Dynamics of Trust Revision: Using Health Infomediaries

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ABSTRACT: This study explores the process by which trust evolves over time. There have been a number of studies underscoring the importance of trust in the online environment. However, most trust studies have concentrated on the initial trust, and there is little known about how trust beliefs evolve over time. The dynamics of trust are of particular importance in the use of infomediaries (online information providers), among which health infomediaries are the most important for Web consumers in dealing with their wellness and health issues. We investigate the evolution of trust using the case of health infomediaries. The examination of the temporal changes in trust was carried out through two approaches—comparative statics and dynamic analyses.

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The research method was laboratory experiment and the data were collected for two episodes of encounters. Two comparative statics models and one dynamic model were estimated in order to examine the parameter changes from one episode of encounter to the next as well as the dynamics of belief changes. The results of analysis show that the structure of trust changes over time and information quality becomes the single most important antecedent in infomediary trust building in the later stages of use. Furthermore, our study also indicates that satisfaction plays an important role in changing Web customers' trust beliefs. Contributions as well as research and managerial implications are discussed.

KEY WORDS AND PHRASES: agency theory, change in trust beliefs, emotional trust, information integration theory, satisfaction, trust attitude.

STUDIES ON E-COMMERCE AND ONLINE RECOMMENDATION systems have demonstrated the importance of trust in behavior intentions [16, 42]. These studies have primarily focused on initial trust. Even the empirical studies on trust with prior experience between parties do not address how trust evolves over multiple episodes of encounters. On the other hand, it has been argued that building trust is a process that takes place over time [25, 26, 61]. While trust is gained or lost over time, there is little insight about how trust evolves and the factors that contribute to the evolution of trust beliefs. Such an understanding could contribute to forming business strategies and practices that foster Web customers' trust and retention. Therefore, it is important to investigate the factors that play a role in "gaining" trust over time when dealing with Web-based providers.

While previous studies have been informative in identifying various sources of trust and have illuminated the nature of trust from various perspectives (see, e.g., [38]), there has been little formal conceptualization of the factors that play a role in this evolution. In this study, we synthesize the extensive literature on information systems (IS) success and trust in order to identify the process by which trust-related beliefs change over time. In doing so, we formulate the dynamics of trust building using agency theory and information integration theory (IIT) as the bases for our conceptualization. We examine the dynamics of trust building by the comparative statics analysis of trust in two episodes of encounters (T1 and T2) and the process of transition from T1 to T2. The results provide insight into the way the trust-related beliefs change over time, particularly in the context of Web-based providers.

Domain of Research

BECAUSE THE DYNAMICS OF TRUST REVISION DEPEND on the actions and behaviors of Web customers and the context of their actions over time, we have chosen to focus on online information providers (infomediaries), particularly on online health infomediaries (HI). The main service of infomediaries is to supply Web consumers with information, advice, and guidance in making decisions, such as health problem or financial decisions. Infomediaries rely on customers' regular and almost "habitual" use of their

information, making the dynamics of trust building over time of critical importance to them. This is of interest because there is inadequate research on the role of trust in the utilization of infomediaries, or on the process by which such trust evolves over time. HIs play an increasingly important part in providing critical services for helping the global population live a healthier life and make better-informed decisions for their health and fitness maintenance and medical problems [29].

Nature of Consumer–Health Infomediaries Relationship

Infomediaries are online firms that function as third-party providers of information [18, 42, 55]. There are different types and categories of infomediaries, such as search engines, product-focused sites (such as Autotel.com for cars and Reals.com for real estate), and service-focused sites (such as the legal services Web site http://mnfindalawyer.com). For the purpose of this research, we define a health infomediary as an online provider that offers information, advice, guidance, and assessment for wellness and health-related issues, including referrals and wellness-related evaluations.

Web consumers initiate and establish relationships with HIs that may go beyond one encounter. HIs could benefit from returning Web users in multiple ways, including selling subscriptions or services to users, selling online ads based on user traffic, getting business leads, enhancing their reputation, or providing services to health organizations. In exploring the way this relationship is built over multiple episodes of encounters and use, we need to first consider the issue of anthropomorphism [33]. There is little controversy regarding the applicability of cognitively-based constructs of interpersonal relationships to human–information technology (IT) artifact relationships (e.g., trusting beliefs as argued by McKnight et al. [38] and Wang and Benbasat [60]). However, the applicability of affectively-based constructs has not been clearly addressed, and at times such constructs are excluded on the basis of their irrelevance in dealing with online vendors.

Principles of the agency theory apply equally in human interactions with both online and offline vendors [43]. The agency theory has been developed in economics for dealing with market uncertainty and applied to buyer–seller relationships. In this theory, consumers are "principals" and vendors (online or offline) are the providers of information who act as consumers' "agents" [5]. The affective constructs that are present in interacting with offline vendors also are present when consumers interact with online providers. The principal–agent relation argues that the agent has more information than the principal, which is the source of information asymmetry and the increased risk of immoral behavior. We expand the application of the agency theory to the infomediary–Web customers (decision makers) relationship, where Web customers may rely on the information provided by the infomediary in making decisions. In such cases, Web customers benefit from the information provided by the agent in exchange for their subscription or attention, the latter of which is of value to the agent's advertisers or providers. Information asymmetry is relatively substantial in HI–user relationship due to the extent and complexity of the medical and health domain. Hence, trust in HIs and its evolution over time is of particular importance in

this relationship. We will rely on the agency theory in conceptualizing trust and its evolutions as new encounters take place.

Trust

TRUST IS CONSIDERED AN IMPORTANT DETERMINANT for a stable social relationship, the essence of an individual's behavior, thoroughly influential in interpersonal relationships, and a critical component of economic transaction [24, 30, 38, 49]. Trust could be studied from a number of perspectives such as individual personality, institutional phenomena, and social transactions [30]. From the consumers' perspectives, trust has multiple facets—personality, cognitive, social (knowledge base), institutional, and emotional [7, 28, 38, 42]. The majority of research on trust has focused on initial, cognitive, and institutional trust. Gefen et al. [16, p. 55] reviewed 43 papers that offer different conceptualizations of trust and categorize the views of trust as (1) a set of beliefs (primarily ability, benevolence, and integrity), (2) a general belief, (3) an affect that reflects "feelings," or (4) a combination of these views. In studying trust in e-vendors, Gefen et al. [16] focus on consumers with firsthand experience and treat trust as one first-order construct that has antecedents as personality-based, knowledge-based (familiarity), calculative-based, and institutional-based sources for trust formation.

