Supply-Chain Transparency and Governance Systems: Market Penetration of the I-Choose System

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Abstract

In this paper we explore the impacts of key characteristics of Supply Chain Governance Systems in the development and diffusion of technology innovations that promote supply chain transparency. The preliminary model presented in this paper was developed following group model building methods. Our current simulation experiments reveal that the market resists “take-off” unless external financial support can be found. Additionally, “take-off” dynamics of the system are dominated by marketing budgets and external support for infrastructure. Marketing budgets drive how fast users adopt the system, and without external sponsorship of system, the final market collapses. Finally, the quality of governance –reflected in information completeness, openness, relevance and reliability– and the resultant trustworthiness of information determines final sustainable market share.

1. Introduction

This paper presents a preliminary simulation model that presents a theory of market penetration dynamics of a large-scale socio-technical system to promote sustainable consumption through building more transparent supply chains. The model in its current form includes the universe of producers who could potentially contribute information to the system as well as consumers who select to use the information to make better retail purchase decisions. Producer interest in the system is assumed to be influenced by a consideration of the costs and benefits implied in joining the initiative (Ladd, 2010; Malhotra, Gosain, & El Sawy, 2005). Consumers are assumed to become active users when there are many producers and suppliers contributing information to the system, and when the information provided by the system is both trust worthy and of high quality (Sathiyamoorthy, Iyenger, & Ramachandran, 2010; Xiao & Benbasat, 2007). The model

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makes a series of assumptions about how an open governance structure can contribute both to high quality and trustworthy data.

Although transparency of the governance system is at the heart of our current simulation efforts, the model presented in this paper is at the intersection of many different disciplines. For example, the model is related to research interested in measuring the value of information and information technologies as well as the distribution of this value along the supply chain (Elofson & Robinson, 2007; Malhotra, Gosain, et al., 2005; Wang, Tai, & Wei, 2006), the role of transparency in improving performance in supply chains (Bayat, Sundararajan, Gustafson, & Zimmers, 2011; Davis, Nikolic, & Dijkema, 2010), the role of supply chain transparency in building more sustainable supply chains (Davis et al., 2010; Goleman, 2009), the role of information agents in improving buying decisions along the supply chain (Komiak & Benbasat, 2006; Nissen & Sengupta, 2006; Sathiyamoorthy et al., 2010; Xiao & Benbasat, 2007), marketing research in motivations for ethical consumption (Carrington, Neville, & Whitwell, 2010; Kim, Lee, & Park, 2010; Punj & Moore, 2007), product labeling (Beales, Craswell, & Salop, 1981; Caswell & Padberg, 1992), as well as the key role of trust in the development of applications and systems to promote transparency and improved consumption decisions (Komiak & Benbasat, 2006, 2008; Ladd, 2010). We believe that our modeling efforts are going to benefit from knowledge developed in all these different disciplines, and also it has the potential to contribute to all of them.

The paper is organized in six sections, including this brief introduction. The second section of the paper includes a description of our current research efforts developing a system to support ethical consumption and transparent supply chains. The third section includes a literature review on the relevance of governance systems for the development of such systems. The fourth section is a description of the methods that we followed to develop the current preliminary model. The fifth section includes a description of the model structure, as well as some simulation experiments. We end the paper with some final remarks and future research.

2. The I-Choose System

Our current research suggests that some of the current shortcomings of tools that support ethical consumption can be addressed by the creation of a scalable socio-technical system to facilitate information sharing and interoperability among stakeholders in the supply chain (Luna-Reyes, Sayogo, Zhang et al., 2012; Luna-Reyes, Zhang, Whitmore et al., 2011). We envision that the socio-technical system in place should include at least three different components: a set of data standards to share information across the supply chain, a set of Application Programming Interface (API) standards to make it possible for developers and other interested groups to create specific applications to make this information usable by regular consumers, and a governance system, which will be in charge of creating and modifying the standards over time. We are calling this system the I-Choose system (Luna-Reyes, Andersen, Andersen et al., 2012; Luna-Reyes, Sayogo, Zhang et al., 2012).

Through a case study of coffee grown and sold in the North American Free Trade Area (NAFTA), the I-Choose Project team researches collaborative mechanisms to increase supply chain transparency and product data disclosure. The I-Choose project is supported in part by US-NSF (Grant No. IIS-0540069), CONACYT-Mexico (Grant No. 133670), and the Canadian and COMEXUS Fulbright Commissions.[2]

A central goal of our I-Choose project is to build a Full Information Product Pricing (FIPP) System. A FIPP system makes information about how, where, by whom, and under what conditions a particular product was produced available and usable to consumers, and helps them make more informed purchase decision (Luna-Reyes, Andersen, Andersen et al., 2012). Examples of such efforts include "fair trade", "sustainable", "green", "locally produced", "fair wage", or "organic (for food)" production processes. These efforts allow consumers to make ethical decisions with regards of the social and environmental impacts of the coffee they drink (Luna-Reyes, Sayogo, Zhang et al., 2012).

3. The Governance of FIPP Systems

Consumer Trust is a key issue in FIPP information systems. Our earliest case-study research into relatively small-scale systems indicated that establishing a trusted relationship between consumers and producers is a key feature of all successful FIPP systems. Simply put, if a consumer is going to pay a premium for a product based on an expanded information package, then the customer needs to be able to trust the content of that information package. Most producers and distributors in small to moderate scale FIPP systems pay a lot of attention to creating and sustaining trust, according to our interview data. So the question arises of how do large-scale FIPP systems, spanning multiple producing and distribution organizations, both create and sustain consumer trust? This question is especially challenging when one realizes that those who produce the information package (producers and distributors) most likely have a strong financial interest in the content of the package as well as many opportunities to bias or even falsify the information package. Some of our interviews, especially in Latin America indicated that in many instances, government-certified programs fared no better in terms of citizen trust (presumably due to lack of high performance standards or even the perception of graft and/or corruption) (Luna-Reyes, Andersen, Andersen et al., 2012). Therefore, good governance of FIPP systems is required to promote trust in the system and its data.

