Social Media Data for Market Analysis: The Case of Public Higher Education Institutions in Illinois

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Abstract

This research contributes to higher education marketing in two ways: using Twitter data, the research identifies salient attributes that can be used by universities in marketing communications; next, the cusp catastrophe model is used to predict university transfer behavior among students. It is shown that small, downstate universities such as WIU are vulnerable to negative tweets; it takes a total of 43 negative tweets in a two month time period to move a currently enrolled WIU student from a neutral to negative attitude towards the university, negative attitude predicts student's transfer behavior.

Keywords: Twitter, Midwest, Higher Education, Marketing Optimization, Catastrophe Model.

1.0.   Introduction

Public higher education in the Midwest is adapting private sector models, bean counting has resulted in liberal arts departments such as history and philosophy being viewed as profit centers (Smith, 2019). This management style is prevalent among most regionally accredited public universities in Illinois, see the US News and World Report, 2019, for a list of these universities (https://www.usnews.com/best-colleges/search?_mode=table&location=Illinois&schoolType=regional-universities-midwest). Most of these higher education institutions, with little or no brand recognition, are largely dependent on tuition and struggling to fill up their classes (Tandberg and Griffith, 2013). Demographic shifts in the population paint a bleak picture for the future of these institutions, the number of people in the 0-24 age group in Illinois is expected to decline (see Figure 1) and the college participation rate among the 18-24 age group is expected to remain unchanged at the current rate of 41% (NCES, 2019).

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Figure 1: IL Population Forecasts, 0-24 Age Group (mil)
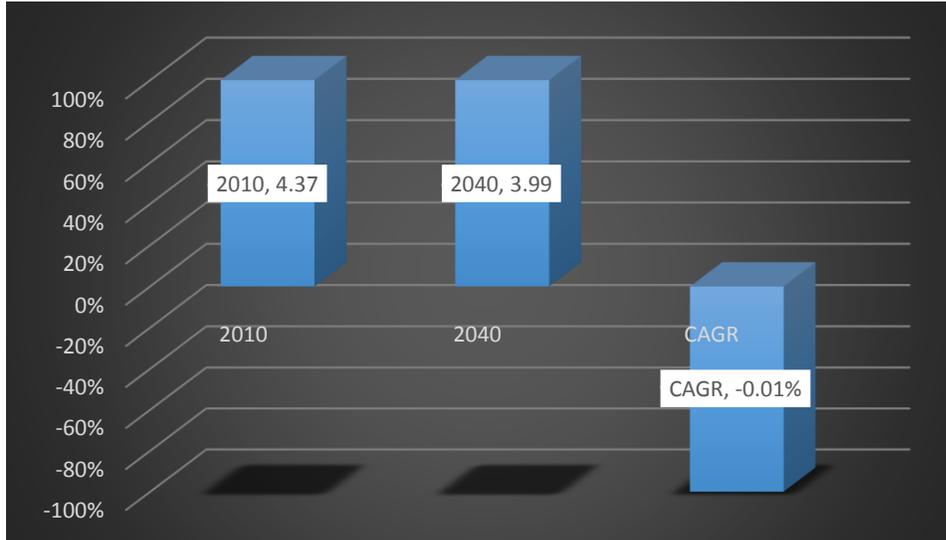
Note: CAGR refers to Compound Annual Growth Rate. It is computed using the expression: Population $_{NOW}$ = (Population $_{BASE}$) e^{rt} where r = growth rate and t = time.

Faced with a difficult operating environment, university administrators are seeking to broaden their pool of prospective students to keep up demand for the education they provide. The way to achieving increases in enrollment numbers is a function of market knowledge, optimal business strategies require adequate knowledge of both customers and competitors. Marketing theorists argue that an optimal business strategy would win market share with lowest cost and minimal competitor response (Best, 2005). How to deduce such an optimal recruitment strategy for higher education institutions? How can social media be used to gather information about market behavior? This paper addresses these and other similar questions.

2.0.   Related Literature
The theory to glean insights into optimal recruitment strategy is based on price elasticity of demand, brand-item's responsiveness to both price cuts and price increases (Oxenfeldt and Moore, 1978). If the brand-item's sales go up sharply in response to even a small price cut, it means that the brand-item is seen as better **value** at this price. Similarly, if its sales do not go down much when the brand-item's price is raised or when competitors lower their prices it suggests that customers see the brand-item as comparatively **unique** in the category (Bezawada, and Pauwels, 2013; Moran, 1994).

