



Understanding Users' Choice of Competing Browsers: an Application of Relative Mechanism using the Theory of Planned Behavior

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Abstract

Though many competing software applications are offered by different vendors, studies in IT adoption rarely look at the adoption of competing products. This study applies the theory of planned behavior to examine user choice of web browser software using *relative mechanism*. In this study, relative mechanism is defined as the degree to which users' evaluation of one product dominates their evaluation of other alternatives. This paper hypothesizes that *relative attitude*, *relative subjective norm*, and *relative perceived behavioral control* will have positive effects on *relative intention to use*, and *relative intention* will have a positive effect on choice. The study is set in the context of two web browsers: Mozilla Firefox and Internet Explorer. A survey shows that applying *relative mechanism* to the theory of planned behavior can explain a high percentage of the variance in intention to use and choice of browser. Important contributions to research and practice are discussed.

Keywords: Theory of Planned Behavior, Relative Mechanism, Choice, Structural Equation Modeling, User Acceptance, Competing Applications



Introduction

Competition within the software applications market is intense; a situation exacerbated by parity exposure where one's product can be easily copied and a product's unique selling proposition is quickly outrivalled and/or outmoded. The proliferation of different products serving similar functions can be seen in virtually any software application market, such as in operating systems (e.g. Linux, MacOS, and Microsoft Windows), office software packages (e.g. Microsoft Office, IBM SmartSuite and StarOffice), and graphics' software (Photoshop, and Corel Draw). As similar products compete for a share of the same user pie, research examining how users choose from amongst similar applications is important.

Though many studies examining user acceptance of different technologies have used the theory of planned behavior (Al-Rafee & Rouibah, 2010; Choi, Choi, Kim, & Yu, 2003; Lu & Weber, 2011; Verkasalo, López-Nicolás, Molina-Castillo, & Bouwman, 2010), studies examining acceptance of competing information technology systems are rare (Lin, Chan, & Wei, 2006; Szajna, 1994).

Psychologists and user behaviorists believe that studying competing products is important as research has showed that analyzing competing products yields a higher percentage of explained variance than studying a single product (e.g., Laroche, Hui, & Zhou, 1994; Sheppard, Hartwick, & Warshaw, 1988; Szajna, 1994; Woodside & Clokey, 1974). Sheppard et al. (1988), in their meta-analysis of the theory of reasoned action (TRA), demonstrated that studies with implicit alternatives (i.e. studies on a specific product, such as Pepsi) have stronger intention and behavior relationships than those without implicit choices (i.e. a general group of products, such as soft drinks) in their meta-analyses of the TRA. Their study's findings showed better accuracy in predicting behaviors even with implicit alternatives. Moreover, analysis of two products can provide information that is not available in the analysis of single product since even if products are similar, there are likely to be some differences.

This study considers the highly competitive Internet browser market which has seen the rise and demise of six different web browsers including the once dominant Mosaic and Netscape. Motivated by the beginning of another possible round of browser wars between Firefox and Microsoft Internet Explorer, this study seeks to identify the factors influencing users' choice



of browser software. Specifically, this study applies the theory of planned behavior to understand how *relative* subjective norms, *relative* perceived behavioral control, *relative* attitude and *relative* intention to use could influence users' browser software choice.

The next section provides some background about the competition in the browser software market. The following section focuses on the theory of reasoned action and the theory of planned behavior. Next is the research methodology, followed by the section on data analysis. The discussion and conclusion section outlines the contributions of this paper with regard to research and practice.

Competition in the Browser Software Market

Tim Berners-Lee and his colleagues developed HTTP and HTML in 1989, and the first web client in 1990. The following year, Nicola Pellow developed the first cross-platform browser, and by 1991 there were four different web clients. In 1993, Marc Andreessen of the National Centre for Supercomputer Application created a browser named Mosaic (Berghel, 1998). By January 1994, Mosaic dominated the browser market with 97% usage share (Berghel, 1998; GVU WWW User Survey, 1994). Within two years, however, Mosaic's usage share dropped dramatically from 97% to 5%, and by April 1996, Mosaic had completely lost the market to Netscape (GVU WWW User Survey, 1996). Netscape itself was to suffer a similar fate and by the end of August 2002, Internet Explorer dominated the browser market, leaving Netscape with only a 3.4% share.