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[2] More information about I-Choose can be found at http://www.ctg.albany.edu/projects/ichoose.

Governance, in the simplest definition, is the process of governing: of steering a system, organization, or society towards certain desirable outcomes (Rosenau, 1995, 2000). Our project focuses on how FIPP systems are and might be governed - i.e. how inter-organizational relationships are formed to promote competition that is based on non-price product characteristics. This is distinct from referring to the internal governance of a corporation or organization. Use of the term governance, in our definition, therefore implies collaboration of various kinds between firms, non-governmental organizations, and governments in order to steer the system towards certain, mutually-agreed upon, outcomes.

But it is not enough to just have 'governance'. The quality of that governance must somehow be assessed. The term 'good governance' is frequently used in the context of states, corporations and international organizations to refer to a desirable set of principles on which organizations should deliver. So what constitutes, or should constitute, 'good governance' among FIPP systems? How might FIPP systems be governed in order to maximize the benefits of such systems to producers, retailers, certifiers, or consumers?

There exists a great diversity of opinion with regard to what constitutes 'good' governance. Fortunately, a review of the scholarly literature reveals a consensus around three core principles (Key works include Kooiman 1993, UNDP 1994, Woods 1999, CEC 2001, Kaufman and Kraay 2002, de Búrca and Scott 2006, Abbott and Snidal 2009, Sabel and Zeitlin 2010, Héritier and Lehmkuhl 2008, Mossialos et. al 2010, World Bank Group 2012, Vermeulen et. al. 2012, Greer, Wismar and Figueras forthcoming). Despite slightly different wording, the concepts of accountability, transparency, and participation are most frequently viewed by organizations and scholars as essential to good governance. By extrapolating from these core governance principles, we can gain some idea of how they can be harnessed to produce trustworthy information and therefore to support FIPP systems.

In the most basic sense, accountability refers to the requirement for those with authority to answer for their decisions and actions. It refers not only to the sharing of key information such as reporting or accounting requirements, but extends beyond that to providing clarity regarding power relationships. Strong accountability within an organization requires that all participants know who is accountable, for what, and to whom (Woods, 1999, p. 44). In FIPP systems, accountability can be used to increase trust. Accountability increases trust in the system because decision-making procedures are clear, and are followed consistently, and because decisions can be challenged. When the system is accountable, we can expect increases in the reliability of the data because participants within the system have channels they can use to challenge the validity of product information and the way it is interpreted.

Transparency refers to the extent to which organizations and individuals outside a system or institution can access information about its decisions and actions. Strong transparency requires not just that information on decision-making procedures be available, but that the resources spent to access the information should be reasonable (OECD, 2002, 2003). The principle of transparency frequently underpins accountability because the ability for participants and outsiders to see how the system works can enhance their ability to challenge decisions made by the system. In FIPP systems, transparency can increase trust by increasing the openness of the system and its data. Transparency of the disclosure process increases trust in the data because it can be accessed and checked independently.

Participation refers to the extent to which relevant stakeholders are willing and able to participate in the system. Strong participation goes beyond merely sharing information with stakeholders, allowing them to take part in decision-making and setting guiding principles, rules, or standards. Participation underpins accountability by supporting avenues which allow outsiders to challenge decisions**.** In FIPP systems, participation breeds trust in the system among participants. Strong participation increases the relevance and completeness of the data by increasing the chance that a stable consensus will be reached regarding such issues as what data should be disclosed and which standards should be adopted.

Extrapolating from this discussion, how should a potential FIPP system be governed? We can say that a FIPP system should have three key governance principles which support and enhance each other: accountability, transparency and participation. And that these key principles should support four key characteristics of the data within the system: completeness, reliability, openness, and relevance. The data disclosed should be as complete as possible, meaning both that it should tell us as much about the supply chain as possible and that the number of missing entries should be minimized. It should be as reliable as possible, meaning that it should accurately reflect the realities of the product supply chain. It should be as open as possible, to allow verification and promote its use and reuse. And it should be as relevant as possible, to promote further disclosure as well as consumer use of the system.

In light of the above discussion, we hypothesize that the key to successful market penetration of I-Choose System is a governance system that supports complete, reliable, open and relevant data in FIPP systems and which can eventually promotes consumer trust in product information. Our goal in this paper, therefore, is to explore key factors for successful market penetration of I-Choose System through a system dynamics group model building and simulation approach.

