

The Interaction of Signals: A Fuzzy set Analysis of the Video Game Industry

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Abstract Customers continuously evaluate the credibility and reliability of a range of signals both separately and jointly. However, existing econometric studies pay insufficient attention to the interactions and complex combinations of these signals, and are typically limited as a result of difficulties controlling for multicollinearity and endogeneity in their data. We develop a novel theoretical approach to address these issues and study different signaling effects (i.e., word-of-mouth, brand reputation, and distribution strategy) on customer perceptions. Using data on the US video games market, we apply a fuzzy set qualitative comparative analysis (fsQCA) to account for cause-effect relationships. The results of our study address a number of key issues in the economics and management literature. First, our results support the contention that reviews from professional critics act as a signal of product quality and therefore positively influence unit sales, as do the discriminatory effects of prices and restricted age ratings. Second, we find evidence to support the use of brand extension strategies as marketing tools that create spillover effects and support the launch of new products.

Key words Signaling Theory, Information Asymmetry, Interactions, Fuzzy sets, Qualitative Comparative Analysis, Video Game Industry

JEL classification C18 · D82 · L10 · L82

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Introduction

A significant number of prior studies have analyzed the influence of signals in the presence of information asymmetry (Spence 1973, Banerjee 1992, Stiglitz 2002, Gao *et al.* 2008, Kirmani and Rao 2000, Hochwater *et al.* 2007, Kang 2008, Ndofor and Levitas 2004, Rao *et al.* 1999). In the specific context of entertainment markets, many other studies have explored the relationship between sales performance and a range of individual and separate signals such as reviews from professional critics, awards and marketing expenditures (Eliashberg and Shugan 1997, Nelson *et al.* 2001, Nelson and Glotfelty 2012). However, in reality, individual signals are unlikely to appear or to be interpreted independently. Consumers continuously evaluate the credibility and reliability of a range of signals both separately and jointly, although existing econometric studies pay insufficient attention to the interactions and complex combinations of these signals and their effect upon sales performance.

This paper aims to analyze the interactions of signals in the presence of information asymmetry by addressing three key research questions. (i) Which specific, observable signals of product quality affect sales? (ii) To what extent is the interaction between observable signals an important determinant of sales? (iii) Which individual signals or interactions have the greatest influence on market sales? We address these research questions through undertaking an empirical analysis of a market for video games software. Products in this market closely adhere to the classic definition of experience goods, where theory suggests that consumers will have the greatest need for reliable

signals of product quality due to *ex ante* uncertainty over consumption utility.

The aforementioned collection of studies that have also used data from entertainment markets (e.g. movies, theaters, music or books) to analyze the effects of product quality signals upon sales performance have typically encountered significant problems of multicollinearity and endogeneity in their data, which may lead to inconsistent estimators. Only a very select number of studies use alternative techniques to account for these issues, such as the neural networks approach used by Marcoux and Selouani (2009) which allows for the interactions of product characteristics and signals of quality for the purposes of forecasting the sales of video games.

The unique contribution of this study to this body of literature is the use of a technique known as qualitative comparative analysis (QCA) to specifically counter the issues of multicollinearity and endogeneity in our data. QCA is based on the assumption that cause-effect relationships are based on a set-subset relationship instead of a correlation relationship. Using logical reduction algorithms, QCA analysis minimizes the set of combinations of cases into a reduced subset of configurations that lead to an outcome of interest (Fiss 2007, Ragin 2008, Ragin and Fiss 2008). The technique is appropriate to analyze complex cause-effect relationships and multiple interactions, helping us to directly formulate theoretical relationships and analyze models based on theoretical considerations.

Cause-effect relationships can also be difficult to interpret in variable-orientated research, as the number of interaction terms have the potential to increase exponentially. QCA has the advantage of being able to consider complex causality and assumes equifinality; the idea that a system can reach the same outcome from distinct paths and different combinations of initial conditions (Katz and Kahn 1978). Consequently, QCA allows us to interpret the logical interconnection of all possible configurations of

distinct conditions.

We base our research on current studies of signaling effects and provide a number of key insights and contributions relating to the market for entertainment goods. We examine the interaction between multiple signals of product quality upon sales performance, as well as a number of interaction terms. We consider the signaling effects of word-of-mouth, professional critics and sequels, but also extend beyond this to test for interactions between a range of other signals including price, product ratings and the market share of publishers. Consequently, we not only study two or three-dimensional interactions but also multiple and complex combinations of different signaling effects.

Literature Review

There is an extensive literature which attempts to model the causal effect of quality signals upon sales performance and revenues, as well as upon the intermediate stages of brand perception and purchase intention. We summarize a considerable number of these studies, as well as the principal signals analyzed in each, in Table 1.

[Table 1 about here]

Typically, these studies focus on hedonic consumption of cultural goods such as movies and books and introduce separate controls for the influence of a variety of signals, typically as independent variables in regression models (e.g., Prag and Casavant 1994, Terry *et al.* 2011). Often, a small number of these signals represent the primary focus of the study, with others included simply to control for other potential sources of heterogeneity. Some of the observable signals of product quality that are most frequently explored are the opinions and experiences of others, be they professional

critics (Basuroy *et al.* 2003, Boatwright *et al.* 2007, Eliashberg and Shugan 1997, Hennig-Thurau *et al.* 2012, Holbrook and Addis 2007, Gemser *et al.* 2006) or consumer word-of-mouth (Archak *et al.* 2011, Chen and Xie 2008, Chevalier and Mayzlin 2006, Chintagunta *et al.* 2010, Decker and Trusov 2010, Dellarocas 2003, Dellarocas *et al.* 2007, Duan *et al.* 2008, Godes and Mayzlin 2004, Hu *et al.* 2008, Liu 2006, Moldovan *et al.* 2011, Shao 2012, Sun 2012). Although these studies typically show that product reviews correlate significantly and positively with sales performance, the extent to which the relationship is causal is open to debate. A significant proportion of these studies have argued that reviews of professional critics may not influence consumer perception *per se* but instead predict sales performance as a result of simply reflecting popular opinion. Without properly accounting and controlling for endogeneity, it is extremely challenging to address this issue directly.