Affective aspects of trust have been used in organizational studies of trust [8, 56]. However, the treatment of affective aspects of trust in IS literature and e-commerce is rare at best. One exception is the work by Komiak and Benbasat [28], in which trust in agent-mediated e-commerce was studied. In this study, Komiak and Benbasat differentiate between cognitive and emotional trust, and define cognitive trust as consumers' "*rational expectation* that a trustee will have the necessary competence, benevolence, and integrity to be relied upon," whereas emotional trust is defined as "the extent that a trustor *feels* secure and comfortable about relying on a trustee" [28, p. 187; emphasis in original]. In their conceptualization of trust, consumers' cognitive trust influences their emotional trust. We follow Komiak and Benbasat's [28] argument and distinguish between cognitive trust as trust beliefs and emotional trust as trust attitude.

Dynamics of Trust

TRUST HAS BEEN RECOGNIZED TO BE DYNAMIC and continuous [20, 61]. Schelling [48] observes that "trust is often achieved simply by continuity of the relation between parties and the recognition by each that what he might gain by cheating in a given instance is outweighed by the value of the tradition of trust that makes possible a long sequence of future agreement" [48, pp. 134–135]. Although the gradual nature of trust building is commonly recognized in the literature [52], little empirical research has been carried out to test the process of trust building over time. Narayandas and Rangan [40] observe that the evolution of buyer and seller relations have rarely been investigated by academicians and practitioners, a point that is echoed by Kanawattanachai and Yoo [26] in their temporal study of trust in virtual teams. This observation also holds true for the investigation of the temporal aspect of online trust.

In building the dynamics of trust formation and revision, the outcomes of trusting behaviors cycle back to the trust process in the next episode. This point was briefly raised in Mayer et al. [35] and in repairing broken trust by Lewicki and Bunker [30], both in the context of organizational studies. This is in line with the findings by Kanawattanachai and Yoo [26], who report that the level of cognitive and affective trust increases temporally in high-performing virtual teams.

The dynamics of trust building is highly critical for the success of HIs. This "evolution in time" affects both Web customers' beliefs and their subsequent attitudes and behaviors, as well as HIs, which change their business practices as they become more popular and prosperous. Most Web information consumers may go back to HIs on numerous occasions and for a variety of information services. The business models of HIs are based on frequent returns of their consumers. Because most HIs rely heavily on advertising revenues, they need the mass of loyal customers who return to the Web site over and over again. The dynamics of trust building have rarely been addressed in trust studies of online vendors. Most studies of trust have relied on behavior intention. However, for studying the dynamics of trust formation, we need to conceptualize the use behavior of Web customers in the context of HIs and its influence in modifying Web customers' beliefs and affective states.

We adopt the IIT from social psychology in conceptualizing the dynamic nature of trust [1, 2]. According to IIT, affective states, attitudes, and beliefs are integrative in that the old states are gradually modified and are combined with new information and experiences in forming new states. IIT is a descriptive behavior theory that is in line with the normative Bayesian approach in which old beliefs (prior probabilities) are modified and integrated with new information to generate new beliefs in the form of posterior probabilities. Hence, we argue that customers integrate their existing level of trust with new experiences as fresh episodes of use lead to new affective states, beliefs, and attitudes.

Conceptual Model

TWO APPROACHES COULD BE USED IN THE INVESTIGATION of trust dynamics. The first approach—comparative statics—shows how the trust-related parameters change from one episode of encounter to the next. The second approach—dynamic analysis—examines the process of transition from one period to the next. Dynamic modeling incorporates time into the model, in many cases in the form of lagged variables [51, 59]. Therefore, the dynamic approach indicates the process by which the transition from one state to the next takes place. We deploy both approaches, because each provides a different insight regarding temporal changes of trust.

The Conceptual Model for Comparative Statics Analysis

This model shows the relationship of trust with its antecedents at each point in time. Trust is formulated by synthesizing social behavior, economics, and personal perspectives of consumers' actions (Figure 1). In this conceptualization, we differentiate

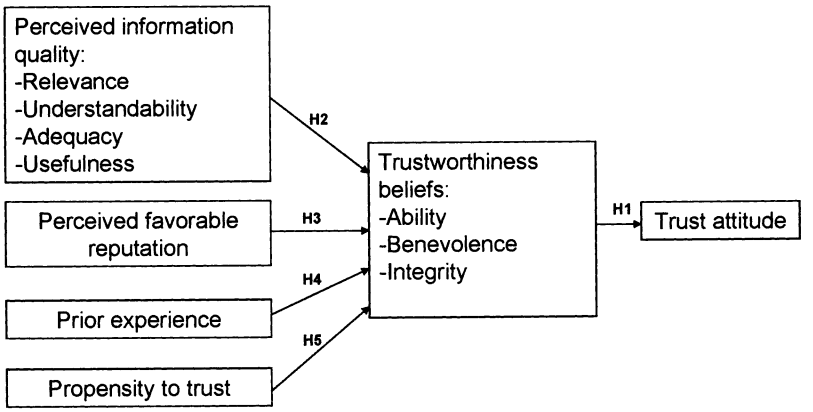

Figure 1. Comparative Static Model of Trust (at time T)

between the cognitive process of trust (as trustworthiness beliefs) and the feeling of trust (as trust attitude).