4. Methods

Simulation methods have been recognized as useful ways to build and test theories in the social sciences (Davis, Eisenhardt, & Bingham, 2007; Hanneman, 1995; Hanneman, 1987). System Dynamics in particular has been associated with other qualitative theory-building methods as a powerful way of developing robust dynamic theories for social phenomena (Andersen et al., 2012; Black, Carlile, & Repenning, 2004; Kim & Andersen, 2012; Kopainsky & Luna-Reyes, 2008; Luna-Reyes & Andersen, 2003). In fact, building small simulation models has been recognized as a way to incorporate current knowledge about a system in order to better understand complex relationships among variables, and refining our understanding of basic theories to continue with empirical research (Davis et al., 2007; Ghaffarzadegan & Andersen, 2012). There are in the literature many different examples on ways in which simulation models have been used to refine theories (Black et al., 2004; Ghaffarzadegan & Andersen, 2012; Luna-Reyes & Gil-Garcia, 2011; Zagonel, Rohrbaugh, Richardson, & Andersen, 2004). Moreover, given the interdisciplinary nature of our work, we have chosen group model building as a way to integrate in a single model a diversity of points of view, using the system dynamics model as a boundary object in this collaborative theory building process (Black & Andersen, 2012). Group model building obtains insightful model structure and extends the ownership of the model by involving a group of people in the model conceptualization and model formulation (Andersen & Richardson, 1997; Richardson & Andersen, 1995; Vennix, 1996).

Overall, our research progressed through three methodological phases: (1) A large-scale concept elicitation meeting with stakeholders in the I-Choose supply chain, (2) A smaller-scale and more formal group model building project involving only team researchers who had been present at the larger stakeholder meetings, (3) The creation of a small model—the model reported on in this paper. Each of these steps are described in more detail below.

Stakeholder involvement at various stages of system development is regarded as a key success factor in system development and implementation (Robey & Farrow, 1982). However, most information systems literature only considers internal stakeholders, largely overlooking the influence of external stakeholders to system development (Pouloudi, 1999). In order to create a prototype of the standards necessary to share supply chain information and a prototype of a governance system to support these standards, our I-Choose project has created a network of stakeholders associated with the coffee supply chain (Zhang et al., 2012).

We had a workshop with these stakeholders in a two-day meeting in August 2011. The goals of the workshop were to understand which were the main stakeholders of a system like I-Choose, and what were the key issues to be considered in the development of I-Choose. The workshop involved a series of brainstorming and discussion sessions that have informed our modeling process (Zhang et al., 2012).

Similar to other theory-building efforts (Luna-Reyes et al., 2006), the second stage of the model involved a group-model-building exercise involving researchers from multiple disciplines. This Group Model Building Efforts are described in more detail elsewhere in these proceedings, but basically consisted in a three-hour meeting to elicit key variables, key model assumptions, boundary considerations, key reference modes and an initial model structure (Luna-Reyes et al., 2013).

Finally, we followed standard system dynamics practices to develop the simulation model presented in this paper (Richardson & Pugh, 1981; Sterman, 2000). As in many other simulation projects the iterative process has resulted on several model versions. The one presented in the model is a parsimonious theory of market penetration.

5. Model Structure and Behavior

In this section of the paper we introduce a description of our current model structure, as well as some basic simulation experiments.

Model Structure

Figure 1 is an abstracted view of our model structure, which illustrates the main causal loops that we now believe to be operating in the system. There are two major reinforcing loops that dominate the system behavior. The increase of the number of producers and the governance openness and trust worthiness of data will lead to the growth of green consumers using the system. More system users will cause higher benefits to costs ratio, which will result the increase of the number of producers providing data to the system. In the meantime, more producers will bring more resources to support the system, reduce net costs of the system and lead to higher benefits to costs ratio of the system.

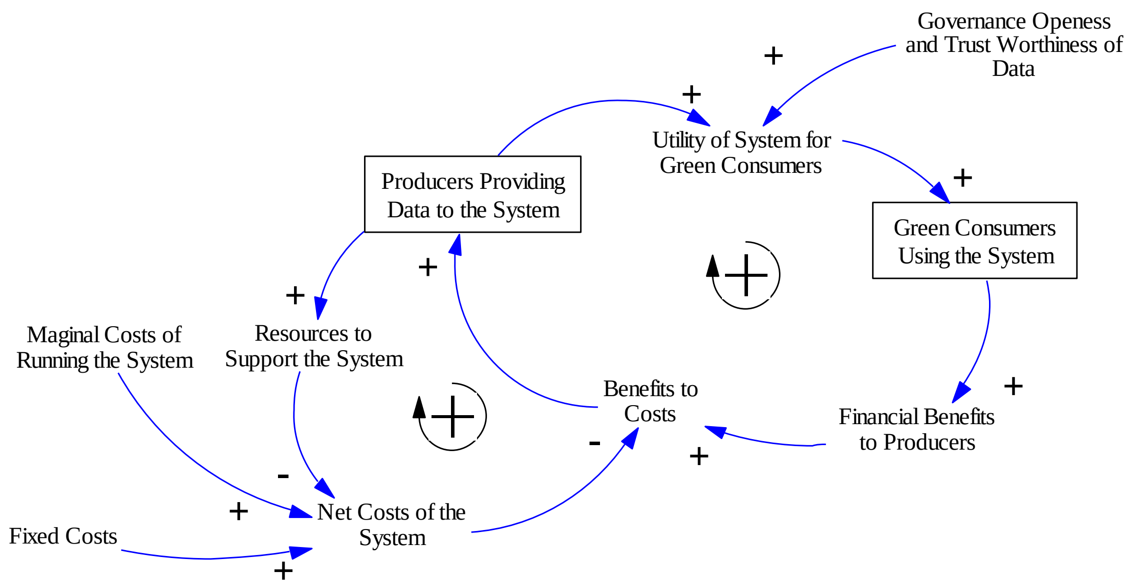

Figure 1 Main Causal Loops – Forces Influencing System Take Off

Of course, these two loops can work in both directions. Once the system is over a key "tipping point" where there are BOTH enough consumers to make it profitable for a producer to join the system AND there are enough producers using the system to provide consumers high enough utility to bother using the system, then a take-off in both consumer and producer adoption of the system will take place. On the other hand without enough consumers using the system, it is not cost effective for the marginal producer to join the system. And without producers adding their data to the system, consumers find little utility in using the overall system. In these cases, the reinforcing loops create a trap that prevents the system from taking off. Even in the presence of a technically perfect prototype system with a governance system that would insure absolute consumer trust in the information in the system, overall grown will not occur as the system remains locked down the trap produced by these two positive loops.