The concepts of 'value' and 'uniqueness' can be combined to deduce four main implications or strategies for student recruitment (Rossiter, Percy, and Bergkvist, 2019; see Figure 2):

1. *High Value / High Uniqueness*: This is the most ideal position, student enrollments respond well to university's price reductions and are insulated

against competitors' price reductions. The key to <u>maintaining the ideal position</u> is to remind customers of the good value of the product.

2. *High Value / Low Uniqueness*: An <u>acceptable position</u>, but could be improved to the "ideal" one. To do this, the university has to find or develop a unique benefit for the brand-item and let the market know about this unique benefit and the overall good value of the item.

3. *Low Value / High Uniqueness*: Depicts an inelastic market, student enrollment numbers do not change if the university raises its tuition, and competitors cannot hurt the university with their price reductions. This is a seldom seen position in the marketplace. If a university does find itself in this position, then it should <u>hold the position</u> by reminding the marketplace of the uniqueness of the product (brand-item).

4. *Low Value / Low Uniqueness*: This is the undesirable position. The focus should be on finding a benefit that adds value and also differentiates the brand.

Figure 2: Student Recruitment Strategies based on Elasticity of Demand Concepts

Uniqueness	Value	
	High	**Low**
High	Maintain position	Raise price, within reason
Low	Develop a unique benefit	Improve product

Note: Adapted from Moran (1994); Rossiter, Percy, and Bergkvist, 2019.

Other than the *Low/Low* grid position, all others require maintaining the current position; *High Value / Low Uniqueness* placement also requires finding or creating a unique benefit for the product. The cusp-catastrophe model (Olivia et al 1995) will aid in efforts to maintain a position and importance-performance analysis (Webster, 1991) could assist in finding or creating new a benefit for the product[2].

2.1.   Cusp-Catastrophe Model
The model is based on the phenomenon of cognitive response (MacInnis and Jaworski, 1989; Petty and Cacioppo, 1981). The theory states that when an individual is exposed to information about an entity (for example, a potential student encountering a university's recruitment personnel) the individual (student) often attempts to relate the expected and the actual information to her existing knowledge about the entity. This process generates a number of thoughts that may support or oppose the new information. These thoughts or cognitive responses originate from a prior attitude

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[2] The terms product and brand-item are used interchangeably, they refer to the product (education) universities provide. It is a 'superlative' category.

(evaluation) toward the university. If the individual's thoughts are primarily favorable, a positive shift in attitude toward the university will occur; if the thoughts are primarily unfavorable, a negative shift in attitude will occur (Athiyaman, 1997 & 2008; Olsen, Slotegraaf, and Chandukala, 2014; Rossiter, 1996).

Figure 3 illustrates the application of cognitive theory to the "maintain current position" strategy, the cusp-catastrophe model (Chen et al 2014; Cobb, 1981; Thom, 1975). In astronomy, the points on a crescent moon are referred to as its cusps. Translated to the problem at hand, think of a student as caught in the crescent of relationship with the university. In the middle of the crescent is the student's average attitude toward the university, which represents the expected level of performance. Actual experiences with the university, including virtual interactions, provide doses of received attitude. These fluctuations cause the student oscillate mentally between being assured that it is a good university and experiencing severe doubts about the quality of the university.

Catastrophe theory suggests that smooth changes in independent variables (for example, information about the university) may lead to abrupt, discontinuous changes in attitudes; negative experiences increase the risk of switching patronage (and liking) to another university when involvement[3] is high. Figure 3a gives a graphical representation of the cusp model. The folded surface is shown, and two scenarios are indicated involving discontinuous and continuous change (see Figure 3b for a cross section of the cusp). The x-y plane is the control plane. For a specific range of the independent variables more than one value of the dependent variable is possible, the dependent variable can be on the bottom, middle, or the top of the folded surface. The middle portion is unstable, inaccessible[4], the dependent variable is bimodal.

Movement through the control plane leads to discontinuing the behavior. To illustrate, consider a highly involved student with a neutral attitude towards the university that she attends. At the neutral point, little no information about the university is processed. If negative information is received by the student, a 'switch' catastrophe results, a sudden jump from continued attendance to discontinuing her studies happens (Figure 3b). Processing of positive information leads to loyalty towards the focal university.