Other signals explicitly investigated include the market share of producers and distributors (Alden *et al.* 2006, Pham *et al.* 2013, Rao *et al.* 2013, Van Horen and Pieters 2012), price (Park *et al.* 2011, Schlereth and Skiera 2012), product (age) ratings (De Vany and Walls 1999, Leenders and Eliashberg 2011, Moon 2010, Ravid 1999) and sequels (Basuroy and Chatterjee 2008, Gierl and Huettl 2011, Sattler *et al.* 2010). Although a majority of these studies focus on a single domestic market (usually the US), Clement *et al.* (2013) compare the effect of a range of such signals on demand for movies across both the US and Germany, finding evidence of reasonably high consistency among the importance of quality signals upon weekly movie revenues in the two territories.

Of those authors who account for interaction terms, Basuroy *et al.* (2006), Basuroy and Chatterjee (2008), and Basuroy and Ravid (2013) explore various combinations of interaction between product reviews, advertising expenditure, sequels and distribution

strategies, while Moon *et al.* (2010) and Hennig-Thurau *et al.* (2012) model interactions between critic and user reviews and other explanatory characteristics, including advertising expenditure. Dhar *et al.* (2012) model interactions between movie sequels and time of release and the resultant impact upon sales performance, while Chandrasekaran *et al.* (2013) investigate the interaction between price and a range of other control variables in determining the factors affecting ‘take-off’ of consumer electronic products.

When exploring the price premium applicable to brand extension products, Sattler *et al.* (2010) explore interactions between the fit of the brand extension to the parent and the quality of the parent brand, while Gierl and Huettl (2010) explore the interaction between different categories of products and product scarcity. In one of the very limited number of studies looking at sales determinants of video game software, Zhu and Zhang (2010) model interactions between review score, popularity and online features. A major limitation of these studies that make use of interaction terms is that they typically limit the interactions under analysis to a discrete subset of independent variables. Additionally, relatively few studies employ formal measures to account for both endogeneity and the interaction effect of signals upon sales. Our study therefore makes a unique contribution to the literature through the use of QCA to simultaneously address both of these issues in a specific market context for entertainment goods where relatively little empirical evidence of this kind exists.

Conceptual Framework

Our theoretical framework assumes a chain of causality between three key stages in the consumer decision-making process. We assume that the consumer actively seeks or is otherwise exposed to one or more *credible signals of quality*, which affects *consumer*

perception towards the product and thereby shapes purchasing intent. Where these signals are interpreted as being positive in nature, this enhances perception of the product and increases the likelihood of a consumer making a purchase. We therefore predict that a significant proportion of variation in *sales performance* can be explained through variations in consumer perception, which in turn are affected by the presence of visible and credible signals of product quality. Figure 1 outlines the key interactions that we propose underpin these relationships.

[Figure 1 about here]

As with most entertainment products, video games are experience goods and thus signals of quality are likely to be important due to the limited information possessed by the consumer *ex ante* of the purchase decision. We argue that the signals of quality that have the greatest potential to shape consumer perceptions are *product reviews* and *brand reputation*. In this specific market context, we argue that reviews from professional critics are particularly likely to influence consumer perception due to the higher effective cost of consumption compared with other forms of entertainment, arising from relatively high unit prices and the significant time investment required. This may lead to the adoption of more risk-averse patterns of consumption for video games compared with other entertainment goods such as movies. We further argue that while reviews from other users may serve as a signal of quality to some extent, these will be less influential in affecting the intention to purchase due to a relative lack of credibility compared with professional critics. This may arise due to self-selection bias among users who post online reviews, where significant heterogeneity has been observed between the views of gaming aficionados/early adopters and those of other

consumer groups (Li and Hitt 2008).

Pre-existing brand reputation is also likely to act as a signal of quality, with franchised games helping to establish consumer loyalty (Wesley and Barcza 2010). Our model predicts that consumers who either have positive personal experiences of previous titles in a franchise or who are otherwise aware of prior sales success are more likely to regard subsequent titles in the same series as possessing a high level of quality. This is a similar form of behavior as seen in the movie industry, where sequels to popular film franchises are typically found to attract audiences based on positive associations with earlier consumption experiences. We therefore suggest that consumer perception will be positively influenced if a given title is a *sequel* to a successful 'parent' title, which will resultantly translate into higher sales performance. We further suggest that *price* is likely to affect sales performance both in the traditional economic sense (i.e. a negative association *ceteris paribus* due to a combination of income and substitution effects) but will also in itself serve as a credible signal of quality. Our conceptual framework predicts that consumers are likely to associate a higher price with a high quality experience and adjust perceptions and purchasing intentions accordingly.

Once credible signals of product quality are collected and assessed, consumer perceptions relating to the likely quality of the product are formed. Consumer perceptions are also likely to be directly influenced by a set of innate and observable *product characteristics*. In this instance, we assume that consumers form perceptions based on particular gaming *genres* and are at least somewhat predisposed towards the consumption of certain types of game, e.g. sports or action titles. The age or *product rating* attached to the game is also indicative of content, e.g., mature games are likely to have a violent or adult theme, whereas games rated as suitable for everyone are likely to be more family-friendly or oriented towards children. These innate product

characteristics combine with the assessment of credible signals of quality to form consumer perceptions which resultantly influence the purchase decision.

One further significant influence upon sales performance is likely to arise directly as a result of the *publisher or distributor effect*. This may either directly affect unit sales due to the *platform popularity* of the hardware model(s) for which the title is released and/or as a consequence of the *distribution strategy* adopted, i.e., whether to release the title exclusively for a single device or across multiple hardware platforms simultaneously. Another important means by which the influence of publishers or distributors may ultimately affect unit sales is through *publisher reputation*, which feeds back directly into brand reputation and further serves as a credible signal of product quality. This feedback loop occurs because consumers are likely to be at least somewhat predisposed towards the games of a particular publisher and/or associated development team(s), such as Nintendo or Rockstar, creating the potential for a positive branding effect even for the first title in a new franchise.

Data and Methodology

Method of Analysis

The identification of causal conditions that are necessary for the occurrence of an outcome of interest is central to the study of social and economic phenomena. Normally and in contrast to variable-oriented analysis, the outcome in question does not follow from individual necessary causal conditions but from several different combinations, also known as the analysis of causal complexity (Ragin 2000). In variable-oriented analysis, causal complexity is analyzed with linear, additive models that estimate complex interaction effects. However, complex interaction models typically suffer from a number of estimation issues. First, interaction models are most effective when the

number of cases is large, the number of independent variables is small, and the cases are fully diverse (Ragin 2000). If this configuration is not observed, interactions terms tend to show a high level of multicollinearity. Second, a number of different interaction models may fit a dataset equally well. Finally, complex interaction models tend to be difficult to interpret. Where the analysis of two-way interaction terms are applicable, the examination of three-way or even four-way interactions assume well-formulated hypotheses and a profound knowledge and support from both theory and empirical evidence.