Hardin, in his book *Trust and Trustworthiness* [20], distinguishes between trust and trustworthiness, and observes that there is a surprising confusion about the two. He observes that because trustworthiness begets trust, researchers confuse one for the other. We subscribe to this point of view, and further argue that trust is an emotion or feeling that is manifested in Web customers' trust attitudes, whereas cognitive aspects of trust are reflected in Web customers' beliefs regarding the trustworthiness of the HI. This is in line with the affective-cognitive model by Williams [62], who labels ability, benevolence, and integrity as cognitively based. Komiak and Benbasat [28] make a similar argument in differentiating between cognitive and emotional trust. These beliefs have been extensively researched in IS literature with almost consensus findings that ability, benevolence, and integrity are the predominantly relevant beliefs in the content of e-vendors and providers (e.g.; [37, 55, 60]). Hence,

> *Hypothesis 1: Web consumers' trust attitude at time t is positively associated with their beliefs about the trustworthiness of the HI at time t.*

Based on the agency theory, we argue that Web customers enter into an implied agreement with the HI and delegate the task of collecting and organizing information services to the HI in return for the benefits that will accrue to the HI as the results of their visits. Each party benefits from this implicit agreement. Web customers access the information services that they need and the HI meets its business goals, such as generating online marketing revenues, creating business leads, enhancing its reputation, or providing services for health organizations or the government.

Because there is information asymmetry in principal–agent encounters, Web users have little control over the HI's information quality. This creates uncertainty about the quality of information services offered by the HI. According to the agency theory, in order to counterbalance the information asymmetry and signal consumers about the high quality of the service, the agent should make clearly visible, high-quality, and

irreversible investments (fixed sunk cost) [52]. In the case of HIs, information quality is the most important visible, high-quality, and irreversible investment. When Web consumers visit an online health information provider, the most visible investment in the site is the depth, breadth, and quality of its information. Furthermore, the HI's costs in collecting, synthesizing, storing, organizing, and displaying information on the site are irreversible and unrecoverable. The quality of information depends on its specificity and relevance [9, 21]. The specific information that matches consumers' information needs leads them to judge whether it is relevant, adequate, understandable, and useful [36]. Hence, information quality serves as one of the most important antecedent consumers' beliefs in HIs' trustworthiness.

Hypothesis 2: Web consumers' beliefs in the trustworthiness of the HI at time t are positively associated with their perception of the information quality of the HI at time t.

Reputation as a source of social knowledge plays a role in trust formation and maintenance. Reputation through word of mouth has always been a reliable source of knowledge in business transactions and relationships, because it is not driven by profit [40]. Furthermore, because reputation is created by a community of interested parties, it is less likely to be biased or inaccurate [40]. Therefore, customers may rely on this collective source of knowledge in forming their trust beliefs.

Hypothesis 3: Web consumers' beliefs in the trustworthiness of the HI at time t are positively associated with their perception of the reputation of the HI at time t.

Past prior experiences with HIs constitute the personal knowledge base and skills of consumers in dealing with information providers. This personal knowledge base could be used by consumers in dealing with information asymmetry. A more experienced consumer is better equipped to pick up the signals and to judge the ability, integrity, and benevolence of the HI. Gefen [15] argues that familiarity allows consumers to have a better understanding of the procedures and protocols used by e-vendors. We argue that the experience with similar e-vendors and the ability to compare their services and behaviors increase the skill of consumers in making a more accurate judgment regarding trustworthiness of a given HI.

Hypothesis 4: Web consumers' beliefs in the trustworthiness of the HI at time t are positively associated with their positive prior experience with the HI-type Web sites at time t.

Another personal knowledge base in dealing with the unknown is consumers' propensity to trust. We argue that the general propensity to trust is too broad to be a part of the knowledge base in the context of interacting with online information providers. Hence, we limit this construct to the general propensity to trust online information providers, which could be another source of knowledge in dealing with the information asymmetry of HIs as agents. Hence, a more focused construct, such as the propensity to trust infomediaries, may capture more accurately the comfort of consumers in relying on the Web for their information needs.

H5: Web consumers' beliefs in the trustworthiness of the HI at time t are positively associated with their propensity to trust infomediaries at time t.

The Dynamic Model of Trust in Health Infomediaries

We conceptualize the dynamics of trust building by identifying the constructs that contribute to changing trust-related beliefs from one period, T1, to the next, T2, after a fresh round of encounter with the HI, as shown in Figure 2.

A change in principals' trust beliefs requires new information. Firsthand experience in the form of a new episode of interaction is one of the most important sources for new information in the context of using an HI. The process of use begins when a consumer accesses an infomediary Web site and begins to read the information and subsequently relies on it to deal with an issue or make a decision. In other words, the HI plays the role of an agent in helping the consumer make an assessment of a health or wellness issue, such as a likely diagnosis of a disease, the decision to consult a physician, the decision to change eating habits, a health assessment, or a fitness initiative. In the case of information services, reading and using the information constitute the targeted consumer behavior by the HI. Numerous studies of trust have shown the relationship between trust and behavior intentions (see Gefen et al. [16] for a review). The extent of use in the context of HIs could be viewed as the overall cognitive assessment of information services. A higher level of use indicates an increased level of benefit to Web customers in dealing with their health issues. However, use behavior requires trust. In the agency theory, trust attitude could be viewed as principals' expectation that the agent will continue to behave in principals' best interest by providing them with the best and most suitable specific information services they need. If an HI is not trusted, Web customers will not spend time on the Web site to explore its information services. Hence,

H6: Web consumers' self-reported information use in the encounter period from t to t + 1 is positively influenced by Web consumers' trust attitude at time t.

A key issue for HI survival is a measure of their success. In dealing with this issue, we refer to the IS literature, where information is the commodity of interest, as it is when using HIs. In this stream of IS research, satisfaction is the single most important consequence of using an IS and the indicator of IS success (see, e.g., [10, 50, 63]). DeLone and McLean [10] review the extant literature on association between use and satisfaction in IS research. Satisfaction is an affective state resulting from use and is a measure of success in using an IT artifact [58]. Assuming rationality, Web customers use information services that generate benefit for them and satisfy their information needs. While increased extent of use indicates a positive cognitive assessment of the information service's benefit for Web customers, satisfaction is the affective state of consumers after the use behavior. It is satisfaction that builds loyalty by bringing consumers back to the Web site as well as by causing customers to recommend the Web site to others, hence spreading its reputation through customers' social networks.