In early November 2004, Mozilla Firefox released its version 1.0. In less than 100 days, the software had been downloaded 25 million times by users worldwide. Its usage share more than doubled from 4.6% in November 2004 to 13.76% in February 2008 (OneStat.com, 2004, 2005, 2008). According to a recent survey (Statcounter, 2011), Mozilla's Firefox global usage share is still growing, accounting for 28% of browser usage in July 2011. In spite of Internet Explorer's dominance, Firefox rapidly attracted European users, attaining usage share of 25% to 35% percent in Finland and Germany in 2008 (OneStat.com, 2008). By 2011, Firefox is the leading Web browser in Europe with 38.1% share, compared with Explorer's 37.5% (The New York Times, 2011).



Theoretical Framework

The theory of planned behavior (TPB) posits that an individual's behavioral intention is a function of the relationship between attitude, subjective norms, and perceived behavioral control (Ajzen, 1985, 1988, 1991). Attitude refers to an individual's evaluation, whether positive or negative, about performing a particular behavior. Subjective norms refer to an individual's perception of how relevant others feel about performing a particular behavior. Perceived behavioral control refers to individuals' perception of their ability to perform a particular behavior.

This study seeks to apply the TPB to understand user choice of browser software *using relative mechanism*. To the best of our knowledge, it is the first study on competing browsers which uses *relative mechanism*. This study also builds on an extensive body of existing research which has applied the TPB in analyzing the use/adoption of technological products and services by different target groups. These include broadband adoption by households (Choudrie & Dwivedi, 2006), adoption of new workplace software by employees (Chau & Hu, 2001; Morris & Venkatesh, 2000; Workman, 2005) and the use of e-commerce services by small and medium-sized enterprises (Grandon, Mykytyn, & Peter, 2004; Harrison, Mykytyn, & Riemenschneider, 1997). Prior research has also focused on applying the TPB to understanding users' online shopping behavior (P.A. Pavlou & Fygenson, 2006), their use of shop-bots (Gentry & Calantone, 2002) and Internet banking (Ravi, Carr, & Sagar, 2006), as well as their propensity to bid in online auctions (Bosnjak, Dirk, & Tuten, 2006) and to participate in web-based surveys (Bosnjak, Tuten, & Wittmann, 2005).

The TPB is an expansion of the theory of reasoned action (TRA) which was used to predict intention and behavior (Ajzen, 1988; Fishbein & Ajzen, 1975). Attitude, subjective norm, intention and behavior are the four constructs in the TRA. The TRA hypothesizes that behavior is influenced by one's intention to perform the behavior. Intention is influenced by a positive or negative evaluation about performing the behavior (i.e., attitude), and perceived social influence to perform or not to perform the behavior (i.e., subjective norm).

In attitudinal research, the attitude construct is considered as affective (a positive or negative feeling) (Fishbein & Ajzen, 1975, p. 12). Thurstone (1931) defined attitude "as affect for or



against a psychological object” (p. 261). Specifically, in a choice situation, people may have a positive or negative feeling toward one product over other products, which may influence their intention to use (or not to use) that particular product. Fishbein and Ajzen (1975, p. 11) also described affect as “the most essential part of the attitude concept” which explains intention to use or not use a product. Thus, we hypothesize that

H1: *Attitude toward a particular product (i.e., Relative Attitude) is positively related to intention to use that product (i.e., Relative Intention).*

Subjective norm refers to users’ perception about whether someone who is important to them thinks whether they should perform a certain behavior. Someone who is influential to a person may affect an intention to perform a behavior. For instance, if a person important to us uses Google talk as her preferred instant messenger, but her peers all use MSN messenger, she may need to change to MSN so she can communicate with those peers. Similarly, when a person important to us uses the same computer application we do, subjective norm would also enhance our intention to continue using the same application. Therefore, the preceding argument suggests that

H2: *Relative subjective norm is positively related to relative intention*

Fishbein and Ajzen (1975) acknowledged that the TRA has some limitations. According to them, there are three boundary conditions that may affect the relationship between intention and behavior: (1) the degree to which the measures of intention and behavior correspond with respect to their levels of specificity of action, target, context and time frame, (2) the stability of intention between time of measurement and performance of the behavior, and (3) the degree to which carrying out the intention is under one’s volitional control.