Model Description

Of course, the final reduced form model is somewhat more complicated than the high level view provided in Figure 1. Our latest version of the model has two main sectors, Growth of Green Market (Figure 2) and Cost-Benefit Evaluation (Figure 3). As shown in Figure 2, we mainly focus on green consumer behaviors at the current stage of model development. We conceptualize three different subgroups in green consumer population, green consumers who are using the I-Choose system, those who are not using the system, and those who are former but not current system users. The basic model sector structure is an adaption of the classic diffusion model. There are two paths by which non-system users would become system users. One is through the influence of word of mouth, and the other is through marketing. The degree of the influence of word of mouth depends on system attractiveness and the number of existing system users, while the degree of the influence of marketing is determined by available marketing budgets and the number of existing system users.

Importantly, retention of current users of the system depends critically on 'Effective System Attractiveness', which in turn is ultimately a function of the 'Market Share' of the producers supplying information to the system and the long term 'Quality of the Information in the System' (see Figure 3 for details). That is, consumers can be induced to first try out the system via one of two dynamic mechanisms (word of mouth or direct marketing efforts), but another dynamic relating to overall quality of the system will drive whether or not they stay with the system in the long run.

As shown in Figure 3, the key variable 'System Attractiveness' is a combined effect of quality of information in I-Choose system and the market share of the system. The quality of information is determined by three system characteristics, the 'System Capacity', the 'Governance Completeness, Relevance, & Reliability', and the 'Governance Openness & Transparency'. The last two variables reflect key governance principles derived from our former theorizing and discussion. The market share is determined by producer behaviors, their willingness to register as a certificated producer in the I-Choose system and disclose full product information to consumers. In our current model, producers' willingness to use the system depends on the benefit-cost evaluation of the system, which is in turn determined by the number of system users and the total cost of building, maintaining, and marketing the system.