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[3] Think of involvement as a high arousal, mental state induced by high cost of attendance. The more one pays for an education, the more involved one would be with the happenings of the university.
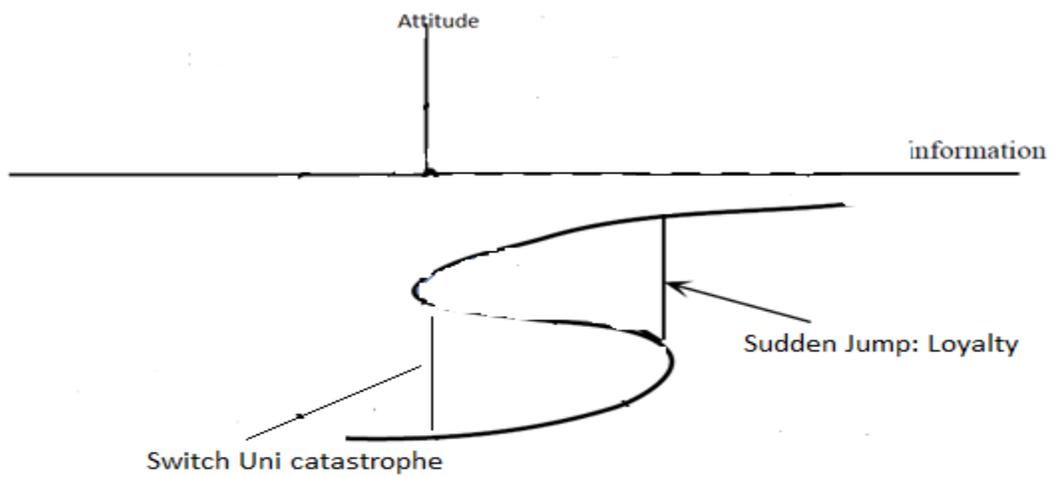
[4] It suggests that processing of information related to the concept polarizes the audience, her attitude towards the concept becomes either positive or negative.

Figure 3: The Cusp-Catastrophe Model

    a.   The Overall Model
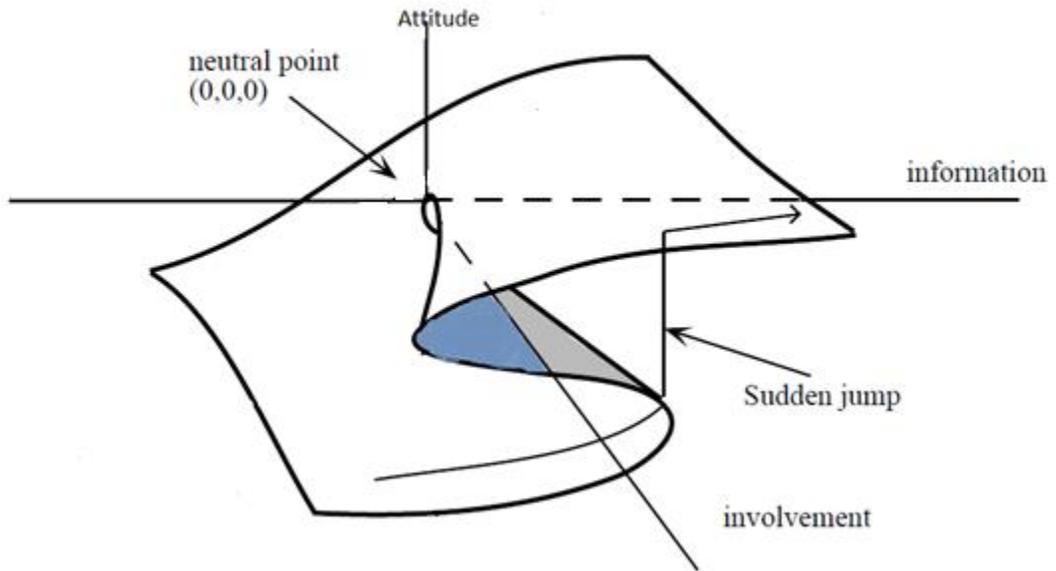
    b. Two Scenarios, cross section of the cusp model depicting hysteresis.

2.2.   Importance-Performance Analysis
This model is based on the assumption that a brand's attributes are evaluated on a two-dimensional space: each attribute's importance as a need-satisfier and the attribute's actual or perceived performance for drive reduction (Jindal, Sarangee, Echambadi, and Sangwon Lee, 2016). An illustrative application of this model for a higher education institution is shown in Figure 4 (a).

To find benefits to highlight to the target market, take the brand's high-delivery benefits (the two right-handed grids in Figure 4a) and then plot them in the importance-uniqueness matrix shown in Figure 4(b). The hot-button attribute(s) and the bells-and-whistles features should be the ones to be highlighted to the target market, to differentiate the brand-item from others in the category.