In contrast to variable-oriented research and its estimation of linear, additive models, the qualitative comparative analysis (QCA) technique simultaneously estimates several different combinations of causal conditions on an outcome of interest. Additionally, while variable-oriented analysis estimates the net effects of a selection of causal variables upon an outcome of interest on the basis of correlations, the QCA approach to causation is based on set-theoretic relationships.

In this study, we use fuzzy sets to model the degree of set-theoretic memberships of causal conditions. Whereas interval-scale variables are categorized according to sample means and standard deviations, fuzzy sets are classified according to theoretical and substantive knowledge. Unlike conventional interval-scale variables, fuzzy sets of cases can vary according to a specific research question and represent continuous membership scores in the value interval between 0 and 1. Consequently, fuzzy sets simultaneously represent qualitative and quantitative data characteristics.

The two qualitative thresholds 1 and 0 indicate a full membership and full non-membership in the fuzzy set. We calibrate all fuzzy sets according to three qualitative thresholds: the threshold for full membership (corresponds to a fuzzy set of 0.95), the threshold for full non-membership (equal to a fuzzy set of 0.05), and the crossover point

(equivalent to a fuzzy set of 0.5). After we set the three membership thresholds, we transform our interval-scale variables into fuzzy set scores according to the log odds of full membership. Finally, we receive a fine-grained calibration of our fuzzy set conditions, with membership scores ranging from 0 to 1.

Source of Data

We used data on a sample of 1,208 video game titles for console and handheld devices including Nintendo DS, Nintendo Wii, Sony PlayStation 3, Sony PSP and Xbox 360. All game titles have been released in the US between 2006 and 2010. The data were collected in 2013 and 2014 using the video game sales tracking website VGChartz, the video game catalog website MobyGames and the selling price tracking website CamelCamelCamel. Word-of-mouth data and video game reviews were obtained from the scoring website Metacritic, which reviews music, movies, TV shows, DVDs and video games according to an aggregated weighted numerical score that is based on the importance and coverage of professional and user's critics.

This data is especially useful for our analysis purposes for several reasons. First, the data contain a rich set of signaling measures such as word-of-mouth, reviews from professional critics, sales prices, genre and age-classification ratings, consequently allowing us to analyze the effectiveness of variant configurations of signaling conditions. Second, the data are restricted to console video games, assuring comparability according to technology requirements, game characteristics and industrial and market structure. Although, the data are uniquely appropriate for the study of markets for experience goods, they are also subject to some limitations. On the one hand, as the data are restricted to console game titles, we do not consider sales of PC games as part of this analysis. On the other hand, although the data consider console games, they include titles from several gaming platforms and diverse gaming genres,

thus offering a certain range of variation in uncertainty and competitive environments. In summary, these points suggest that the data demonstrate sample representativeness and are suitable to analyze the interactions of signals in the market of experience goods.

Outcome Measures

The primary outcome of interest for the empirical analysis is commercial success, measured as lifetime US unit sales of individual video game software titles. QCA requires the transformation of variables into dichotomous sets with continuous values between 0 and 1. Each set must be calibrated according to substantively meaningful thresholds. We choose a three-value fuzzy set classification for the outcome performance measure consisting of full membership, full non-membership and the intermediate membership of the set. The intermediate membership is the point of maximum ambiguity (i.e., fuzziness) in the assessment, indicating whether the variable is neither fully in nor fully out of the set (Ragin 2008). Following Fiss (2011), we calculate the three-value fuzzy set membership for two business performance measures: *high commercial success* and *very high commercial success*.

High commercial success firms are coded 1 (full-inclusion) if unit sales fall within the 90th percentile or higher. In contrast, a firm is coded 0 (full-exclusion) if the title demonstrates low commercial success of average or below-average unit sales (unit sales \leq 50th percentile). Unit sales of the 75th percentile mark the intermediate membership of 0.5. In addition to the analysis of high commercial success titles, we also study the membership in the set of *very high commercial success*. In this set, a title is coded 1 if unit sales fall within the 99th percentile or higher, with a crossover point of 0.5 at the 90th percentile. The 75th percentile represents the threshold for average or below-average commercial success, while unit sales at the 75th percentile or below are coded as 0. Consequently, the very high commercial success set is more restrictive than the high

commercial success set. For robustness reasons, we additionally include two sets that measure *low commercial success* firms and *very low commercial success* firms. Both sets are coded as the negation of the two sets *high commercial success* firms and *very high commercial success* firms.

Independent Measures

As mentioned above, all variables need to be transformed into fuzzy sets with the specification of full membership, full non-membership and the crossover point of maximum membership ambiguity. Our first measure, *product reviews*, assesses the signal effects of professional critics and word-of-mouth on consumer perception. We use the metascores from Metacritic to evaluate the influence of product reviews on customers' buying decisions. A metascore is a weighted average scale that assigns more importance to critics with a stronger reputations and impact factors. Scores range from 0 to 100, with higher metascores indicating better assessments of game titles. A measure of membership in the two sets is created based on the extent to which reviews from professional critics and consumers are positive, following the classification bandings used by Metacritic. We calibrate full membership to reviews that demonstrate 'universal acclaim' (score ≥ 90), full non-membership with mixed or average reviews (score ≤ 74), and the crossover point with generally favorable reviews (i.e., a score of 75-89).

The second signal, *brand reputation*, is based on the hypothesis that the success of previous titles in a particular franchise positively affects the sales performance of sequels, thus accounting for the occurrence of a spillover effect. We measure brand reputation on the basis of the unit sales achieved by the previous title appearing in the same series. Using this measure, we code precursor titles with unit sales above the 90th percentile as being fully included in the set of high spillover effects, while titles beneath the 50th percentile are considered to be fully excluded. The 75th percentile marks the

crossover point.