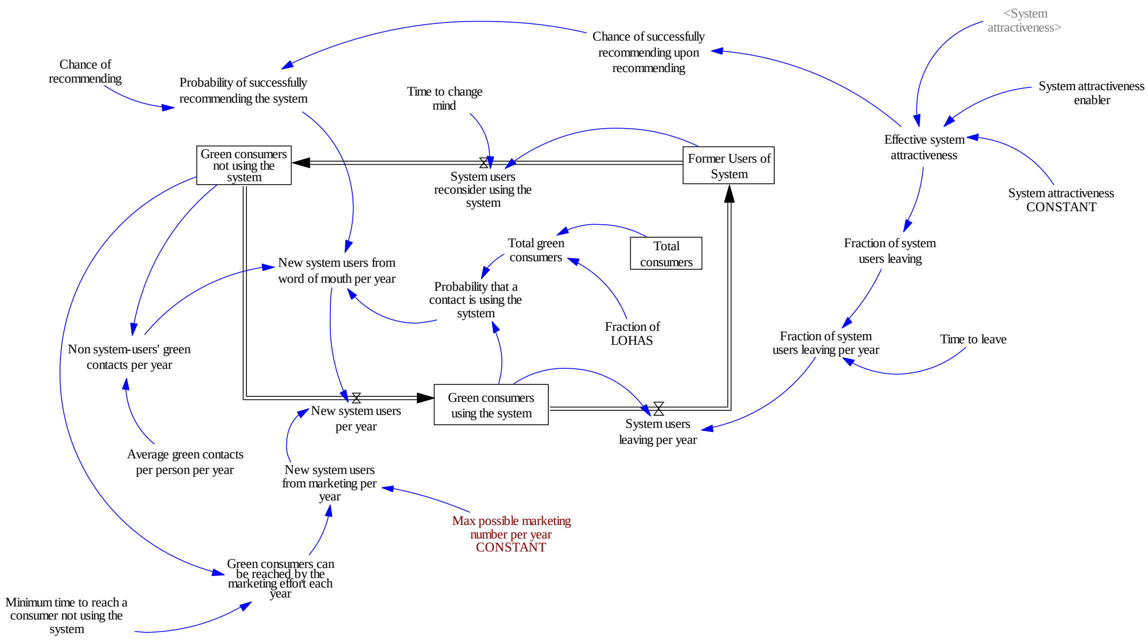

Figure 2 Model Sector I – Growth of Green Market

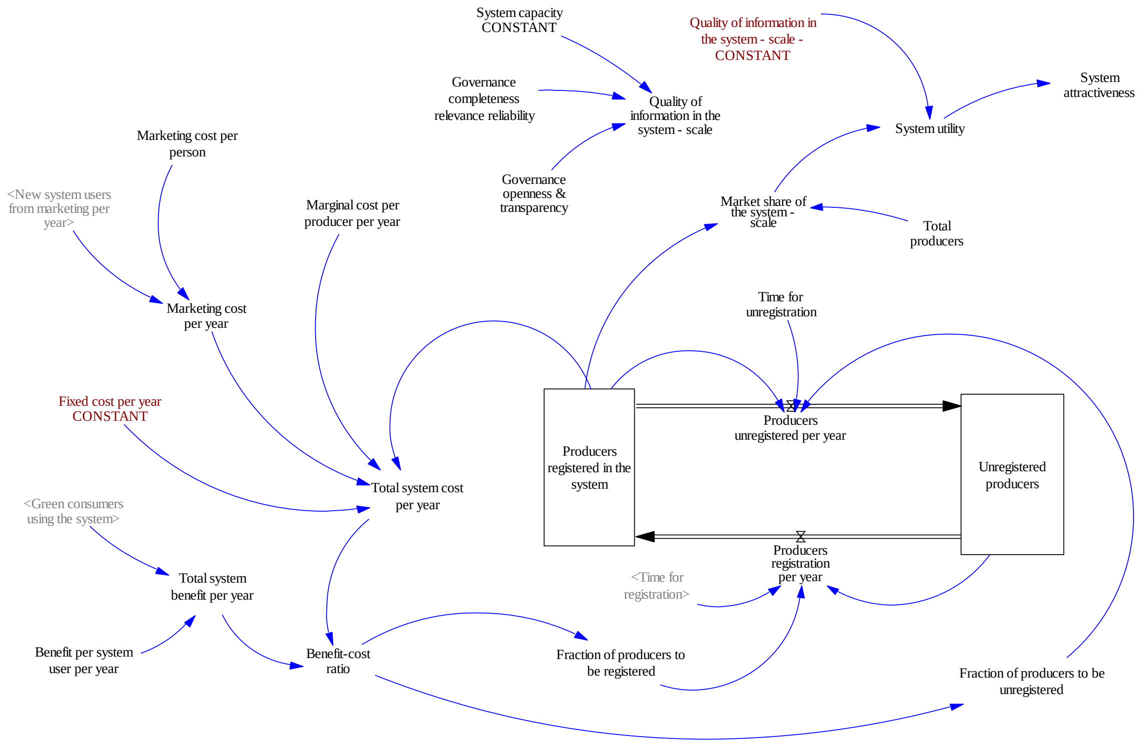

Figure 3 Model Sector II – Cost-Benefit Evaluation

Model Experiments

Through the iterative model-refinement process and extensive experiments, we have learned that model behaviors are greatly shaped and confined by factors in three dimensions: (1) The information quality, which is the reflection of governance factors in the model as well as the overall and final system capacity. These are key determinants of whether or not consumers continue to use the system, (2) system fixed costs per year which drive the overall Benefit-Cost ratio that controls whether or not new producers choose to join the I-Choose system and (3) The variables that reflect marketing efforts. Variables associated with marketing impact on producer decisions to join I-Choose because marketing costs are part of the benefit-cost calculation that drive new producer acquisition. In turn, marketing also promotes initial uptake of I-choose by consumers, helping to push the system toward a consumer-driven “take-off” point. Hence marketing variables impact both on consumer and producer market share.

Therefore, we conducted a series of experiments to explore the influence of factors in these three dimensions. Figure 4 and Figure 5 illustrate two sets of experimental results designed to shed insight on the dynamics that are driving the model. In this reduced form model, there is a total of 30,000 potential Green consumers in the system being supplied by a total of 100 producers.

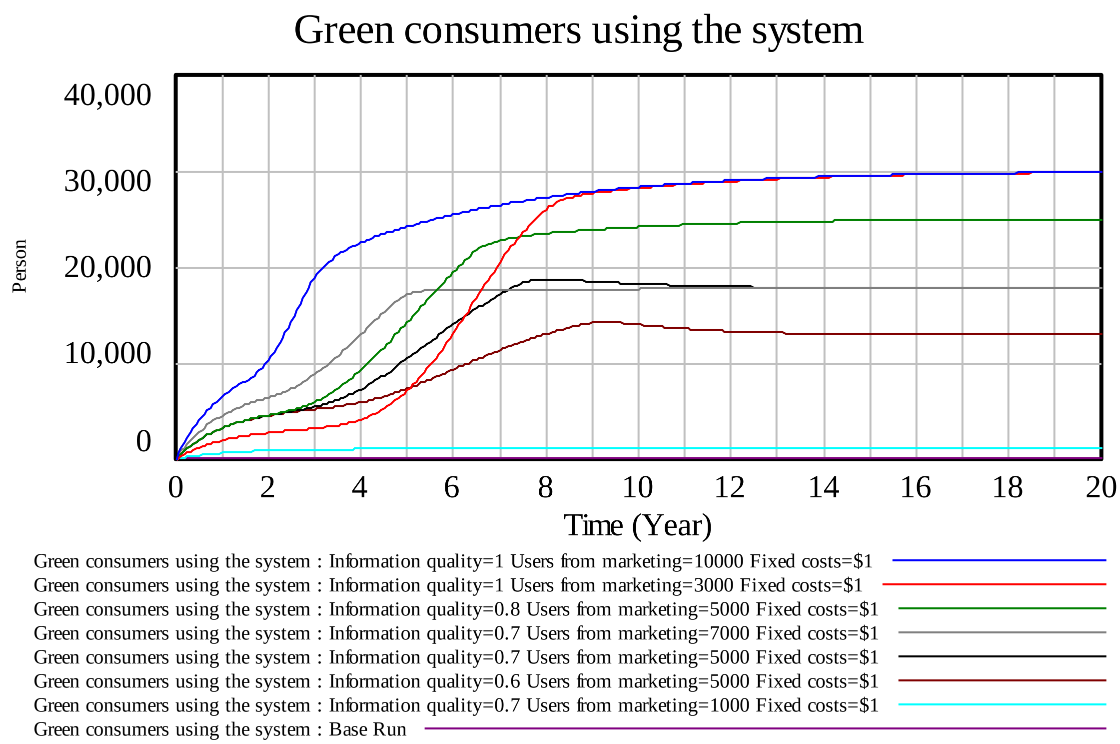

Figure 4 Information Quality Drives Final Equilibrium (Market Share)