Since the TRA could not fully explain behavior that is not entirely under volitional control (Ajzen, 1991), the construct of perceived behavioral control (PBC) was included in the TPB to help predict both intention and behavior. In a choice situation, perceived behavioral control has been shown to be an important factor predicting intention and choice of travel mode between bus and car (Bamberg, Ajzen, & Schmidt, 2003). In fact, it is quite logical if individuals perceive that they have more control over one product than over others, their intention to use that product will be greater and they will most likely choose that product. Consequently, we hypothesize



H3: *Relative perceived behavioral control* is positively related to *relative intention*.

H4: *Relative perceived behavioral control* is positively related to choice.

Studies using the TRA or TPB have established the theoretical basis for the intention-choice relationship (Gummesson, Jonsson, & Conner, 1997; Kasper, 1988; LaBarbera & Mazursky, 1983; Mathur, 1998; Raats, Shepherd, & Sparks, 1995). In those studies, intention is hypothesized to have a positive effect on actual behavior. Many of these studies have also replaced actual behavior with choice (e.g., a target behavior such as eating healthy food can be viewed as *choosing* not to eat unhealthy food). For instance, previous studies have examined whether different choice behaviors such as eating healthy and unhealthy breakfast (Gummesson, et al., 1997), choosing different TV sets (Kasper, 1988), choosing different grocery products (LaBarbera & Mazursky, 1983), choosing five different brands of toothpaste (Mathur, 1998), choosing different types of milk (Raats, et al., 1995) can be predicted by intention. Consistent with these studies, this study proposes that

H5: *Relative intention* is positively related to choice.

Research Methodology

A survey questionnaire was developed to measure how factors such as *relative* subjective norms, *relative* perceived behavioral control, *relative* attitude and *relative* intention influence Internet users' choice of browser software.

Absolute and Relative Mechanism

A distinction should be made between measuring constructs in *relative* and *absolute* value. An approach applying *absolute* value measures two products separately. For instance, the *absolute* value approach measures attitude, subjective norm, and perceived behavioral control for two products, but it does not compare attitude and intention for each product, and no other relationship between products is examined.

An approach applying *relative* value can be performed in at least two ways. One of the methods applying *relative* value requires evaluation of an alternative against a comparative product, usually *direct substitutes* (e.g., I intend to use Firefox much more than Internet Explorer). Another method of measuring *relative* value is to calculate the differences between the items of each product. For instance, if attitude for Firefox is 5, and attitude for Internet

Explorer is 4, the relative attitude is 1 (i.e., 5 minus 4) (e.g., Lin, et al., 2006). In this paper, the first method of applying *relative* value was applied as the comparison is more direct.

Apart from choice, all the survey items used a seven-point *direct substitute* Likert scale which compared Internet Explorer on one end (1) with Mozilla Firefox on the opposite end (7) such as “Internet Explorer is much more” (1), “Internet Explorer is more” (2), “Internet Explorer is slightly more” (3), “Neutral” (4), “Mozilla Firefox is slightly more” (5), “Mozilla Firefox is more” (6), and “Mozilla Firefox is much more” (7). Figure 1 contains an example of the item relating to “Social Influence/Subjective Norm”.

Figure 1. Example of Likert-scale item using <i>Relative Mechanism</i>						
Social Influence / Subjective Norm						
People who are important to me think that I should use.....						
1	2	3	4	5	6	7
IE much more than FF	IE more than FF	IE slightly more than FF	Neutral	FF slightly more than IE	FF more than IE	FF much more than IE

Construct Measurement

Most items in the survey were adapted from previous research in which the TRA/TPB items had been modified to fit the IT acceptance context (Ajzen, 1991; Taylor & Todd, 1995; Venkatesh, Morris, Davis, & Davis, 2003). Subjective norm items were from Taylor and Todd (1995). Other TRA/TPB items such as attitude, perceived behavioral control and intention – which have been applied to the IT acceptance context by Venkatesh et al. (2003) – were from Ajzen (1991). Appendix A lists all the items. Choice was accurately captured through a *CGI variable*, i.e., as subjects completed the survey, a program accurately identified the operating system and browser they were using.