Figure 4: Importance-Performance Analysis

(a) Illustrative Application for a University

Importance	Performance / Delivery	
	Low	High
High	Digitized classroom	Cost of attendance
Low	Closer to home	Recreational facilities

(b) Identifying Unique Benefits

Importance	Uniqueness	
	Low	High
High	Entry Tickets	Hot buttons (Cost)
Low	Delete if possible and cut cost	Bells and whistles (Rec. facilities)

3.0.   Measures and Methods
Data to compute Illinois public universities' *value* and *uniqueness* were obtained from the Integrated Post-secondary Education Data Systems (https://nces.ed.gov/ipeds/use-the-data). Specifically, for a set of 10 universities and autonomous campuses (Table 1), the following data were obtained and arc elasticity-of-demand were computed over a finite range of changes in enrollment and cost of attendance variables:
CINSON: cost of attendance for full-time, first-time degree/certificate seeking in-state undergraduate students living on campus for the academic years 2007-2008 to 2016-17. It includes in-state tuition and fees, books and supplies, on campus room and board, and other on campus expenses.
FTE12MN: 12-month full-time equivalent enrollment for academic years 2007-2008 to 2016-17. The full-time-equivalent (FTE) enrollment used is the institutions' FTE undergraduate enrollment.

Table 1: Study Sample, the 10 Illinois Universities and Campuses

EIU: Eastern Illinois University	SIU-E: Southern Illinois University, Edwardsville
GSU: Governors State University	UoI-C: University of Illinois, Chicago
ISU: Illinois State University	UoI-S: University of Illinois, Springfield
NIU: Northern Illinois University	UoI-UC: University of Illinois, Urbana Champaign
SIU-C: Southern Illinois University, Carbondale	WIU: Western Illinois University

Note: EIU, GSU, SIU-E, UoI-S, and WIU are Midwest, regional universities; the others enjoy national recognition (see US News and World Report's University Rankings, 2019).

Social media data were gathered to understand the *positioning* of universities, customers' overall evaluation of the institutions. Twitter is a social network and microblogging service launched in 2006 which accepts users' posts (Tweets) of up to 280 characters. Registered users of the service can post Tweets. In the first quarter of 2019 Twitter averaged 330 million monthly active users[5]. Research suggests that majority of tweets are informational (Barrelet, Kuzulugil, and Bener, 2016).

Our focus is on polarity classification, Tweets about the universities are analyzed for positive, neutral, and negative thoughts (Pak., and Paroubek, 2010). The Tweepy Python library was used to access the Tweets[6]. The TextBlob implementation of sentiment analysis was used, a Python library for processing textual data[7]. The Lexicon-based technique works on the assumption that sentiment expressed by a Tweet can be identified by the polarities of the lexical units that compose it. Each word in the lexicon has scores for:

⇨ Polarity: negative versus positive (minus 1.0 to plus 1.0);
⇨ Subjectivity: objective versus subjective (0.0 to plus 1.0);
⇨ Intensity: modifies next word (0.5 to a weight of 2.0).

To illustrate, for a single word "great" the polarity is 0.8 (positive sentiment) and subjectivity is 0.75 (mostly opinion and not factual). For a string of words the algorithm averages the polarity scores and returns it as a sentiment score in the range of 0% to 100%.

Denote $n_t(k,s)$ as the number of Tweets at time t about university k that projects a positive sentiment s. The proportion of s of all Tweets about k at time t would be:

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[5] See https://www.statista.com/statistics/282087/number-of-monthly-active-twitter-users/

[6] http://docs.tweepy.org/en/3.7.0/

[7] https://textblob.readthedocs.io/en/dev/

$$p_t(k,s) = \frac{n_t(k,s)}{n_t(k)}$$

The change in *p* over time is the velocity of sentiment *s*. It is computed as:

$$V_t(k,s) = n_t(k,s) - n_{t-1}(k,s)$$

The rate of change of velocity, acceleration, is given by:

$$A_t = V_t(k,s) - V_{t-1}(k,s)$$

The plot of A_t is used to highlight changes, including negative shifts in sentiments, and a multidimensional scaling of sentiment was calibrated to show the position of the *k* universities in *n* dimensional attributes space. These attributes are then used in the construction of importance-performance analysis.

Finally, polarity scores (*P*) were used to indicate the criterion variable in the cusp model (Cobb and Watson, 1980). The model is defined by the dynamic system:

$$\frac{dP}{dt} = -\frac{dF(P,x,y)}{dt}$$

where the potential function is (Honerkamp, 1994):

$$F(P,x,y) = \frac{1}{4}P^4 - \frac{1}{2}P^2y - Px$$

The predictors of *P* include *x*, the asymmetry control factor measured using number of tweets with negative sentiments (dissatisfaction). The relationship between overall evaluation of *P* and *x* is both linear and nonlinear, it depends on the level of customer involvement (*y*); this bifurcation or splitting control factor *y* was measured using the cost of attendance variable for university k, the CINSON measure (cf. the economic search theory of Nelson (1970)).