In Figure 4, we can see that when system costs are low enough to neglect (one dollar in this set of simulations), the amount of marketing efforts determines how quickly the number of green consumers using the system grows (the system starts to take off), but the final system equilibrium, the market share of the I-Choose system, is determined by the level of quality of information provided by the system. In all of these runs, the operational costs of operating the system is low enough so that producers will ultimately opt into the system if and when the customer base grows. Initial growth is promoted by the marketing budget and support by a word-of-mouth campaign explaining why in these runs the market takes off. However, long term equilibrium is determined not by consumers' initial decision to try out the I-Choose system, rather by their longer term decision to stay with the system (to not quit using the system). For this set of decisions, the model assumes that long term information quality is the dominant factor. The model further assumes that governance variables drive information quality.

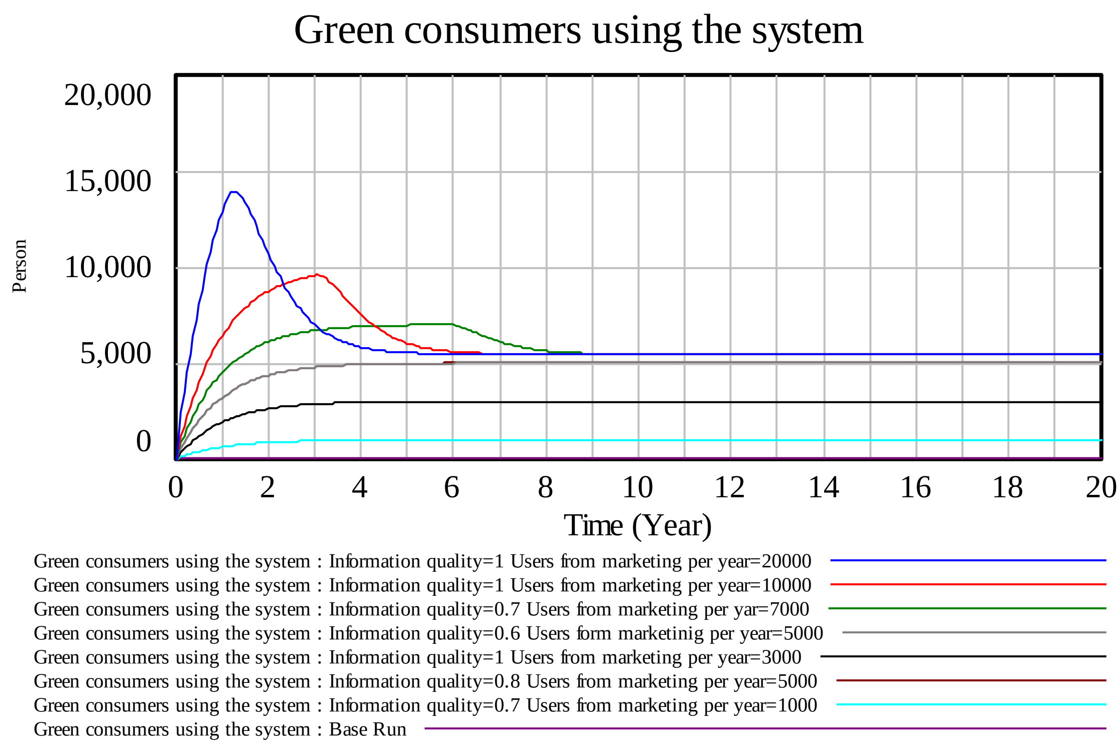

Figure 5 Final Market Share Collapses without External Subsidy of System Costs

Figure 5 illustrates the combined effect of factors in all three dimensions. The effects of information-quality and marketing factors remain the same, but with regular system costs (one million dollars in this set of simulations) and without external subsidy of the costs, final market share collapses eventually. In Figure 4 final the final equilibrium level for Green consumers was dominated by consumer decisions to stay in the system. The highest possible information quality (Information Quality = 1) yielded the largest retention of users and hence in equilibrium all of the 30,000 eligible Green consumers eventually became system users. In Figure 5, even with the highest possible quality of information, the final equilibrium is much lower, not because of information quality, but rather because participation by producers is lower. Producer participation is lower because the benefit-cost calculation that drives consumer signing up is lower and prevents all producers from joining the system. The initial push from marketing coupled with word-of-mouth effect is sufficient to support a transient growth in the customer base, but when enough producers fail to come on line the overall system overshoots and eventually falls back to an equilibrium that is jointly determined by the quality of the system as perceived by consumers and the benefit-cost ratio of the system as perceived by the producers.

6. Discussion of Overall Dynamics in the Model

Our simulation experiments show that take-off dynamics of the I-Choose system are dominated by marketing budgets and investment support for system costs. The number of green consumers using the system resists growing unless external financial support can be found to pay for marketing and to cover system costs. On the other hand, the quality of governance and the resultant trust worthiness of information drives final sustainable market share. So we come to the conclusion that there appears to be a mutual dependence between private support for market development and the openness of governance structures regulating Green product information systems such as I-Choose. Ultimately, the economic success of I-Choose-like systems is determined both by the dynamics of take-off (dominated by private investment and marketing) and the final market share of the system (related to long term information quality assumed in our model to be an indicator of governance structures). Direct private investment in infrastructure and in marketing is critical to market take-off, and an open governance structure is a key determinant of final market share of the information commons.

