concern. For sellers in this market, conditions are good as well. The lack of stashing is no surprise for items that are neither collectible nor expected to gain in value. The viability of markets such as Diamond Ring, which involve high value items that are difficult to evaluate online, attests to the potential of e-business. For buyers, the high level of matching translates to opportunities for finding a ring to one's liking at a relatively low starting bid price. With CDs of classical music, it is essentially a retail market as there is scant competitive bidding. Yet the market is viable for specialized and experienced sellers who hope to profit from volume in spite of low margins.

5. CONCLUSION

We presented a global comparative study of four online auction markets in eight countries as a demonstration of a topological model as a data mining and visualization tool, relying only on operational data. A graphical rendition of the model gives shape to such markets, facilitating the visualization of characteristics such as market efficiency, and changes that may favor either buyers or sellers. Conceptually, the star glyph maps market topology into iconography. Research is ongoing to quantify this approach by optimising the dimensional configuration to maximize the resolution of the buyer-seller dichotomy. While the topology is completely independent of market economics, information on the latter can be used in either a knowledge-base or neural net approach to identify shapes of interest. While only casual observations are made for the present purpose of illustration, the potential exists for more in-depth analysis in the context of plotting e-business strategies in a networked economy, especially when the online auctioning model becomes more widespread in a business-to-business (B2B) environment.

ACKNOWLEDGEMENT

Santosh Bukitgar designed the MS Excel macros for the data mining used in this work. The EMBA class in e-Commerce Projects at UIC in Summer 2004, contributed to the data collection and analysis in this study.

REFERENCES

[1] Chambers, J., W. Cleveland, B. Kleiner, P. Tukey, *Graphical Methods for Data Analysis*, Belmont, CA: Wadsworth Press, 1983.

[2] Ho, J. K., "Topological analysis of online auction markets", *International Journal of Electronic Markets*, Vol. 14, No. 3, pp202-213, 2004.

[3] Hof, R.D., "The eBay economy", *BusinessWeek*, 25 August 2003.

[4] Hoffman, P., G. Grinstein, "A survey of visualizations for high-dimensional data mining", in U. Fayyad et al (eds.) *Information Visualization in Data Mining and Knowledge Discovery*, Morgan Kauf- mann, pp47-82, 2001.

[5] Klein, S., "Introduction to electronic auctions", *Electronic Markets* Vol. 7, No. 4, pp3-6, 1997.

[6] Lucking-Reiley, D., "Auctions on the internet: what's being auctioned, and how?' *The Journal of Industrial Economics*, Vol. 48: pp227-252, 2002.

[7] O'Toole, K., "The auction architects", *Stanford Business*, Vol. 69, No. 2, 2001.

[8] Perkins, A. B., M. C. Perkins, *The Internet Bubble*, (Revised Edition), New York: HarperBusiness, 2001.

[9] Roth, A. E., A. Ockenfels, "Last minute bidding and the rules for ending second-price auctions: theory and evidence from a natural experiment on the Internet", *American Economic Review* Vol. 92, No. 4, pp. 1093-1103, 2002.

[10] Turban, E. "Auctions and bidding on the Internet: an assessment', *Electronic Markets* Vol. 7, No. 4, pp7-11, 1997.