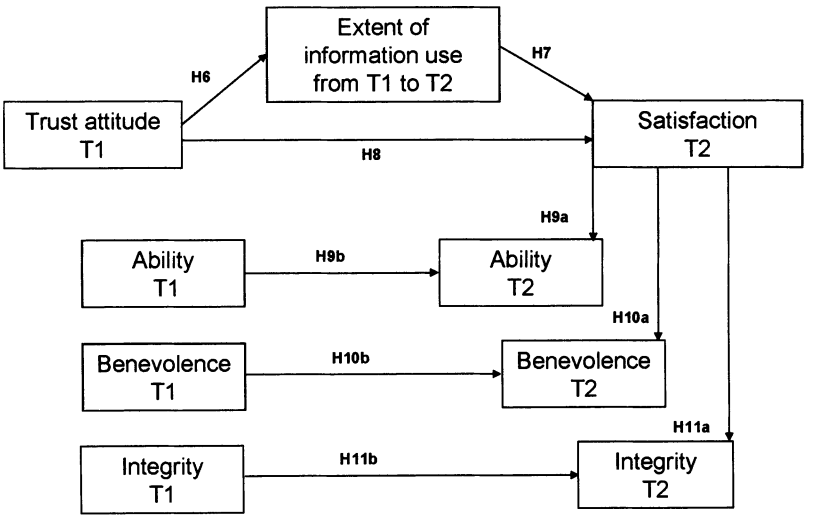

Figure 2. Dynamic Model of Trust: Transition from T1 to T2

H7: Web consumers' higher level of satisfaction with the HI at time t + 1 is positively associated with their increased extent of self-reported information use in the encounter period from t to t + 1.

The relationship between trust and satisfaction has been studied in single-period static models in a number of areas, including job satisfaction [46], selling partner relationships [53], customer relationship management [14], and brand marketing [19]. In a theoretical piece, Singh and Sirdeshmukh [52] argue that trust beliefs should influence satisfaction in building customer relationships. In e-commerce research, Floh and Trieblmaier [12] observe that satisfaction and trust lead to loyalty in e-banking, and Balasubramanian et al. [3] observe that trustworthiness beliefs influence satisfaction in online investing. However, to our knowledge, there is no empirical study of the dynamic influence of trust attitude at time t on satisfaction at time $t + 1$.

Trust attitude reflects consumers' affective state at time t regarding the agency of HI in providing the information services consumers need. It reflects consumers' expectations of how the HI will perform in providing the best information. Satisfaction is a postbehavior affective state reflecting consumers' feelings regarding the specific episode of information use. According to IIT in social psychology [1], affective states are integrative in that the old states are modified and integrated into the new affective states. Hence,

H8: Web consumers' satisfaction with the HI at time t + 1 is positively influenced by their positive trust attitude at time t.

The lower part of Figure 2 shows the process of trust-related beliefs revisions from encounter period from t to $t + 1$. It has been argued that satisfaction affects the future behavior of IS users by changing their expectations and, consequently, their future

behaviors [50]. In other words, satisfaction is the glue that links the present outcomes to the future beliefs and subsequent behaviors. This argument could be made more specific and cogent in the case of trust-related beliefs in HIs.

In IIT, Anderson [1, 2] argues that affective states, attitudes, and beliefs are not replaced by new information or events. Instead, old states, attitudes, and beliefs get integrated with new information in forming new attitudes and beliefs. Sawyers and Anderson [47] demonstrate the integrative nature of revision in a lab experiment where participants respond to a series of sequential information.

Furthermore, the belief adjustment theory in cognitive psychology has a similar premise [22]. When information unfolds over time, the belief revision will be subjected to contrast and adaptation depending on the negative or positive effect of the new information and the strength of prior belief [22, 27, 44]. IIT is also consistent with the Bayesian approach in which the old belief (prior probability) is integrated with the new information to form a new belief in the form of posterior probability. IIT is also in line with the theory of human learning, which has been extensively applied in developing neural network systems. It posits that learning is a gradual process and new learning is formed based on the new information as well as what was already learned (see, e.g., [64]). In other words, IIT has a parallel premise in a number of other theories regarding the gradual process of learning and belief revision. IIT postulates that affective states and attitudes also follow this gradual revision process. Hence, based on IIT, we postulate that trust-related beliefs at time $t + 1$ are revised based on the extent of satisfaction with a fresh episode of encounter as new information. Furthermore, this new information gets integrated with the old trust beliefs at time t to form the new trust beliefs at time $t + 1$.

H9a: Web consumers' belief about the ability of HI at time t + 1 is positively affected by satisfaction with the HI at time t + 1.

H9b: Web consumers' belief about the ability of the HI at time t + 1 is affected positively by their belief about the ability of HI at time t.

H10a: Web consumers' belief about the benevolence of HI at time t + 1 is positively affected by satisfaction with the HI at time t + 1.

H10b: Web consumers' belief about the benevolence of the HI at time t + 1 is affected positively by their belief about the benevolence of HI at time t.

H11a: Web consumers' belief about the integrity of HI at time t + 1 is positively affected by satisfaction with the HI at time t + 1.

H11b: Web consumers' belief about the integrity of the HI at time t + 1 is affected positively by their belief about the integrity of HI at time t.