4.0.   Results and Discussion
4.1.   *Elasticities of Demand, $\epsilon_{q,p}$ and η_{ij}*
The price elasticity of the ten universities were in the range of -2.19 to 0.70. The majority of the brand elasticities (70%) were less than -1.0, inelastic and of low value (see Table 2 and Figure 2). Of the ten universities, Eastern Illinois University is the most price sensitive with $\epsilon_{q,p}$ = -2.19. Both Northern Illinois University and Western Illinois University have $\epsilon_{q,p}$ at the boundary between elastic and inelastic.

Table 2: Effects of University "Cost of Attendance" (Price) Changes on Enrollments

Price Elasticity of Demand, $\epsilon_{q,p}$									
EIU	**GSU**	**ISU**	**NIU**	**SIU-C**	**SIU-E**	**UoI-C**	**UoI-S**	**UoI-UC**	**WIU**
-2.19	0.10	0.15	-1.06	-0.62	0.23	0.67	0.70	0.60	-1.08

To understand the competitive relationships between the universities cross-price elasticities (η_{ij}) were computed. As shown in Table 3 all campuses of the University of Illinois gain in enrollments if SIU-E raises its price. Little or no such gains in enrollments are evident for EIU, NIU, SIU-Carbondale, and WIU.

Cooper (1988) has developed summary measures of brand competition based on cross elasticities, 'competitive clout' and 'vulnerability'. Competitive clout is defined as the ability of a brand to take share away from competitors and is measured as: $\sum_{\substack{j \\ j \neq i}} \eta_{ji}^2$,

where η_{ij} is the cross-elasticity of demand. Vulnerability is the ability of competitors to take share away from the brand and is given by:

$$\sum_{\substack{j \\ j \neq i}} \eta_{ij}^2.$$

The clout statistics suggest that NIU and WIU do have the competitive ability to take share away from competitors, if other influences on college enrollments such as demographics and household income remain unchanged; SIU-E is most vulnerable for competitive attacks (Table 3).

Table 3: Some Cross-Price Elasticities (η_{ij}) and Brand Competitiveness Statistics

Institution	Cross-Price Elasticity	Inst.	Clout	Vulnerability
ISU with price of SIU-E	0.58	ISU	.002	.03
UoI-C with price of SIU-E	2.65	NIU	.13	.03
UoI-S with price of SIU-E	2.76	SIU-C	.04	.02
UoI-UC with price of SIU-E	2.37	SIU-E	.006	.67
NIU with price of ISU	-0.88	UoI-C	.05	.06
WIU with price of UoI-S	-0.99	WIU	.13	.04

Negative cross-price elasticities suggest that the products are complements, for example, WIU will lose enrollments if UoI-S starts losing market share. This argument can be justified based on the premise that potential enrollees might believe that price increases at UoI-S will result in matching price increases at WIU (anchoring effect, tying the cost of attending WIU to UoI-S costs (Kiechel, 2010), students would avoid enrolling in either of the focal universities).

4.2.   Positioning

Brand positioning is a psychological concept, it mentally tells the stakeholders what the brand offers (Athiyaman and Merrett, 2010). This latent construct manifests as stakeholders' overall evaluation of the brand, the scaled polarity scores of Tweets about the university (Table 4).

Table 4: Brand Positioning, Overall Evaluation of Universities for the Calendar Years 2017 and 2018

Overall Evaluation, Measure ranges from -1 to +1									
EIU	GSU	ISU	NIU	SIU-C	SIU-E	UoI-C	UoI-S	UoI-UC	WIU
2017									
0.12	0.09	0.11	0.11	0.04	0.06	0.07	0.15	0.09	0.07
2018									
0.17	0.13	0.16	0.12	0.07	0.08	0.10	0.12	0.12	0.08

EIU and ISU posted the largest gain in overall evaluations, a five point increase from their 2017 ratings. Rhodes (2019) confirms the predictive validity of the positioning scores, EIU and ISU gained large increases in freshmen class for Fall 2019. UoI-S slipped in its overall stakeholders' evaluation, its 2018 positioning score was three points less than its 2017 score. Overall, EIU, GSU, and ISU have superior scores, above the median positioning scores for the universities; this suggests that EIU, GSU, and ISU need to maintain their current positions. In contrast, NIU, SIU-E, UoI-S, and WIU had scores less than the median, these institutions have to identify hot button and bells and whistles features and highlight them to the stakeholders. We implement MDS to understand the factors that make up the positioning scores. Appendix 1 shows the plots of 'acceleration', the velocity of positive sentiments, A_t, for the universities.