The third signal represents *product characteristics*, measured by the ESRB age ratings¹ and the genre classification. Following movie studies from De Vany and Walls (2002) and Ravid (1999), we classify the age rating characteristic of video games in two categories based on whether or not an individual title received the ESRB rating ‘M’ (Mature). M-rated titles are assigned full membership of the fuzzy set measure of ESRB age-ratings, while non M-rated titles are fully excluded. Given the absence of a crossover point, ESRB age ratings are therefore measured as a crisp set. Compared with fuzzy sets, crisp sets consist of only two degrees of set membership: full inclusion and full exclusion from the set. The introduction of a crisp set measure does not represent a significant problem, as both crisp and fuzzy sets are based on the same assumption of Boolean algebra and its set-subset-relationship. The second product characteristic is a game’s genre classification(s). Video game titles are classified as belonging to one or more game genres, such as action, adventure, or racing. We proceed on the assumption that game titles with multiple genre classifications appeal to a wider set of consumers and are therefore more likely to generate high commercial success. For the fuzzy set of video games with a high number of genre classifications, game titles with ≥ 4 genre affiliations were fully included in the set, while game titles with ≤ 1 genre affiliation were fully excluded. As a crossover point, we choose game titles with 2 genre classifications.

The fourth measure, *publisher and distributor effects*, is the product of the publisher’s or distributor’s reputation measured as market share, distribution strategy,

¹ The Entertainment Software Rating Board (ESRB) assigns the age and content ratings for video games and mobile apps. ESRB rating categories mainly consist of the three categories Everyone (E), Teen (T), and Mature (M). E titles include content that is generally suitable for all ages. T represents content that is generally suitable for ages 13 and up and M reflects video games that are generally suitable for ages 17 and up. Thus, M-rated video games may contain intense violence, blood and gore, sexual content and/or strong language.

and platform popularity. *Market share* accounts for the size of a publisher in relation to its market and its competitors. Following the age rating condition, market share identifies large publishers² according to a crisp set measure. Consequently, we code game publishers that belong to the group of publishers with a high market share as being fully included in the set and any other publishers as being fully excluded. *Distribution strategy* represents a publisher's product release strategy, measured as a summed scale of a title's aggregated platform releases. Following the genre classification condition, we create a measure of membership in the set of game titles with a wide distribution strategy, coding full membership for games that have been released on ≥ 4 gaming platforms and full non-membership for titles that have been released on ≤ 1 gaming platform. The crossover point is set at a 2 platform release strategy. *Platform popularity* represents the last condition in the measure of publisher and distributor effects and captures the size of the installed user base, as well as network externalities of the respective gaming platform. Thus, platform popularity contains the market share of each console in terms of cumulative unit sales up to and including the year the game was released. A cumulative platform market share of the 90th percentile or more is classified as full membership, a cumulative platform market share of the 50th percentile or less is classified as full non-membership, and a cumulative market share of the 75th percentile is set as the crossover point.

The final measure, *price*, follows the assumptions of a Marshallian demand function, indicating a weakening demand for video games while market prices for game titles rise. Due to high levels of homogeneity among original sales prices for titles on a particular hardware platform, we collect the original market prices of all game titles in

² The group of big publishers consist of the following companies: Activision Blizzard, Capcom, Electronic Arts, Konami, Microsoft, Namco Bandai, Nintendo, Sony, Square Enix, THQ, Take-Two, Ubisoft, Warner Bros., and Zynga.

our dataset and reclassify the price thresholds based on the deviation of individual game prices from the average platform price. Specifically, game titles with price ratios above the 90th percentile are coded as fully in the set of high unit sales prices whereas game titles with price ratios beneath the 50th percentile are coded as fully out of the set. The midpoint is set at the 75th percentile.

The Truth Table Algorithm

Following the calibration of the degree of fuzzy set memberships of causal conditions and outcomes of interest, QCA identifies minimal configurations of these conditions. The minimization process is structured on a hierarchical composition and applies a logical reduction algorithm that reduces the number of causal conditions into a minimized subset of configurations leading to the outcome of interest.

Truth tables constitute the first step in the minimization process. A truth table is a data matrix that consists of 2^n rows of all n causal conditions. Each row r_i represents a specific combination of different conditions. Consequently, the final truth table shows all logical combinations of causal conditions in one matrix. Additionally, each row r_i is associated with corresponding empirical cases, with some rows containing several cases, some rows containing few cases and even some rows containing no cases if there is no empirical evidence for the specific combination.

After the construction of a truth table, the total number of rows r is minimized according to the minimum frequency number and consistency level required for a solution. The minimum frequency number refers to the most number of cases that must be considered for a solution. The minimum consistency level refers to the percentage of cases that are correctly described by the solution, i.e., consistency tells us *how well we explain the phenomenon*. The consistency is described as the proportion of cases N that reflect all causal conditions X and the outcome Y in relation to cases N that reflect all

causal conditions X but do not reflect the outcome Y . Accordingly, for any outcome Y and N number of cases, the consistency of a causal condition or a combination of conditions X is defined as

$$Consistency = \frac{\sum_{i=1}^N \min(X_i, Y_i)}{\sum_{i=1}^N X_i} \quad (1)$$

While the appropriate consistency threshold is research-specific and of no general fit, Ragin (2008) recommends a consistency level of no lower than 0.75.

Finally, a logical minimization algorithm, known as the truth table algorithm, reduces remaining information contained in the truth table. Primarily, the truth table algorithm compares pairs of configurations that do not differ significantly in their conditions but match in their outcome. Subsequently, the algorithm deletes redundant information and proceeds with the minimization process until all remaining logical true combinations of conditions can no longer be reduced. For example, consider the two configuration ABC and ABc (uppercase letters indicate the presence of causal conditions whereas lowercase letters indicate the absence of causal conditions) that lead to the outcome of interest ($ABC \rightarrow Y$ and $ABc \rightarrow Y$). In this example, the condition C can be deleted from both configurations because both its presence and absence does not influence the occurrence of the outcome in question. The result of the minimization process is a simplified combination of conditions AB that lead to the outcome ($AB \rightarrow Y$).

All simplified configurations are summarized in solution formulas. In a solution formula, all minimized sets of causal combinations are supplemented by the three logical Boolean operators OR (equated with a “+”), and AND (identified as “*”), and the negation of causal conditions NOT. These three basic operators express any given relationship between the configurations and the outcome of interest. For instance, given

an outcome set Y and the prime expressions of core causal conditions A , B , and c , then the configuration $A * B + c \rightarrow Y$ indicates that the conditions A and B or the negated condition of C lead to the outcome Y .