Instrument Development and Experiment

THE INSTRUMENTS FOR TESTING THE MODELS WERE developed by modifying the existing scales to fit the experiments. Descriptions of constructs and the sources used for developing the items are reported in Table 1.[1]

Table 1. Construct Definition

Constructs	Operational definition	Sources
Favorable reputation (FR)	Web consumers' perceptions about the health infomediary's favorable evaluation.	[24]
Perceived prior experience with infomediaries (PPE)	Web consumers' positive experiences in interacting with infomediaries in general.	[42, 55]
IQ–relevance (IQRV)	Web consumers' perceptions about relevance, clearness, and goodness of information on the health infomediary's Web site.	[36]
IQ–understandability (IQUD)	Web consumers' perceptions about the clarity, understandability, and readability of information on the health infomediary's Web site.	[36]
IQ–adequacy (IQA)	Web consumers' perceptions of the sufficiency, completeness, and necessity of information on the health infomediary's Web site.	[36]
IQ–usefulness (IQUF)	Web consumers' assessments of the usefulness of the health infomediary's information.	[16, 36]
Propensity to trust (PT)	Web consumers' tendency to trust infomediaries.	[24, 35, 42]
Ability (A)	Web consumers' perceptions about the health infomediary's knowledge and competence in providing quality health information.	[6, 7, 24, 34, 37]
Benevolence (B)	Web consumers' perceptions about how much the health infomediary cares about its users.	[7, 24, 34, 37]
Integrity (I)	Web consumers' perceptions about the health infomediary's good faith and honesty.	[7, 24, 34, 37]
Trust attitude (TA)	Web consumers' favorable trust feelings toward the health infomediary.	[7, 24, 34, 37, 42]
Use (U)	Web consumers' perceptions about extent of usage of the health infomediary.	[57]
Satisfaction (SAT)	Overall evaluation based on the experience with the health infomediary over time.	[3, 11, 14, 36, 58, 63]

A pilot test of the instruments was carried out using 23 participants of the targeted sample population, and modified items based on feedback from participants. The comparative statics and dynamic models were tested through a multiple-phase controlled lab experiment. The static model was tested twice for two episodes of encounters to an HI. The instrument instructions were slightly modified in the second episode to anchor participants to express their *current* perceptions, beliefs, and feelings.

The controlled experiment involved three phases. All data were collected through a Web-based protocol. In Phase I (T1), participants were given the choice between two popular HIs (WebMD, www.webmd.com, and MedlinePlus, www.medlineplus.gov). This was done to increase the interest of participants and inject a voluntary aspect into the process. Participants were asked to surf their chosen site to get information on a variety of health issues in a number of general categories, covering possible medical and health topics. Within each category, participants were given the choice of investigating issues of their interest. This constituted the first episode of encounter (T1) with the HI. Participants then were asked to answer a series of questions from the contents of the HI. These questions were designed to ensure participants' serious surfing of their chosen HI Web site and becoming familiar with its contents as well as investigating the health and medical information of their interest. The intention of this protocol was to promote variability in the extent of use and satisfaction and provide a sense of voluntariness in the extent of using the site. After the participants answered HI-related questions, they were prompted to complete the instrument. This phase was their second episode of encounter that constituted their use of their chosen HI.

In Phase III, at the end of the month, participants returned to the lab. They were asked to bring their completed assignments to the lab session. Only those who had completed their assignments were allowed to participate in the second lab session. In this session, participants completed the survey instrument for T2, with the focus on their current perceptions, beliefs, and feelings. In this session, participants entered into the lottery to win a cash prize for the completion of the experiment. Participants were students in two universities (one in the Midwest and one in the South). In addition to the cash prize, they received a small credit toward their course work.

Data Analysis

More than 400 subjects participated in Phase I, and about half completed their required one-month use of their selected Web site in Phase II. In Phase III, seven cases were removed due to a system problem. A total of 209 participants completed all phases of the experiment with usable data.[2] A series of χ^2 tests regarding the possible group differences in the choice of HI did not result in any significant differences. The use of students for Web studies using controlled lab experiments is a common practice (see, e.g., [16, 28, 31, 32, 41]). Web users are relatively young and more educated [54] and they have a higher reliance on the Web in searching for products and services. College students fall into this category. Therefore, using student subjects is not a threat to the external validity of our results.

Tests for Common Method Variance

One of the major concerns in using single participants in answering questions for each case is the threat of common method variance. We took a number of steps to reduce common method variance, as recommended by Podsakoff et al. [45]. We used neutral wording for the items, semantic differential scales, and multiple items for constructs, all of which help reduce the occurrence of common method variance. We carried out three statistical analyses for checking and correcting for common method variance. The first analysis was carried out by applying Harman's single-factor test. This test involves an exploratory factor analysis (EFA) of all items to "determine whether the majority of the variance can be accounted for by one general factor" [45, p. 890]. Harman's test showed that the first factor accounted for 44 percent of the variances of all items. This finding indicated the presence of common method variance. The second analysis for common method variance was carried out to remove the common method variance. Podsakoff et al. [45] recommend two major approaches in removing common method variance. One is to incorporate a single factor consisting of all items in the analysis. The second approach is to use a marker item to purify the data. We tried both approaches.

The first approach, as predicted by Podsakoff et al. [45], led to overidentification and the structural equation modeling (SEM) solution did not converge. In the second approach, we used a general item as a marker. We regressed every item used in the model as the dependent variable and a marker item as the independent variable. We captured the residual for each item. The residuals constituted the items purified from the effect of common method. We subjected the purified data to another round of Harman's test. This test indicated a 33 percent reduction in variance explained by the single factor. Hence, we used the purified data in place of the original data in the estimation of the structural equations method, including the estimation of the measurement model, as recommended by Podsakoff et al. [45]. All reported results are based on the purified data. The marker item was excluded from the analysis.

Validity and Reliability Checks

We carried out EFA for the first-order factors. Two items in integrity and two items in ability were removed due to cross-loadings. The reliability of constructs was measured using Cronbach's alpha, composite factor reliability (CFR), and average variance extracted (AVE), as reported in Table 2. All Cronbach's alpha values are at or above the threshold of 0.70. Similarly, all CFR values are well above the cutoff value of 0.70, and all AVE values are well above the cutoff value of 0.50, together providing support for the reliability of constructs. We also computed the correlations of items within each construct with the general question for that construct. The high and statistically significant values of these correlations support the convergent validity of constructs. The general question for each construct was included neither in reliability checks nor in the model estimations.