The results of multidimensional scaling (Figure 5) suggests that the positioning of the ten universities can be represented in a two-dimenaional space; the horizontal axis represents the size of the higher education institution and explains 83% of the variance in the positioning scores. The vetrical axis represents geographical location: downstate versus upstate Illinois, and it explains 17% of the variance in the positioning scores.

Size is often associated with prestige, a salient determinant of university choice (Whitehead, Raffan, and Deaney, 2006). A location variable that is correlated with university choice is the "closer to home" variable (Athiyaman, 2008). Espiona, Crandall, and Tukibayeva (2014) argue that a student's household income is a moderator of this relationship, more the household income lower is the influence of "closer to home" variable on university choice. This could be a reason why the the location vector is less salient than the size or the prestige factor in explaining the variability in positioning scores.

Figure 5: MDS Analysis, Average of the Absolute Value of Log Fold Change
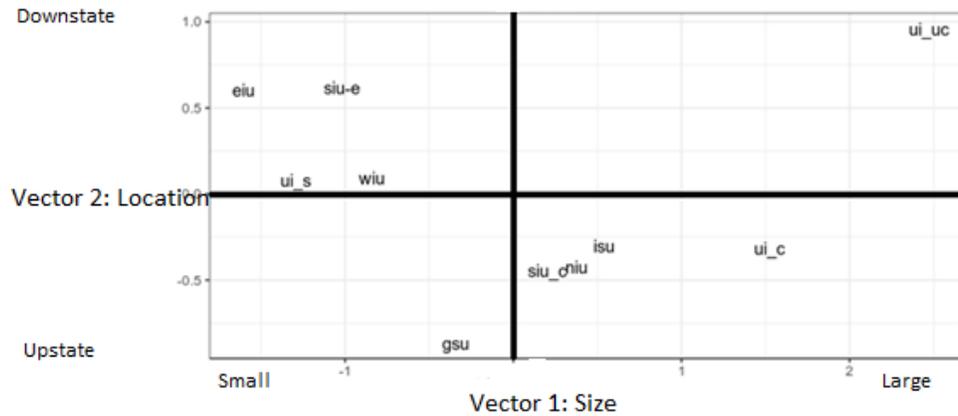

Figure 5 shows that UoI-UC is the largest in size and located downstate whereas GSU is small and located upstate. Table 5 shows all the moderators related to university choice sourced from Tweets. These are the evaluative attributes that determine placement of a university on the importance-uniqueness grid. For example, WIU, a small, downsate university, competes on these salient attributes: price, attractive location, and online courses. Less important attributes of university choice for WIU include: excellence in undergraduate research, and a place to have a "great time". In contrast, UoI-C, a large, urban university, is perceived by stakeholders to be salient in all types of research and healthcare programs. Thus for WIU, the optimal recruitment strategy would be to communicate to stakeholders the university's low prices, online programs, and attractive facilities such as the Quad City's riverfront campus.

Table 5: Adjective and Noun Phrases: Determinants of Positioning

University	Salient Adjective-Noun Combinations
Eastern Illinois University	Rural school; International students; Big academic shakeup.
Governors State University	Affordable education; Suburban university; Black / Spanish culture.
Illinois State University	Healthy campus; Great college; Many scholarships.
Northern Illinois University	New courses; Great time; Mismanaged university.
Southern Illinois University – Carbondale	Diverse students; Great facilities; Outstanding policy research.
Southern Illinois University – Edwardsville	Good athletics department; Competitive graduates; High tuition and fees.
University of Illinois – Chicago	Urban university; Top research; Healthcare university.
University of Illinois – Springfield	Good educational technology; Online courses; Excellent outreach, civic engagement.
University of Illinois – Urbana-Champaign	Innovative programs; Free tuition, full ride scholarships; Flagship, old university.
Western Illinois University	Riverfront campus; Online program; Fixed price, tuition.

Table 6a shows that the cusp model fits the data better than the linear or the logistic model; coefficient summary for the cusp model is shown in Table 6b. The results of the cusp model highlight the importance of managing negative information; for example, at $12, 848 undergraduate tuition and fees per student, WIU will start losing student loyalty if the number of negative tweets exceed 43 in a two-month period. The same number for EIU, with a tuition and fees of $11, 803 per annum, is 60 negative tweets in a two month period. Established, large universities such as UoI-UC suffer more from negative information, it takes only 24 negative tweets for UoI-UC to lose its loyal students; UoI-UC charges $17, 281 in tuition and fees, per year, per student (Figure 6).