Key structural assumptions driving system dynamics (future research)

The reduced form model described and analyzed above depends critically on a number of structural assumptions that need to be the subject of future research. Several of these key structural assumptions are briefly discussed below:

Business model assumes that producers pay all system costs. Our simulations assume that both the marketing costs and the infrastructure development costs of an I-Choose-like system are to be born by producers. When total benefits fall short of total costs, producers will not join the system. In another business model, system costs or some share of marketing costs could be somehow shared in a broader commons supported by the government or a broader alliance of Green producers.

Rest of the supply chain is missing. Our model ignores many complications that need to be considered because stakeholder other than just producers need to voluntarily supply information to a Green product information system such as I-Choose.

Different dynamics for short term versus long term system adoption. A key assumption of our model is that word-of-mouth and marketing first draw consumers into using the I-Choose system but that other longer-term factors associated with quality and trust-worthiness of the information retain customer loyalty. These assumptions explain much of the differences between transient take-off and long term equilibrium dynamics.

Scaling effects on fully investigates. Our model assumes a specific hypothetical scale—100,000 consumers in total, 30,000 potential Green consumers, only 100 producers, specific benefit and cost figures, and so on. Varying these specific parametric values will deflect typical dynamics in a base run and in policy runs.

Governance is identical to (highly related to?) Quality of Information. This overall research effort began with an effort to investigate the impact of various governance regimes on overall market growth. As we moved toward the reduced form model, many of the original co-flows and possible dynamics associated with governance were made more and more simple. The core remaining linkage between a complex discussion of governance motivating this work and the formal simulation runs in the reduced form is the (quite plausible) set of assumptions that (a) consumers decisions to remain in the system are dominated by overall trust-worthiness of information in the system, and (b) governance issues will be important determinates of trustworthiness by consumers. While these assumptions are certainly plausible, they have not been empirically proven and tested.

Implications of Simulation Results for Governance of Green Product Information Systems

The larger I-Choose project within which this pilot simulation study is nested is an exploration of how a particular type of web-based technology (semantic web technologies based on OWL ontologies) can create an information system to produce a kind of open source product information about non-observable product traits to a wide range of consumers. We are seeking to create a pilot FIPP system. If we assume that a FIPP system such as I-Choose is totally feasible from a technical point of view, this study explores what other conditions must exist in markets and in governance systems for such a system to achieve market share and become a commercial success.

We have found that a deep partnership between commercial producers and suppliers in the supply chain and others involved in the governance of such a system will be critical to commercial viability. In our simulator, producers and suppliers are necessary to provide marketing push and to support the development of system infrastructure. Third party certifiers, consumer advocates, and government regulators are the stakeholders who must design and insure a trusted governance structure—who must craft and monitor the "rules of the road", who must stay on top of how these systems are being governed. Without trust arising from governance coupled with market share driven by private investment FIPP product information systems such as the I-Choose system will not become a commercial reality (even if they are technically feasible).

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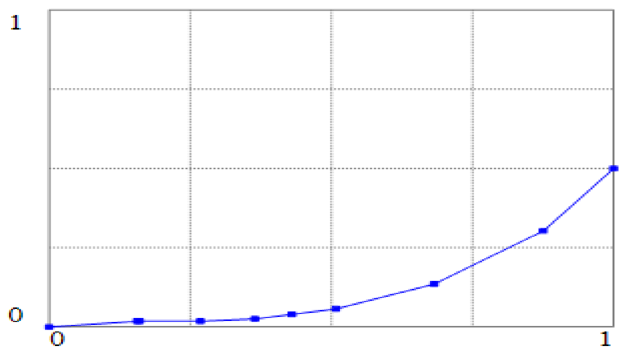
Appendix: Model Equations

Sector I – Growth of Green Market

Average green contacts per person per year = 365   Units: Person/Person/Year

Chance of recommending = 2/365   Units: Dmnl

Chance of successfully recommending upon recommending: Graph Lookup

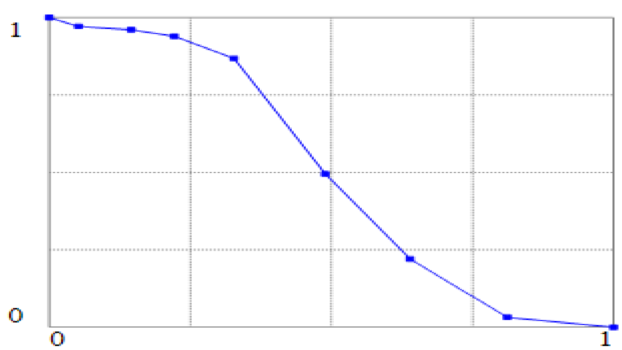


Effective system attractiveness = System attractiveness * System attractiveness enabler + System attractiveness CONSTANT * (1-System attractiveness enabler)   Units: Dmnl

Former Users of System = INTEG (System users leaving per year-System users reconsider using the system, 0)   Units: Person

Fraction of LOHAS = 0.3   Units: Dmnl

Fraction of system users leaving: Graph Lookup



Fraction of system users leaving per year = Fraction of system users leaving/Time to leave Units: 1/Year

Green consumers can be reached by the marketing effort each year = Green consumers not using the system/Minimum time to reach a consumer not using the system
Units: Person/Year

Green consumers not using the system = INTEG (System users reconsider using the system-New system users per year, Total green consumers)   Units: Person

Green consumers using the system = INTEG (New system users per year-System users leaving per year, 0)   Units: Person