In addition to the consistency statistic, the solutions generated by QCA can also be assessed by the coverage measure.³ The coverage represents the ratio of cases that are explained by the solution formula, i.e., coverage tells us *how much of the phenomenon we explain*. The coverage is described as the proportion of cases N that reflect all causal conditions X and the outcome Y in relation to cases N that reflect the outcome Y but do not reflect the causal conditions X . Accordingly, for any outcome Y and N number of cases, the coverage of a causal condition or a combination of conditions X is defined as

$$Coverage = \frac{\sum_{i=1}^N \min(X_i, Y_i)}{\sum_{i=1}^N Y_i} \quad (2)$$

Estimation Results

Descriptive statistics and correlation coefficients for all independent and outcome measures are presented in Table 2. The figures show positive correlations between professional product reviews, brand reputation and high commercial success as well as very high commercial success. The other conditions feature low positive or negative correlations and thus offer minor additional explanatory power.

[Table 2 about here]

Following the notation of solution tables introduced by Ragin and Fiss (2008), we

³ Measures of consistency and coverage can be thought of as being similar to the significance level and R^2 in a variable-oriented analysis. However, a direct conceptual comparison should be avoided (Schneider and Grofmann 2006).

use different types of circles to indicate the occurrence of causal conditions. In the solutions formulas, black circles (●) indicate the presence of a condition and white circles (○) indicate the absence of a condition. Conditions without a circle indicate that the condition could be either absent or present and hence does not influence the occurrence of the outcome in question. Consequently, final configurations are categorized by their affirmed and negated core conditions. Additionally, the solution tables only show configurations of conditions that pass the required frequency and consistency threshold and thus consistently lead to the outcome of interest.

Causal Configurations for Achieving High Commercial Success

Table 3 presents the results of the fuzzy set qualitative comparative analysis (fsQCA) of high commercial success. The solution tables show four core configurations that meet the necessary consistency threshold of 0.75. The finding of four distinct solutions emphasize the presence of equifinality, i.e., that different paths and combination of conditions can lead to the outcome of interest. In addition, the minimum acceptable frequency threshold is set at two.

[Table 3 about here]

Solutions 1a and 1b indicate two important paths to high commercial success. Both solutions combine product reviews from professionals and brand reputation effects for sequel game titles as core conditions for achieving high commercial success. Solution 1a suggests that professional reviews and a franchise's brand reputation combining above average selling prices is sufficient for achieving the outcome in question. Whereas solution 1b points out that a multiplatform distribution strategy together with positive reviews from professional critics and the presence of a franchise brand's

spillover effects positively influence unit sales. Both solutions show a relatively high raw coverage score of approximately 0.30 and an average unique consistency rate of 0.76. As either the presence or absence of any remaining conditions is necessary for high commercial success, these can consequently be ignored.

Solutions 2a and 2b emphasize the importance of the simultaneous occurrence of product reviews from both professional critics and word-of-mouth for the achievement of high commercial success. However, both solutions indicate the presence of professional critics and the absence of word-of-mouth as prime paths to the outcome of interest. This finding is in conflict with many existing studies into the effect of word-of-mouth on product sales (Chevalier and Mayzlin 2006, Chintagunta *et al.* 2010, Zhu and Zhang 2010). Nevertheless, solutions 2a and 2b differ in their complementary conditions. Specifically, solution 2a indicates that brand reputation combined with the presence of professional critics and the absence of the word-of-mouth condition is a sufficient combination that leads to high commercial success. Solution 2b slightly differs from solution 2a, in that this configuration combines positive critics and negative word-of-mouth with a wide distribution strategy. As before, any remaining conditions can be ignored. The diagnostic measures of both solutions are similar to 1a and 1b, with raw coverage of approximately 0.30. However, solution 2a shows a unique consistency of 0.61 and thus reveal a slight deviation from the recommended consistency threshold of 0.75.

Additionally, Table 3 lists the overall solution consistency and coverage scores, allowing us to evaluate the overall importance of all four causal configurations. The solution paths show an overall coverage of 0.65, indicating that the combined model accounts for 65 per cent of membership for achieving high commercial success. Consequently, the overall solution coverage is affected by considerable levels of

randomness and idiosyncrasy within the causal configurations. Furthermore, the overall solution consistency of results in Table 3 is 0.52 which, although high, is still some way below the recommended consistency threshold.

In summary, Table 3 highlights the simultaneous occurrence of substitutionary and complementary causal conditions. In particular, it should be noted that product reviews from professional critics are present throughout all four solutions. Accordingly, professional reviews not only represent a core causal condition, but also a complementary condition for all solution configurations.

Causal Configurations for Achieving Very High Commercial Success

Table 4 presents the results of the fuzzy set analysis of very high commercial success. The results show the existence of one distinct path to the outcome in question. Regarding core conditions, solution 1 indicates that generated spillover effects for sequel games, combined with restrictive age classifications and high sales price is sufficient for achieving very high commercial success. Thus, the analysis of very high commercial success confirms the sufficiency of professional critic reviews as a necessary core condition. However, it should be noted that the consistency threshold is set at 0.60, since no sufficient configurations met the recommended threshold of 0.75. In combination with the unique consistency of 0.53, the solution should be assessed with some degree of caution. Nevertheless, solution 1 still has a raw coverage of 15 per cent, indicating that the paths present a substantive degree of causal importance. Although there is only one sufficient configuration, the analysis suggests that there may be other configurations that lead to the outcome in question and that will pass the minimum threshold criterion if applied to an extended data source.

[Table 4 about here]

Causal Configurations for Achieving Low and Very Low Commercial Success

The solution differences between the analysis of high and very high commercial success already show the asymmetric understanding of causality of fsQCA. Consequently, it is important to not only study the necessary causal conditions that lead to the presence of the outcome in question, but to also investigate the necessary causal conditions that lead to its absence. Tables 5 and 6 show the results of the fuzzy set analysis of low and very low commercial success, two outcome measures that represent the negated form of the outcome sets of high commercial success firms and very high commercial success titles. Following previous analysis, we again set the necessary consistency threshold at 0.75 and the minimum acceptable frequency threshold at two.