Table 6: Coefficients and Model Fit Statistics: Cusp, Linear, and Logistic Regressions (n = 80)

a. Model Fit Statistics

Model	R^2	AIC	AICc	BIC
Linear model	0.16	227.17	228.25	234.12
Logistic model	0.41	214.54	216.21	223.23
Cusp model	0.58	108.28	110.68	118.71

b. Coefficient Summary: Cusp Model

	Estimate	Std. Error	z Value	P(>|z|)
Intercept – Negative Tweets	-0.48	-1.76	-1.76	0.07
Negative Tweets	0.13	0.05	2.52	0.01
Intercept – Tuition & Fees	7.47	2.87	2.59	0.01
Tuition & Fees	-0.11	0.06	-2.16	0.03
Intercept – Polarity	-3.36	0.40	-8.28	0.00
Polarity	0.29	0.03	8.93	0.00

Figure 6: Number of Negative Tweets Needed to Trigger Student Switching Behavior, Two-Month Time Period

Threshold for Negative Tweets
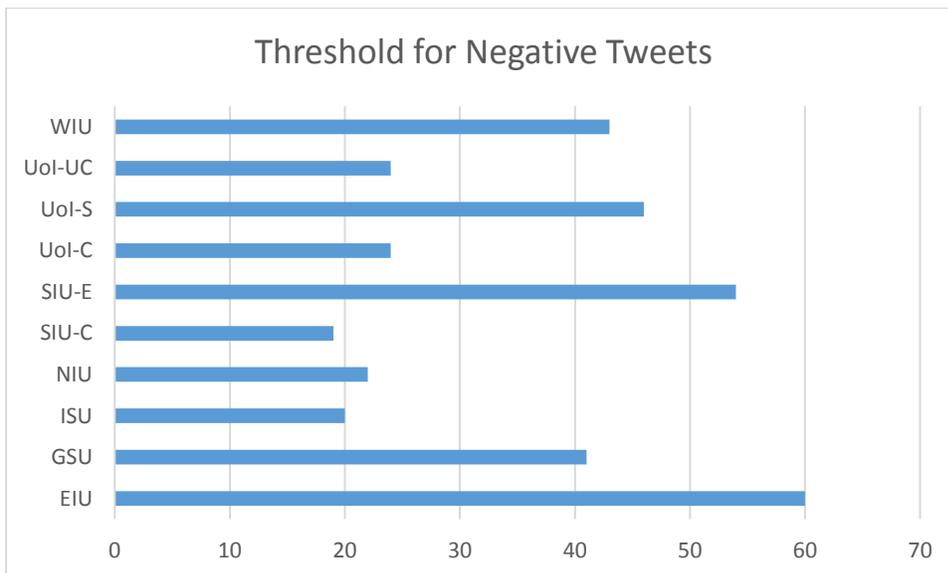
5.0.   Summary and Conclusion

This paper highlights the salient attributes of university choice. Two factors drive student enrollment behavior: size or reputation of the university, and geographical location. Small, downstate universities rely on online programs to attract students. Large, upstate universities rely on innovative programs, and research to attract students. From Twitter data this research has extracted salient, adjective-noun phrases (attributes) that can be used by the universities in their marketing communications.

Another contribution of this research is the use of cusp catastrophe model to predict university switching or transfer behavior of students. Since social media has become the major source of information for students, switching behavior was modeled as a function of number of negative tweets about the university. Results suggest that smaller, downstate universities such as WIU are vulnerable to negative tweets; for example, it takes 43 negative tweets in a two month time frame to move a student from neutral to negative attitude towards WIU. Since attitude predicts behavior, it is essential that universities manage social media to address switching behavior of students.

This research has taken noisy, social media data and inferred useful patterns and regularities for use in marketing higher education institutions. Illinois public universities don't differentiate themselves (Dold, 2019). It is hoped that the methods presented in this paper will be adapted by higher education practitioners to differentiate their offerings from others.