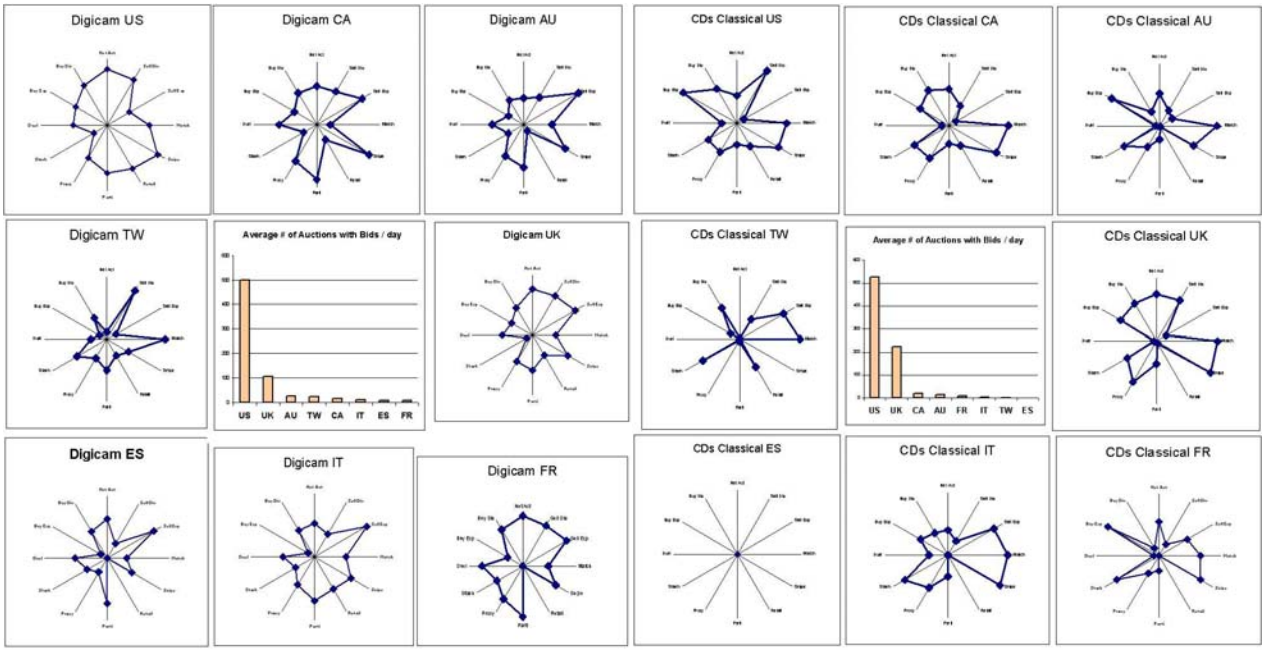

Figure 2. Topologies of Digicam market

Figure 4. Topologies of CDs Classical market

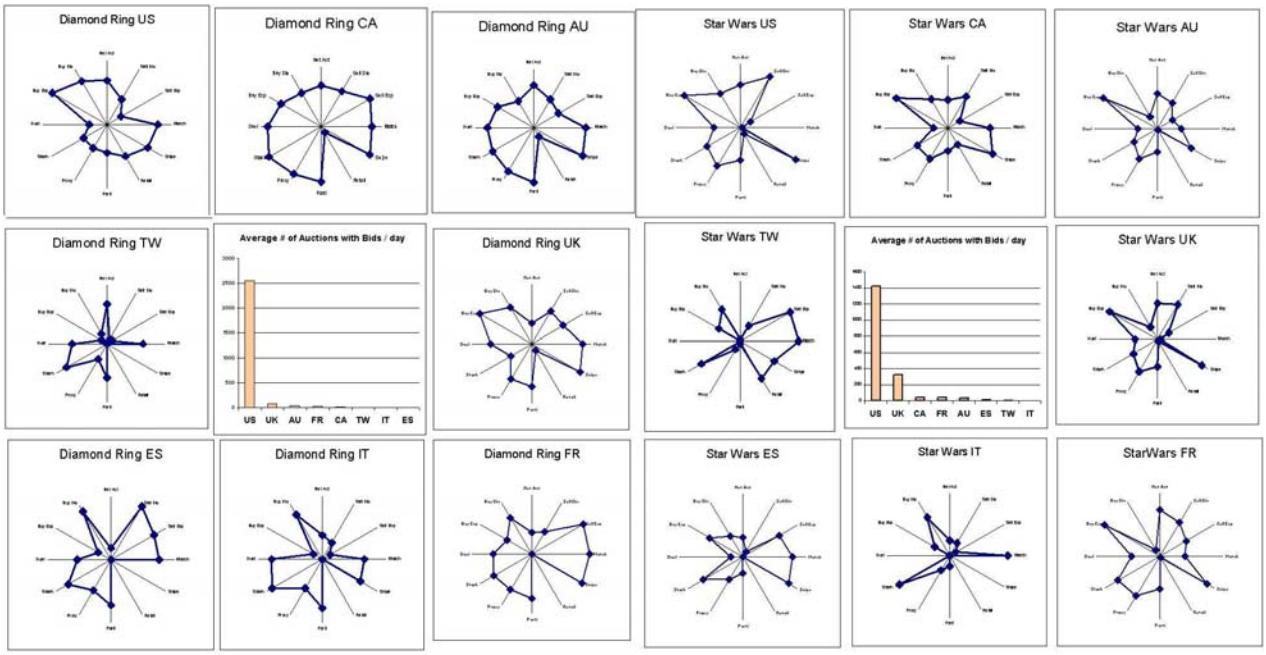

Figure 3. Topologies of Diamond Ring market

Figure 5. Topologies of Star Wars market