[Tables 5 and 6 about here]

Solutions 1, 2 and 3 presented in Table 5 indicate that either the absence of a major publisher, low metacritic scores from professional critics, or a narrow platform release strategy is sufficient for achieving low commercial success. Additionally, solutions 4a, 4b, and 4c indicate that low commercial success is explained by non-sequels to successful titles, as well as non-M-rated game titles, low sales prices, low popularity of the relevant hardware platform or metacritic reviews from users. With regards to very low commercial success, solutions 1, 2, 3, and 4 suggest that either the absence of product reviews from professional critics, successful precursors, restricted age ratings or the presence of positive word-of-mouth response lead to very low commercial success. Furthermore, both the overall solution consistency and coverage rate and the unique consistency and raw coverage scores of the solutions presented in Tables 5 and 6 are extremely high. Consequently, since the solutions almost cover all possible paths to

achieving low and very low commercial success, the results indicate that the conditions for achieving the outcome are both sufficient and necessary.

Comparing the solutions that lead to the absence of the outcome of interest with the solutions that lead to its presence highlights two major advantages of fsQCA. First, the findings allow for the construction of a highly detailed picture of asymmetric causality. Second, the results of high and very high commercial success as well as low and very low commercial success reveal consistent interrelationships between conditions and the outcome that are robust against substantive modifications.

Robustness Checks

We conduct several sensitivity checks to test the robustness of our findings and the implementation of alternative coding of the causal conditions. We compare the results of the fsQCA analyses presented above with alternative coding for product reviews, brand reputation, product characteristics and publisher effects. Specifically, we vary the degrees of memberships of professional critics and word-of-mouth and code game titles as fully included with a metascore of ≥ 75 , fully excluded with a metascore of ≤ 49 and with a crossover point set at 62. Additionally, game sequels receive the same set thresholds used for the classification of very high commercial success (as opposed to high commercial success in the previous analysis). The two conditions, genre classification and distribution strategy, are given more conservative measures of membership, coding full membership with a threshold of two, full non-membership with a threshold of zero, and the crossover point set at one.

The results of the sensitivity analysis show only minor differences in the number of solutions and specific unique consistency and raw coverage scores. However, the frequency and consistency cutoffs remain unchanged and thus the general conclusions and interpretations of the results are consistent.

Managerial Implications

Our findings show that the clearest and most consistent signal associated with increased unit sales of video games is the presence of an earlier title in the same series that has also experienced high commercial success. Therefore, the most significant managerial implication of our findings is that it is typically strategically advantageous to develop and extend existing successful franchises as opposed to launching entirely new intellectual property. This is consistent with findings from studies such as Erdem and Swait (2004) and Völckner and Sattler (2006), which have found that the quality of the parent product, as well as the fit with the parent, to be important success determinants for brand extension strategies. In this particular market context, success clearly breeds success; video games publishers and developers should bear this in mind in the development of their strategies for brand extension and new product releases.

The contrast of solutions relating to high and very high sales success illustrates the key distinctions between the roles of signals determining different levels of sales performance. Both reviews from professional critics and the distribution strategy adopted by a publisher appear to play a vitally important role in determining the extent to which a title is included in the high sales set, but is not an important determinant for inclusion in the very high sales set. This result, combined with the aforementioned influence of sequels, indicates that there is an asymmetric relationship in the role of these signals in influencing the sales performance of new versus existing franchises. If developers and publishers are considering the development of a new IP, our findings suggest that it would be beneficial to devote increased development resources to these games, as well as ensuring a wide, multi-platform distribution strategy. Ensuring any new IP is widely available and of the highest quality will maximize the likelihood of receiving positive reviews from professional critics and resultantly help a title to

generate high sales success. Titles subsequently released in the same series then enjoy a greater likelihood of achieving very high commercial success without having the same reliance on positive reviews from professional critics or cross-platform availability. Therefore, it could be surmised that a cross-platform distribution strategy and high product quality, as validated by trusted professional critics, appear to be of crucial importance in establishing a successful franchise, but not as important in maintaining one.

These findings are mostly consistent with arguments presented by Keller and Lehmann (2006), who suggest that personal consumption experience, as well as the experiences of others (including reviews of professionals and consumer word-of-mouth) can exert a strong influence on consumer perception of brands. However, a significant contrast highlighted in our study is the lack of influence from consumer reviews and word-of-mouth play in determining sales success. Indeed, an *absence* of positive consumer reviews is found to associate with high sales success in two of our solutions. It therefore appears to be a far more important determinant for success that video games titles receive positive reviews from professional critics, which our results indicate are a far more influential and trusted signal of product quality than the opinions of other users. Despite the weight of published evidence pointing to the importance of positive consumer word-of-mouth in other markets, Chakravarty *et al.* (2010) has previously observed that frequent moviegoers are more strongly influenced by professional critics and significantly less influenced by reviews from other consumers. East *et al.* (2008) has also shown that consumers may resist negative word-of-mouth for brands they are already very likely to choose and resist positive word-of-mouth for brands they are very unlikely to choose. Our results reconcile with these findings if we assume that video game players tend to demonstrate a greater frequency of consumption relative to

consumers of other entertainment products and/or are already predisposed to purchase particular types of games (e.g., sequels to titles that have previously been successful) to the point where the views of other users are resisted. An obvious managerial implication of this finding is that publishers and developers should not be overly concerned about achieving positive online word-of-mouth coverage for their games and should instead focus their energies and attentions towards achieving the best possible response from professional critics.

The final significant managerial implications relate to price and age ratings. Solutions for both high and very high sales success thresholds shows evidence that a higher price associates with improved sales performance. While we do not by any means suggest that the demand curve for video games software is upward sloping, we do find evidence that a high price serves as a positive signal of quality, which at least partly offsets the traditional economic association between price and demand. Ultimately, this suggests that consumers are not particularly sensitive to price and that demand for video games software can therefore be described as being relatively price inelastic. The literature is not without precedence on this issue, as studies such as Shiv *et al.* (2005) and Erdem *et al.* (2008) have previously shown that price can unconsciously influence expectations of product quality, which in turn leads to enhanced sales performance. Additionally, with regard to age ratings, our findings show that M-rated titles associate positively with sales success, which may be contrary to expectations given the restricted availability of these titles. A clear managerial implication of these last two findings is that publishers should not be concerned about setting a high/premium price point or including adult content in their games, especially if the title receives positive reviews from professional critics and/or is a sequel to a highly successful franchise.