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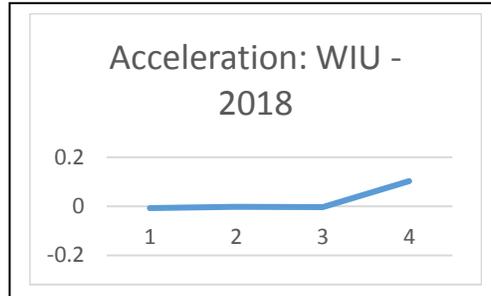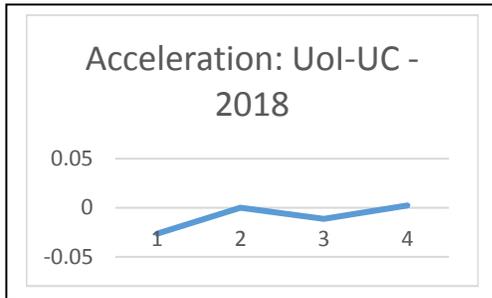
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Appendix 1: The Rate of Change of Velocity of Positive Sentiments
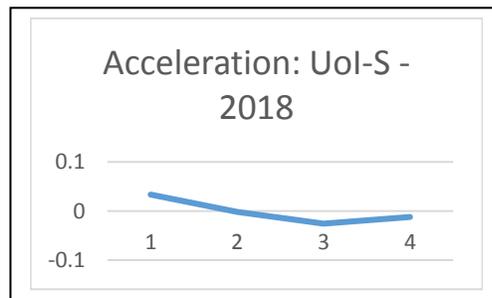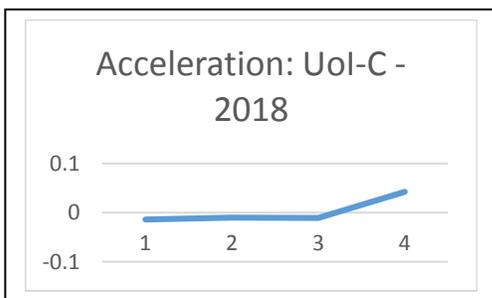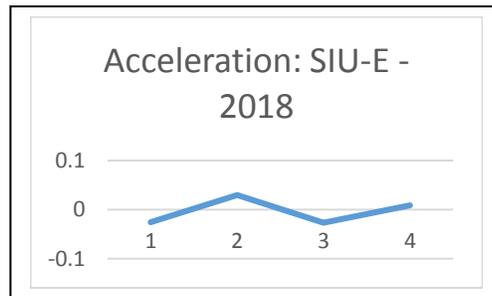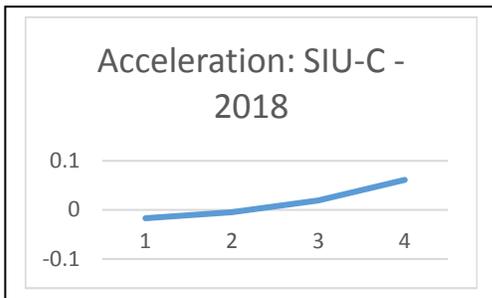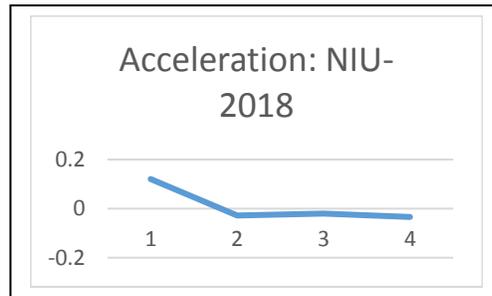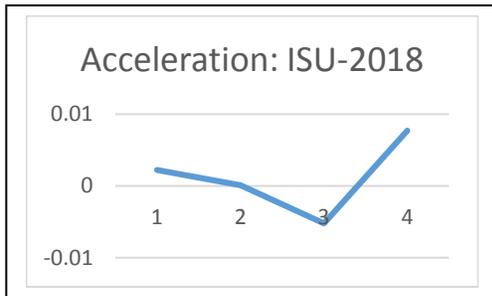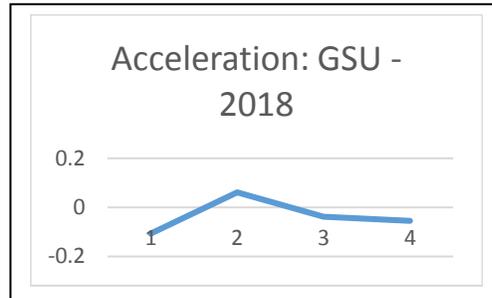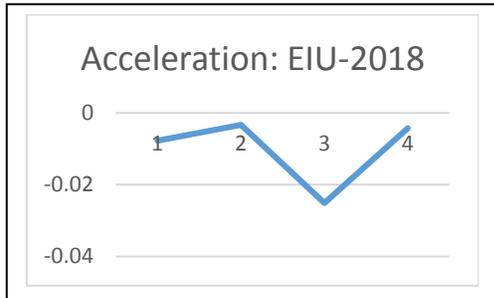
Appendix 1 (Cont'd…….)

Note
The data are bimonthly, positive sentiments for 2018.