Survey Administration

The subjects were undergraduate students in a university in Asia. Most of them were young adults in their early twenties who used the Internet extensively. The survey was conducted

online and administered to 310 subjects over a one-week period. Two-hundred and fifty two (252) responses were usable.

Data Analysis

The research model described in Figure 2 was analyzed using SPSS version 15, and LISREL version 8.53. LISREL is a second generation multivariate technique which could assess measurement model (i.e. reliability coefficients, factor analysis) and structural model (i.e. path coefficients, and R square) simultaneously in one operation. Anderson and Gerbing (1991) suggested a two-step procedure to examine (i) the measurement model, which measured convergent and discriminant validity, and subsequently (ii) the structural model, which assessed the strength and direction of the relationships.

For the measurement model, convergent validity was assessed by calculating composite reliability of the construct. In addition, discriminant validity was assessed in four different ways: (1) by conducting a factor analysis; (2) by comparing the χ^2 of the CFA with five latent variables against other CFAs with four different latent variables; (3) by examining the average variance extracted (AVE) values, which should be larger than the required value of .70; and (4) by analyzing the square root of the AVE value of each construct, which should be greater than its correlations with the other constructs.

Additionally, seven fit indices were used to examine the adequacy of the research model: the ratio of chi-square value to degrees of freedom < 3; the goodness of fit index (GFI) > .90; the normed fit index (NFI) > .90 and the Tucker-Lewis Index (TLI) > .95; the relative fit index (RFI) > .90; the comparative fit index (CFI) > .93; the standardized root mean square residual (SRMS) < .05; and the root mean square of approximation (RMSEA) < .80 (Bentler & Bonett, 1980; Browne & Cudeck, 1993; Byrne, 1994; Hoelter, 1983; Hu & Bentler, 1998).

Table 1 shows the descriptive statistics of the constructs used in the study.

Table 1. Descriptive statistics for all constructs used in the model					
	Min	Max	Mean	Std. Dev.	Definition
SN	1	7	3.554	1.202	SN=Subjective Norm
PBC	1	7	2.848	1.411	PBC=Perceived Behavioral Control



ATT	1	7	3.310	1.373	ATT=Attitude
INT	1	7	2.939	1.701	INT=Intention
Choice	1	2	1.218	0.414	Choice=1(Microsoft), 2 (Mozilla
Valid N (listwise)	252		Firefox)		

Measurement Model

Factor analysis was first applied to verify all items used in the study. Except for two items in attitude construct, which had higher cross-loadings, other items were loaded appropriately into their intended constructs. Table 2 shows the loading and cross-loading after these two items were deleted.

Convergent validity was subsequently assessed using composite reliability and average variance extracted (AVE). Table 3 shows that all measures fulfilled the recommended levels of reliability (i.e. composite reliability was greater than 0.70), and the AVE was also higher than the recommended values of 0.50 (Fornell & Larcker, 1987).

Discriminant validity was assessed by examining whether items in a construct are highly correlated with other constructs by examining the AVE of each construct and their correlations with other constructs. Table 4 shows that the square root of the AVE for each construct was higher than the correlations between other constructs (Fornell and Larcker 1981). Discriminant validity was also validated by comparing the χ^2 of the original CFA with its five latent variables against other CFAs with four latent variables (i.e., every possible combination of two constructs was examined). The χ^2 of the original CFA was significantly better than any possible union of any two latent variables. Therefore, these indicated that the instrument has appropriate discriminant validity.

Table 2. Factor Analysis				
Rotated Component Matrix(a)				
	Component			
	1	2	3	4
SN1				.943
SN2				.946

PBC1	.837			
PBC2	.849			
PBC3	.826			
PBC4	.813			
ATT2			.839	
ATT3			.838	
INT1		.711		
INT2		.702		
INT3		.759		
INT4		.738		
Rotation Method: Varimax with Kaiser Normalization. a Rotation converged in 5 iterations.				