Conclusion

The analysis of the influence of different signals on the perception of consumers remains one of the most pursued topics in marketing and economics research. In this study, we have argued for the importance of developing a holistic picture of the market mechanism by considering simultaneous exposure to a range of market signals, as opposed to a consideration of separate factors independently. To meet this challenge, we develop and implement both a conceptual framework that proposes the definition of core causal conditions and their interrelationships, as well as a methodology that shifts the field of empirical attention from relationships based on correlation towards set-theoretic relationships.

Specifically, QCA helps to understand the interrelationships of core conditions, their configurations and the outcome, identifying relationships that may otherwise be ignored using standard statistical methodologies. The distinction between sufficient and necessary conditions is one of the prime advantages of QCA and the set-theoretic approach compared to correlational models. Through the combination of implementing our conceptual approach and the introduction of a novel methodology, we are able to improve the understanding of causality and the important drivers in cause-effect relationships, an issue that is relevant to both academics and practitioners.

However, the solutions presented in Tables 3 and 4 do not cover all possible paths that lead to high and very high commercial success. The defined frequency and consistency thresholds exclude those configurations that are sufficient but not necessary for achieving commercial success in the video game industry. Nevertheless, the set-theoretic approach used in this study allows for the analysis of causal asymmetry, also indicating the solutions that lead to low and very low sales performance. Specifically, the test of causal asymmetry allows QCA to act as a complement to the standard range

of statistical and linear modeling approaches, which ultimately results in a more comprehensive understanding of the cause-effect relationships between theoretical constructs.

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Figures and Tables

Table 1. Literature review summary

<i>Author(s)</i>	<i>Journal</i>	<i>Product</i>	<i>Dependent Variable</i>	<i>Word of Mouth</i>	<i>Professional Critics</i>	<i>Sequels</i>	<i>Price</i>	<i>Product Rating</i>	<i>Publisher Market Share</i>	<i>Genre</i>	<i>Distribution Strategy</i>	<i>Interaction of Signals</i>
Archak et al. (2011)	Management Science	Electronic Goods	Sales rank	x			x					
Basuroy & Chatterjee (2008)	Journal of Business Research	Movies	Weekly box office revenue		x	x					x	x
Basuroy & Ravid (2013)	Working Paper	Movies	Weekly box office revenue	x	x			x		x	x	x
Basuroy et al. (2003)	Journal of Marketing	Movies	Weekly domestic revenue		x	x		x			x	
Basuroy et al. (2006)	Journal of Marketing Research	Movies	Weekly box office revenue	x	x	x				x	x	x
Boatwright et al. (2007)	Quantitative Marketing and Economics	Movies	Sales diffusion		x	x		x				
Bruce et al. (2012)	Journal of Marketing Research	Soft drinks	Weekly sales									
Chandrasekaran et al. (2013)	International Journal of Research in Marketing	Consumer electronics	International sales ('take-offs')				x					x
Chen & Xie (2008)	Management Science	Electronics and video games	Whether review is available	x								
Chevalier & Mayzlin (2006)	Journal of Marketing Research	Books	Sales rank	x			x					
Chintagunta et al. (2010)	Marketing Science	Movies	Opening gross	x	x						x	
Clement et al. (2013)	International Journal of Research in Marketing	Movies	Weekly revenues and screens	x	x	x		x	x	x		
De Vany & Walls (2002)	Journal of Business	Movies	Success (box office gross, returns)					x				
Decker & Trusov (2010)	International Journal of Research in Marketing	Mobile phones	Word of mouth product rating	x			x					
Dellarocas et al. (2007)	Journal of Interactive Marketing	Movies	Aggregated box office	x	x			x		x	x	
Dhar et al. (2012)	Marketing Letters	Movies	Weekly & total attendances, Gross margins	x		x		x	x	x	x	x
Duan et al. (2008)	Journal of Retailing	Movies	Daily box office gross	x				x	x			
Eliashberg & Shugan (1997)	Journal of Marketing	Movies	Weekly box office revenue		x						x	
Gemser et al. (2007)	Journal of Cultural Economics	Movies	Box office (opening weekend and cumulative)		x	x				x	x	
Gierl & Huettl (2010)	International Journal of Research in Marketing	Conspicuous consumption goods	Consumer attitude towards product				x					x

The Interaction of Signals: A Fuzzy set Analysis of the Video Game Industry

<i>Author(s)</i>	<i>Journal</i>	<i>Product</i>	<i>Dependent Variable</i>	<i>Word of Mouth</i>	<i>Professional Critics</i>	<i>Sequels</i>	<i>Price</i>	<i>Product Rating</i>	<i>Publisher Market Share</i>	<i>Genre</i>	<i>Distribution Strategy</i>	<i>Interaction of Signals</i>
Gierl & Huettl (2011)	International Journal of Research in Marketing	Consumer products	Evaluation of brand extension			x						
Godes & Mayzlin (2004)	Marketing Science	TV Shows	Neilsen ratings	x								
Hennig-Thurau et al. (2012)	Journal of Cultural Economics	Movies	Long and short term box office revenues		x	x		x		x	x	x
Holbrook & Addis (2007)	Journal of Consumer Research	Movies	Popular appeal	x	x							
Hu et al. (2008)	Information Technology and Management	Books, DVDs, Videos	Unit sales	x			x				x	
Leenders & Eliashberg (2011)	International Journal of Research in Marketing	Movies	Opening weekend and cumulative box office performance					x		x	x	
Liu (2006)	Journal of Marketing	Movies	Weekly box office revenue	x	x			x		x	x	
Marcoux & Selouani (2009)	Computer Science and Information Engineering, 2009 WRI World Congress on	Video games	Weekly sales	x	x	x	x		x	x		
Moldovan et al. (2011)	International Journal of Research in Marketing	'Useful' products	Word of mouth (volume and valence)	x								
Moon et al. (2010)	Journal of Marketing	Movies	Amateur review scores and box office revenues	x	x	x		x	x	x	x	x
Park et al. (2011)	International Journal of Research in Marketing	Mobile communications	Consumer willingness to pay for bucket pricing plans				x					
Pham et al. (2013)	International Journal of Research in Marketing	TV Commercials	Brand attitudes						x			
Prag & Casavant (1994)	Journal of Cultural Economics	Movies	Lifetime box office		x	x		x		x		
Rao et al. (1999)	Journal of Marketing Research	Televisions (real and fictional brands)	Quality perception						x			
Ravid (1999)	Journal of Business	Movies	Revenues (domestic box office, videos etc.)		x	x		x		x		
Riefler (2012)	International Journal of Research in Marketing	Soft drinks, lingerie	Brand perception						x			
Sattler et al. (2010)	International Journal of Research in Marketing	Consumer products	Price premium on brand extension			x	x					x
Schlereth & Skiera (2012)	International Journal of Research in Marketing	Digital music	Consumer willingness to pay for bucket pricing plans				x		x			
Shao (2012)	International Journal of Marketing Studies	Movies	Box office gross	x				x		x	x	
Sun (2012)	Management Science	Movies / Books	Opening Gross / Difference in Sales Ranks	x	x			x		x		
Terry et al. (2011)	South-western Economic Review	Movies	Domestic box office gross		x	x		x		x		
Van Horen & Pieters (2012)	International Journal of Research in Marketing	Consumer goods	Evaluation of brand names						x			
Zhu & Zhang (2010)	Journal of Marketing	Video games	Monthly sales data	x			x		x			x