Max possible marketing number per year CONSTANT = 100   Units: Person/Year

Minimum time to reach a consumer not using the system = 0.5   Units: Year

New system users from marketing per year = MIN (Green consumers can be reached by the marketing effort each year, Max possible marketing number per year CONSTANT)
Units: Person/Year

New system users from word of mouth per year = "Non system-users' green contacts per year" * Probability of successfully recommending the system * Probability that a contact is using the system   Units: Person/Year

New system users per year = New system users from word of mouth per year + New system users from marketing per year   Units: Person/Year

"Non system-users' green contacts per year" = Average green contacts per person per year * Green consumers not using the system   Units: Person/Year

Probability of successfully recommending the system = Chance of successfully recommending upon recommending * Chance of recommending   Units: Dmnl

Probability that a contact is using the system = Green consumers using the system/Total green consumers   Units: Dmnl

System attractiveness = System utility   Units: Dmnl

System attractiveness CONSTANT = 1   Units: Dmnl

System attractiveness enabler = 1   Units: Dmnl

System users leaving per year = Green consumers using the system * Fraction of system users leaving per year   Units: Person/Year

System users reconsider using the system = Former Users of System/Time to change mind
Units: Person/Year

Time for registration = 1   Units: Year

Time to change mind = 4   Units: Year

Time to leave = 1   Units: Year

Total consumers = 100000   Units: Person

Total green consumers = Total consumers*Fraction of LOHAS   Units: Person

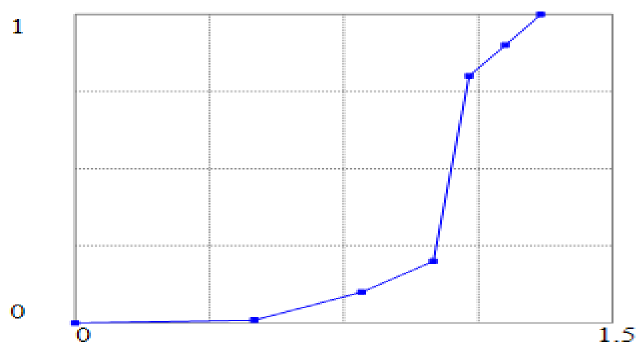
Sector II – Cost-Benefit Evaluation

Benefit per system user per year = 16 * 2   Units: Dollar/Person/Year

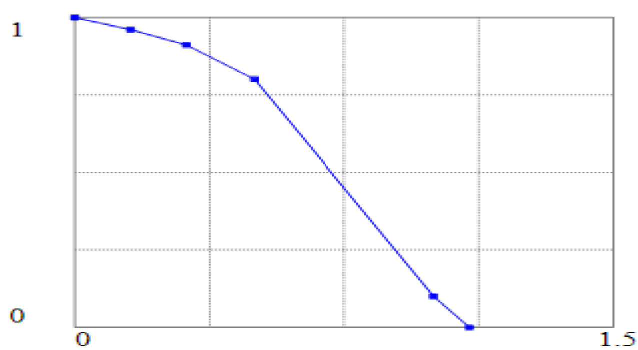
"Benefit-cost ratio" = Total system benefit per year/Total system cost per year
Units: Dmnl

Fixed cost per year CONSTANT = 1   Units: Dollar/Year

Fraction of producers to be registered: Graph Lookup



Fraction of producers to be unregistered: Graph Lookup



Governance completeness relevance reliability = 0.2   Units: Dmnl

"Governance openness & transparency" = 0.2   Units: Dmnl

Green consumers using the system = INTEG (New system users per year-System users leaving per year, 0)   Units: Person

Marginal cost per producer per year = 1000+200   Units: Dollar/Producer/Year

"Market share of the system - scale" = Producers registered in the system/Total producers
Units: Dmnl

Marketing cost per person = 20   Units: Dollar/Person

Marketing cost per year = Marketing cost per person * New system users from marketing per year   Units: Dollar/Year

<u>New system users from marketing per year</u> = MIN (Green consumers can be reached by the marketing effort each year, Max possible marketing number per year CONSTANT)
Units: Person/Year

<u>Producers registered in the system</u> = INTEG (Producers registration per year-Producers unregistered per year, 0) Units: Producer

<u>Producers registration per year</u> = Unregistered producers * Fraction of producers to be registered/Time for registration Units: Producer/Year

<u>Producers unregistered per year</u> = Producers registered in the system * Fraction of producers to be unregistered / Time for unregistration Units: Producer/Year

<u>Products initially registered</u> = Initiators * Products per producer Units: Product

<u>"Quality of information in the system - scale - CONSTANT"</u> = 0.04 Units: Dmnl

<u>"Quality of information in the system - scale"</u> = System capacity CONSTANT * Governance completeness relevance reliability * "Governance openness & transparency"/100 Units: Dmnl

<u>System attractiveness</u> = System utility Units: Dmnl

<u>System capacity CONSTANT</u> = 100 Units: CapacityProcess

<u>System utility</u> = "Market share of the system - scale"*"Quality of information in the system - scale - CONSTANT" Units: Dmnl

<u>Time for registration</u> = 1 Units: Year

<u>Time for unregistration</u> = 2 Units: Year

<u>Total producers</u> = 100 Units: Producer

<u>Total system benefit per year</u> = Benefit per system user per year * Green consumers using the system Units: Dollar

<u>Total system cost per year</u> = Fixed cost per year CONSTANT + Marginal cost per producer per year*Producers registered in the system + Marketing cost per year Units: Dollar/Year

<u>Unregistered producers</u> = INTEG (Producers unregistered per year-Producers registration per year, Total producers) Units: Producer