Table 3. Psychometric Properties of Measures				
Construct	Item	Loading	St. Error	T-Statistic
Subjective Norm CR = 0.95; AVE= 0.90	SN1	0.96	0.08	17.47
	SN2	0.94	0.08	17.04
Perceived Behavioral Control CR= 0.95; AVE= 0.83	PBC1	0.91	0.04	18.80
	PBC2	0.94	0.03	19.91
	PBC3	0.88	0.05	17.75
	PBC4	0.92	0.04	19.04
Attitude CR= 0.91; AVE= 0.83	ATT2	0.91	0.06	18.00
	ATT3	0.91	0.06	18.03
Intention CR= 0.97; AVE= 0.90	INT1	0.97	0.02	20.94
	INT2	0.97	0.02	21.05
	INT3	0.97	0.02	21.09
	INT4	0.88	0.06	17.58
Note: CR=Composite Reliability		AVE=Average	Variance	
		Extracted		

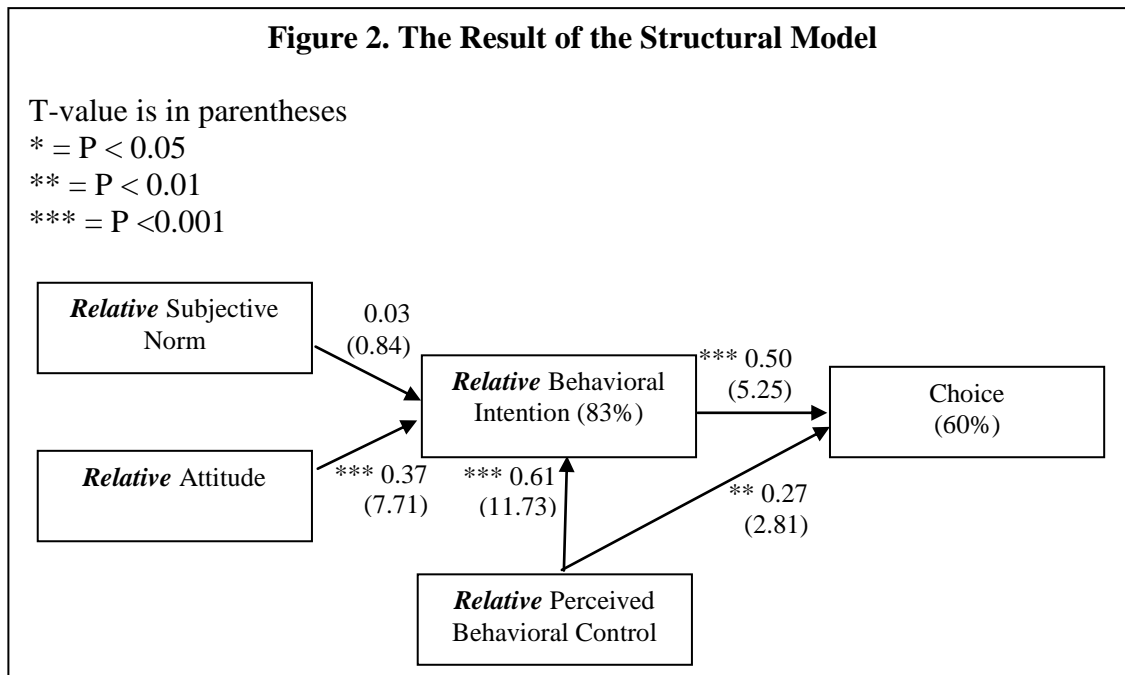
Table 4. Average variance extracted for the constructs (in bold)					
	SN	PBC	ATT	INT	CHO
SN	0.90				
PBC	0.14	0.83			
ATT	0.16	0.55	0.83		
INT	0.17	0.70	0.70	0.90	
CHO	0.13	0.46	0.42	0.59	1
SN=Subjective Norm			ATT=Attitude		
PBC=Perceived Behavioral Control			INT=Intention		
CHO=Choice					

The measurement model for all constructs was also assessed by a confirmatory factor analysis (CFA) using LISREL 8.53 and the sample covariance matrix. The χ^2 of 119.16 with 56 degrees of freedom showed a chi-square to degrees of freedom ratio of less than 3. GFI was 0.93, NFI was 0.99, TLI was 0.99, RFI was 0.98, CFI was 0.99, Standardized RMR was 0.02, and RMSEA was 0.07. These results provide strong empirical support for the reliability, validity, and model fit in the study.