Table 2. Reliability Measures for Model Constructs

Construct	Time T1			Time T2		
	Cronbach's alpha	Composite factor reliability	Average variance extracted	Cronbach's alpha	Composite factor reliability	Average variance extracted
Favorable reputation (FR)	0.87	0.91	0.66	0.88	0.90	0.64
Perceived prior experience (PPE)	0.89	0.91	0.73	0.91	0.91	0.72
IQ–relevance (IQRV)	0.89	0.84	0.64	0.94	0.82	0.60
IQ–understandability (IQUD)	0.91	0.86	0.67	0.93	0.90	0.76
IQ–adequacy (IQA)	0.90	0.88	0.71	0.91	0.90	0.74
IQ–usefulness (IQUF)	0.93	0.85	0.65	0.93	0.85	0.65
Propensity to trust (PT)	0.72	0.79	0.56	0.70	0.83	0.62
Ability (A)	0.85	0.85	0.65	0.86	0.80	0.57
Benevolence (B)	0.78	0.83	0.71	0.84	0.79	0.65
Integrity (I)	0.90	0.87	0.69	0.90	0.81	0.59
Trust attitude (TA)	0.95	0.96	0.87	0.95	0.92	0.75
Use (U)	—	—	—	0.92	0.91	0.72
Satisfaction (SAT)	—	—	—	0.91	0.85	0.66

Moreover, we carried out confirmatory factor analysis (CFA) for establishing the convergent and discriminant validity by estimating the measurement model. The software for the estimation of the measurement model and the SEM estimation of the research model was MPlus, which was developed by Muthén and Muthén [39].[3]

The high values for factor loadings provide further support for convergent validity of the constructs. Furthermore, the *t*-values for factor loadings of manifest variables were well above 2, supporting the statistical significance of factor loadings [39]. Moreover, the high R^2 values for the indicators support the assertion that the indicators are good measures for the construct [16]. The measurement models fit indices are reported in Table 3. As shown in Table 3, all fit indices met desired criteria and suggest that the measurement models adequately fit the data. Although the marker variable reduced the common method variance, the fits of the measurement models did not seem to be affected, which indicates that the marker variable did not removed any significant structure from the data.

The guideline for discriminant validity is that the square root of AVE for each construct should be greater than the correlation values of the construct with other constructs [13]. Each construct's correlation values with other constructs are less than the square root of AVE for that construct, which provides further evidence for the discriminant validity of constructs. There are exceptions in the case of ability, integrity, and benevolence at T2, which indicate that these three subdimensions may have questionable discriminant validity at time T2. To further investigate discriminant validity, we followed the procedure suggested by Gefen et al. [16, 17] and assessed discriminant validity by comparing the original measurement model (CFA) with full latent constructs against other measurement models with two constructs combined. We analyzed every possible combination of collapsing two constructs into one. The χ^2 value in the original CFA was significantly better than all combinations of the reduced measurement models. The results fully supported the discriminant validity of constructs.[4]

Model Estimation

THREE MODELS WERE ESTIMATED: the comparative statics models at time T1 and T2 and the dynamic model for the transition process from T1 to T2. The estimation method is SEM using MPlus. The estimation algorithm is the mean-adjusted maximum likelihood, which adjusts the estimation results with respect to nonnormality in the data and computes scaled χ^2 and robust standard errors. In the estimation of the dynamic model, we allowed the covariance between error terms of the main variables T1 and T2 periods to be free. Table 3 reports the fit indices for SEM estimation. The fit indices indicate good fit of the three models into the data. Findings regarding each of the models are discussed below.

Comparative Statics Analysis T1 and T2

As shown in Figure 3, all hypothesized paths in the static model are supported at time T1. One exception is prior experience, which is marginally significant at time T1.

Table 3. Fit Indices for the Measurement Models and SEM Models

Fit index	Comparative Static T1		Comparative Static T2		T1-to-T2 Dynamic		Cutoff Values
	Confirmatory factor analysis	Structural equation modeling	Confirmatory factor analysis	Structural equation modeling	Confirmatory factor analysis	Structural equation modeling	
Normed chi-square (chi-square/df)	1.50	1.50	1.67	1.69	1.66	1.69	<3.0 or 5.0
GFI (goodness-of-fit index)	0.84	0.84	0.82	0.84	0.88	0.87	> 0.90
AGFI (adjusted goodness-of-fit index)	0.82	0.92	0.80	0.83	0.84	0.84	> 0.80 or 0.90
CFI (comparative fit index)	0.94	0.94	0.92	0.91	0.95	0.94	> 0.90
TLI (Tucker–Lewis index)	0.93	0.93	0.91	0.91	0.93	0.93	> 0.90 or 0.95
NFI (normed fit index)	0.84	0.84	0.82	0.84	0.88	0.87	> 0.90
NNFI (nonnormed fit index)	0.93	0.93	0.90	0.91	0.94	0.93	> 0.90
RMSEA (root mean square error of approximation)	0.049	0.049	0.057	0.058	0.056	0.058	< 0.06
SRMR (standardized root mean square residual)	0.060	0.061	0.064	0.068	0.050	0.070	< 0.10

See [4, 16, 17, 23] for recommended thresholds.

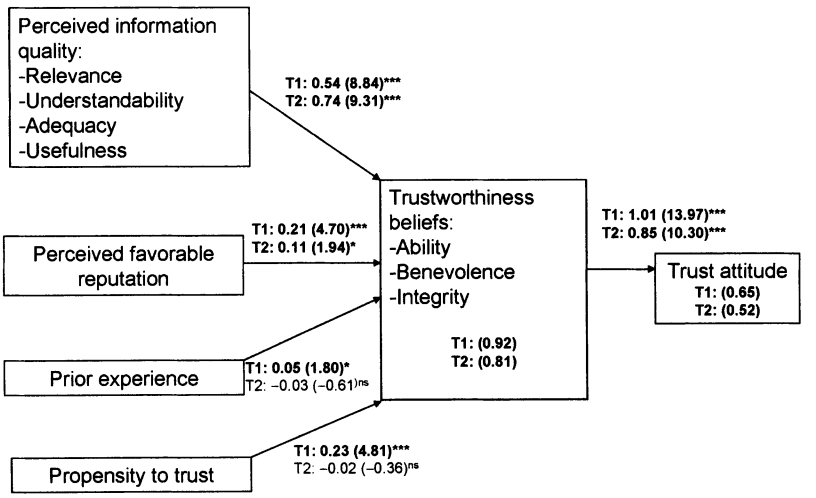

Figure 3. Estimated Comparative Static Model of Trust (at times T1 and T2)
Notes: Values on lines are path coefficients and their *t*-values. Values in boxes are R^2. ns = not significant; * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