Table 2. Descriptive statistics and correlation coefficients

Variable	Mean	Std. Dev.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Professional Critics	.42	.34										
2. Word-of-Mouth	.49	.33	0.54***									
3. Sequels	.27	.34	0.31***	0.08***								
4. ESRB Age Ratings	.21	.24	0.06**	0.10***	0.02							
5. Distribution Strategy	.32	.30	0.03	-0.20***	0.11***	-0.11***						
6. Platform Popularity	.26	.36	-0.01	0.23***	-0.04	0.10***	-0.34***					
7. Original Sales Price	.31	.37	0.30***	0.17***	0.24***	0.07***	0.05*	-0.10***				
8. Genre Classification	.19	.39	0.08***	0.004	0.02	-0.08***	-0.03	-0.20***	0.08***			
9. Market Share of Publishers	.55	.50	0.18***	0.06**	0.27***	-0.05*	0.002	0.01	0.12***	-0.05*		
10. High Commercial Success	.26	.35	0.47***	0.18***	0.51***	-0.006	0.10***	-0.06**	0.28***	0.08***	0.21***	
11. Very High Commercial Success	.11	.21	0.41***	0.15***	0.46***	0.01	0.01	-0.01	0.26***	0.11***	0.16***	0.84***

Significance. 0.01 '***' 0.05 '**' 0.1 '*'

Table 3. Solution table of core causal configurations for achieving high commercial success

Configuration	Solution			
	1a	1b	2a	2b
<i>Product Reviews</i>				
Professional Critics	●	●	●	●
Word-of-Mouth			○	○
<i>Brand Reputation</i>				
Sequels	●	●	●	
<i>Product Characteristics</i>				
ESRB Age Ratings				
Genre Classification				
<i>Publisher or Distributor Effects</i>				
Market Share of Publishers				
Distribution Strategy		●		●
Platform Popularity				
<i>Price Effects</i>				
Original Sales Price	●			
Unique Consistency	0.78	0.74	0.72	0.61
Raw Coverage	0.32	0.29	0.30	0.31
Overall Solution Consistency			0.52	
Overall Solution Coverage			0.65	

Black circles indicate the presence of a condition, and white circles indicate its absence.

Blank spaces indicate that the condition could be either absent or present and hence does not influence the occurrence of the outcome in question.

Frequency cutoff is set at 2, and consistency cutoff is set as 0.75.

Table 4. Solution table of core causal configurations for achieving very high commercial success

Configuration	Solution
	1
<i>Product Reviews</i>	
Professional Critics	
Word-of-Mouth	
<i>Brand Reputation</i>	
Sequels	●
<i>Product Characteristics</i>	
ESRB Age Ratings	●
Genre Classification	
<i>Publisher or Distributor Effects</i>	
Market Share of Publishers	
Distribution Strategy	
Platform Popularity	
<i>Price Effects</i>	
Original Sales Price	●
Unique Consistency	0.53
Raw Coverage	0.15
Overall Solution Consistency	0.53
Overall Solution Coverage	0.15

Black circles indicate the presence of a condition, and white circles indicate its absence. Blank spaces indicate that the condition could be either absent or present and hence does not influence the occurrence of the outcome in question.

Frequency cutoff is set at 1, and consistency cutoff is set as 0.6.

Table 5. Solution table of core causal configurations for achieving low commercial success

Configuration	Solution					
	1	2	3	4a	4b	4c
<i>Product Reviews</i>						
Professional Critics		○				
Word-of-Mouth						○
<i>Brand Reputation</i>						
Sequels				○		
<i>Product Characteristics</i>						
ESRB Age Ratings				○	○	○
Genre Classification						
<i>Publisher or Distributor Effects</i>						
Market Share of Publishers	○					
Distribution Strategy			●			
Platform Popularity					○	
<i>Price Effects</i>						
Original Sales Price					○	
Unique Consistency	0.82	0.89	0.79	0.87	0.84	0.84
Raw Coverage	0.49	0.70	0.35	0.71	0.46	0.47
Overall Solution Consistency				0.79		
Overall Solution Coverage				0.96		

Black circles indicate the presence of a condition, and white circles indicate its absence.

Blank spaces indicate that the condition could be either absent or present and hence does not influence the occurrence of the outcome in question.

Frequency cutoff is set at 2, and consistency cutoff is set as 0.75.

Table 6. Solution table of core causal configurations for achieving very low commercial success

Configuration	Solution			
	1	2	3	4
<i>Product Reviews</i>				
Professional Critics	○			
Word-of-Mouth		●		
<i>Brand Reputation</i>				
Sequels			○	
<i>Product Characteristics</i>				
ESRB Age Ratings				○
Genre Classification				
<i>Publisher or Distributor Effects</i>				
Market Share of Publishers				
Distribution Strategy				
Platform Popularity				
<i>Price Effects</i>				
Original Sales Price				
Unique Consistency	0.98	0.92	0.96	0.91
Raw Coverage	0.63	0.50	0.79	0.82
Overall Solution Consistency			0.91	
Overall Solution Coverage			0.99	

*Black circles indicate the presence of a condition, and white circles indicate its absence.
Blank spaces indicate that the condition could be either absent or present and hence does not influence the occurrence of the outcome in question.*

Frequency cutoff is set at 2, and consistency cutoff is set as 0.75.

Figure 1. Conceptual framework