Structural Model

Figure 2 shows the structural model results. Similar to results in the measurement model, all indices were within the acceptable threshold. Specifically, the χ^2 of 121.40 with 58 degrees of freedom showed a chi-square to degrees of freedom ratio of less than 3. GFI was 0.93, NFI was 0.99, TLI was 0.99, RFI was 0.98, CFI was 0.99, Standardized RMR was 0.02, and RMSEA was 0.07. Except for subjective norm, attitude and perceived behavioral control explained about 83% of the variance in intention. The result also showed that both behavioral intention and perceived behavioral control explained about 60% of the variance in choice.

Figure 2. The Result of the Structural Model



Discussion and Conclusion

This study confirms previous research in social psychology and marketing which argues that studies with behavioral alternatives provide higher accuracy than those without. For instance, Van den Putte, Hoogstraten, and Meertens (1996) improved the explained variance of intentions from 49 to 69 percent by using direct comparison as opposed to non-comparison when testing alternative expectancy value models (Van den Putte, et al., 1996). Recent user acceptance studies applying the TPB showed that the explained variance in intentions ranged from 50 to 60 percent (e.g., Hsieh, Rai, & Keil, 2008; P.A. Pavlou & Fygenson, 2006; P. A. Pavlou, Liang, & Xue, 2006; Venkatesh, Morris, & Ackerman, 2000). By applying relative value to compare two competing products, the present study shows that attitude and perceived behavioral control could explain a high percentage (83%) of the variance in intention.

The study's findings show that when it comes to the adoption of browser software, Internet users are heavily influenced by individual attitude and not social factors. This stands to reason as Internet surfing is typically an activity which is usually undertaken independently. When surfing for information or entertainment, users will naturally want to enjoy a high level of self-efficacy in their online navigation, so as to obtain the information or entertainment

which they require and/or seek. Hence, attitudes such as “This software makes my life more interesting” and “I like working with this software”, coupled with perceived behavioral control, e.g. “I have the resources necessary to use this software” and “I have control over this software” explain 83 percent of the variance in intention. In contrast, subjective norms such as “People who influence my behavior think that I should use this software” did not significantly influence behavioral intention.

From the descriptive statistics in Table 2, it is shown that the means for all constructs are below 3.5. The cut-off line for the two technologies is 4 (neutral), any mean values lower than 4 means that the subjects prefer Internet Explorer more than Mozilla Firefox. The explanation is that Internet Explorer still has the largest market share in Asia with 60% share in 2010 (Melanson, 2010) and our subjects’ ratings reflect the market position of Internet Explorer. This is confirmed by their actual choice of browser (i.e. the browser that they were using when they completed the survey). The choice mean is 1.2, which means that the subjects leaned more toward Internet Explorer.

The findings have managerial implications for the design and marketing of browser software. First, browser software selection is clearly an individual choice and not socially influenced. Marketing campaigns should therefore focus on individual decision-making rather than on other social factors, such as peer influence. Second, given the critical role that browsers play in enabling people to effectively access and use the Internet, it is imperative that the users’ control (i.e., perceived behavioral control) over browser software be enhanced. Users are likely to feel a greater sense of self-efficacy when they have control over the use of the browser application. The greater the perception of behavioral control in using a particular browser software, the more likely the user is to select that browser over others. Third, the more positive an individual’s attitudes are towards a particular browser, the more likely she or he is to choose it. In this regard, marketing campaigns should attempt to instill in potential adopters positive affect for the browser software rather than merely emphasizing its functionality.



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Appendix A. Questionnaire Items	
SUBJECTIVE NORM	
SN1	People who influence my behavior think that I should
SN2	People who are important to me think that I should
PERCEIVED BEHAVIOURAL CONTROL	
PBC1	I have the resources necessary to use
PBC2	I have the knowledge necessary to use
PBC3	I have control over
PBC4	Given the resources, opportunities and knowledge it takes to use this software, it would be easy for me to use
ATTITUDE	
ATT1	Using this software is a good idea.
ATT2	This software makes my life more interesting.
ATT3	Working with this software is fun.
ATT4	I like working with
INTENTION	
INT1	I plan to use
INT2	I predict I would use
INT3	I intend to use
INT4	I intend to increase my use of this software in the future.