At time T2, all trustworthiness antecedents except for information quality become either nonsignificant or marginally significant ($p < 0.10$). Of these antecedents, perceived favorable reputation is marginally significant, and its path coefficient is reduced by half, from 0.21 to 0.11. On the other hand, information quality's coefficient is increased by 50 percent, from 0.54 to 0.74. A *t*-test of the difference between the two coefficients (assuming independence) shows that the difference between T1 and T2 coefficients of information quality is statistically significant. This is an important finding. It indicates that after the initial episode of encounter, the most important and significant factor for trust building in HI is information quality. Other antecedents fade away.

Dynamic Analysis T1-to-T2

The transition from T1 to T2 was tested in the dynamic model, as shown in Figure 4. In H6, H7, and H8, we hypothesized that trust attitude influences satisfaction both directly as well as indirectly through the mediated impact of the extent of information use. These hypotheses are supported.

H6 posited that trust attitude has a positive effect on extent of use. This hypothesis was supported at $p < 0.01$ with a standardized coefficient of 0.30. H7 and H8 posited that extent of use of the HI in the period T1-to-T2 and trust attitude at time T1 positively affected satisfaction with the HI at T2. Both of these hypotheses are supported with a *p*-value less than 0.01 and coefficients 0.29 and 0.29. Hence, satisfaction at T2 is affected by trust attitude at time T1 directly and through use during the T1-to-T2 transition. Therefore, trust attitude at time *t* has both a direct and a mediated (through use) effect on satisfaction with HIs at the subsequent episode of use.

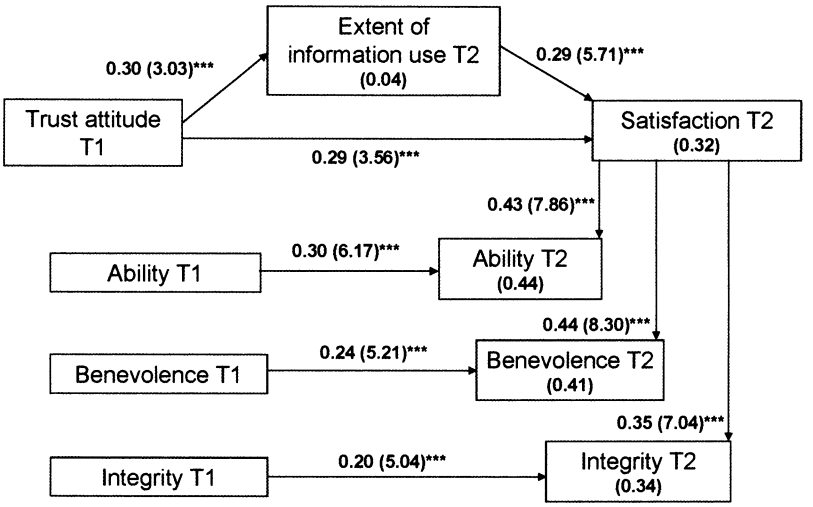

Figure 4. Estimated Dynamic Model to Trust (transition from T1 to T2)
Notes: Values on lines are path coefficients and their *t*-values. Values in boxes are R^2. ns = not significant; * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

We also hypothesized in H9, H10, and H11 that each one of the trust-related beliefs (ability, benevolence, and integrity) at time $t + 1$ is a function of the respective belief at time t and satisfaction at time $t + 1$. As shown in Figure 4, ability belief at T2 is a function of ability at T1 as well as satisfaction at T2. The R^2 for ability belief at T2 is 0.44, indicating that satisfaction and lagged ability belief explain 44 percent variation in ability at T2. The path coefficient of ability at T1 is 0.30 and that of satisfaction at T2 is 0.43, indicating that satisfaction has a higher share in the revision of ability belief. Both path coefficients are significant at $p < 0.01$.

Similar results are found for benevolence and integrity beliefs, in that satisfaction at T2 and respective belief at T1 explain a relatively high percentage of variance, with R^2 0.41 and 0.34. The path coefficients are also significant at $p < 0.01$. In these two cases, satisfaction also has a larger share (0.44 and 0.35) than the old belief at T1 (0.24 and 0.20).

Discussion

THE RESULTS OF TESTING THE COMPARATIVE STATICS and dynamic models provided a number of interesting insights. The comparative statics analysis shows that the relationship between trustworthiness beliefs and trust attitude continues to remain strong over time. Furthermore, the relatively high R^2 values of trust attitude in both periods indicate good explanatory power for the comparative statics analysis. The slight reduction in the path coefficient between trust beliefs and trust attitude may indicate that as the number of encounters increases, factors other than trust beliefs may arise to influence the affective state of trust. In other words, trust attitude may not have a fixed structure

and other factors that are not initially important may gain significance in changing Web customers' trust attitudes.

The most interesting finding of the comparative statics analysis is the increased role of perceived information quality and the loss of significance of prior experience with infomediaries and propensity to trust. Even the effect of reputation on trust beliefs becomes marginalized. This result confirms the prominence of concerns about information asymmetry in the agency theory and the argument that information quality is the single irrevocable and visible investment by HIs that could bolster consumers' trust beliefs in order to counter their fear of information asymmetry. This is particularly true after the initial episode of encounter, indicating that trustworthiness beliefs and trust in subsequent encounters depend almost exclusively on the quality of HIs' information.

The findings of the dynamic model T1-to-T2 provide support for satisfaction as the outcome of information use. Trust attitude and extent of information use are strong antecedents of satisfaction after an episode of use. Furthermore, trust attitude has a significant effect on extent of information use even in the mandatory conditions of the lab experiment. However, the mandatory condition of the data collection experiment could have caused a low R^2 value for extent of information use.

The dynamic model also provides support for IIT in the revision of ability, benevolence, and integrity beliefs. This theory posits that beliefs are revised gradually and the new information is integrated with the old belief to produce the new belief. In the context of using HIs, the new information is the level of satisfaction after an episode of information use. In all three cases, the belief is revised by the integration of satisfaction with the old belief.

Another interesting finding is that in all three cases, the values of path coefficient for satisfaction are 50 to 100 percent more than those of the old beliefs (T1), indicating that satisfaction has a higher effect. In other words, new information resulting from an episode of use changes Web customers' beliefs relatively quickly. Web consumers seem to have a short memory about their initial beliefs and are willing to change their beliefs after an episode of use.

The results confirm the theories used in building the conceptual models. The prominent role of information quality in trust building over time provides support for the agency theory. It shows the continued concern of customers (as principals) about information asymmetry and possible moral hazard in dealing with HIs, and their need for assurance of information quality. Furthermore, our empirical analysis provides support for the IIT in that new experiences (in the form of use and satisfaction) are integrated with existing states (trust and trust beliefs) to form new beliefs and attitudes.

Implications

THIS STUDY IS THE FIRST IN OUR KNOWLEDGE to formulate theoretically and investigate empirically how trust beliefs are revised over time in the context of information providers. We reported our findings regarding the comparative statics analysis and dynamic transition of trust-related beliefs and their antecedents. So far, research in trust has

assumed that the structure of trust (either initial trust or subsequent trust) remains constant. Our results show that the structure trust model in the forms of antecedents of trust beliefs changes over episodes of information use. This is a new finding that points to a fresh area of inquiry of trust in Web-based vendors and providers. Furthermore, our findings show the increased prominence of information quality in later stages of trust building for information providers.

Our findings have multiple managerial implications. They suggest that in developing strategies for promoting customer loyalty, infomediaries need to focus on enhancing their information quality and providing evidence that assures customers of quality of information services on Web sites. This has a significant implication for Web design as well as marketing and customer relation management. Information providers need to clearly identify their target customers and regularly monitor the relevance, understandability, adequacy, and usefulness of their information services for their target markets. Information providers' marketing strategy should adopt multiple approaches to reduce customers' apprehension regarding their information quality, such as advertising, focusing on the credibility of their information sources, and getting support from well-known experts.

The results of the dynamic model show that trust beliefs change over time as new Web consumers gain more experience in using the HI, and that satisfaction plays a major role in the belief revision process. The significance of satisfaction in the process of belief revision once again highlights the role of this important construct. Our results indicate that the role of satisfaction is not limited to e-commerce vendors and extends to infomediaries. It also indicates that Web customers do not hold fast to their beliefs and their views could easily change as they use information services. Trustworthiness beliefs of infomediaries' customers are fragile and could be easily damaged with a few episodes of bad experience. Infomediaries are in a risky business, as a large cadre of customers at one time does not guarantee their return. Again, this points to the importance of vigilance on the part of information providers in tracking their customers' satisfaction and finding innovative ways to enhance customers' experience when visiting their sites.

Limitations and Future Research

AS IN ANY EMPIRICAL INVESTIGATION, OUR STUDY has a number of limitations. The lab experiments were carried out using participants from the university student population, who are young and relatively well educated. Furthermore, data were collected at only two points in time. The participants were not required to take any action or decision based on the information they acquired from the Web sites used as the stimuli. Furthermore, in order to increase the voluntary nature of participants' activities and promote variability of data, we used two Web site stimuli, which could introduce uncontrolled factors in the experiment. Moreover, in Phase II, participants were allowed to access their chosen Web site outside the lab environment, which was not under our control. Although we tried to ensure use by collecting assignments from participants,

the extent of use in Phase II was self-reported and could have been subject to error in recall. Together, these limitations could constrain the generalizability of our results.

Despite the study's limitations, this paper is one of the first to study the dynamics of trust building and to focus on HIs. We investigated the dynamics of trust change by deploying two approaches—comparative statics analysis and dynamic analysis. We relied on the theory of agency and the extensive studies in trust and satisfaction to provide an overarching theory for the antecedents of trust in HIs, and used IIT to formulate the dynamic revision of trust-related beliefs. We tested the models in a multistage experiment. Three models were estimated: two comparative statics models (T1 and T2) and the dynamic model. Our results showed that the structure of trust changes over multiple episodes of encounter and use of the HI. The secondary sources of knowledge about the HI and the categories of HIs lose their relevance as the firsthand knowledge of Web consumers increases through encounter and use. The prominence of information quality provides support for the agency theory and the concern for information asymmetry. To reduce concern for information asymmetry and to build trust, online information providers need to continually provide assurances for information quality.

A higher level of information quality leads to increased trust and a higher level of use, both of which, in turn, lead to a higher level of satisfaction. Satisfaction is the important outcome of encounter and use, which has a major role in the revision process of trust beliefs, providing the evidence that the theory of information integration is at work for the belief revision.

This research could be extended in multiple directions. Our models should be tested and compared with those for other infomediaries, such as financial and e-commerce infomediaries. Furthermore, this work has opened a new venue for investigating the dynamics of trust adjustment. This topic should be explored in various settings and under different conditions. Finally, as is the case for all lab experiments, our results are contingent on the sample population, HIs, and protocol we used in the data collection process. Further testing of the models is needed with other types of populations (such as elderly people or those who have had little experience with the Web) and other methods (such as field experiments or case studies).

Notes

1. Instruments are available upon request from the authors.
2. Due to space limitation, the detail of participants' profiles in the two institutions and their Web activities and interest in health information are available upon request from the authors.
3. The result of the CFA is available upon request from the authors.
4. The pairwise discriminant analysis is available upon request from the authors.

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