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Option framing and Markov chain: A descriptive approach in a state-space modeling of customer behavior

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Abstract

In the field of marketing, option framing is a product or service configuration where the consumers customize the package they wish to procure either by adding options to a base model, an initial configuration with a minimum number of essential features, or by subtracting options from a fully-loaded model, a product or service configuration with both essential and all of the optional features. Additive framing is selecting features to augment the base model, while subtractive framing is deselecting features from the fully-loaded model. A focal issue for companies that could possibly offer such products or services with option framing is finding out which process, additive or subtractive framing, is bound to give a final configuration with more features. The scenarios of option framing can be described by a finite Markov chain process. The Markov chain attempts to capture the decision process of the two types of framing through the estimated probabilities of movement from one phase to the other. In each of the decision phases, the key measure is the number of features in the configuration and the transition probabilities. The option framing is used on an actual study, where the empirical results verify the theories favoring subtractive framing, such as differential loss aversion and anchoring-adjustment theories. Separate Markov chains are evaluated for additive and subtractive framing, with the final configurations of the product or service package, along with the corresponding number of options, as main results.

Theoretical background and study structure

The application and structure of option framing in marketing was earlier explored by Park, Jun and McInnis (2000). Option framing is a product or service configuration where the consumers customize the product or service either by adding options to a base model, an initial configuration with a minimum number of essential features, or by subtracting options from a fully loaded model, a product or service configuration with both essential and all of the optional features. Additive framing is selecting features to augment the base model, also referred to as bottom-up customization. On the other hand, subtractive framing is a top-down process, where the starting point is the fully loaded model from which certain features or options may be removed.

A focal issue for companies offering such products or services with option framing is finding out which process, additive or subtractive framing, is bound to give a final configuration with more features. The method of selection of the features can affect the consumer decision process. The differences between the two framing alternatives are basically seen in two aspects: reference point and task. Reference point is the initial model, base or full, that serves as the vantage point for customization, while the corresponding task involved is the addition (or subtraction) of features with reference to the base (or full) model.

According to Hermann et al (2013), consumers tend to select more options, ending up with more expensive configuration, when following subtractive framing. One possible explanation as to why subtractive framing leads to more selected features is given by the differential loss aversion theory (Hardie, Johnson and Fader, 1993). Under subtractive framing, consumers tend to be reluctant to deselecting options to avoid losing the utility of certain features. Lowering the utility of the product or service is not sufficiently compensated by reduced purchase price. The gain in utility in additive framing, however, is overshadowed by the increase in purchase price of the final configuration (Dipayan and Biswas, 2009).

Another model which possibly explains the final configuration advantage of the subtractive framing is anchoring and adjustment theory (Tversky and Kahneman, 1974; Simonson and Drolet, 2004). The anchor is the reference point and the adjustment is the consumer reaction to and decision regarding modification of the initial product or service level. The decision flow starts with the initial point, and thereafter, adjustments are made to this anchor. The theory states that the consumer tends to hold on to the initial point, making insufficient modifications so as not to considerably deviate from such initial point. In the additive model, the consumer tends to add few changes to product configuration, whereas in the subtractive model, the consumer does not make considerable deselection, in an attempt to hold on closer to the full model utility (Tversky and Kahneman, 1974; Epley and Gilovich, 2006). Hence, this tendency favors the subtractive framing in terms of the number of features in the final configuration.

There is a growing trend in applying and studying option framing in marketing, with a number of articles published in recent years. As reported by certain studies (e.g., Levin, Schreiber, Lauriola and Gaeth, 2002; Biswas and Grau, 2008; Park and Kim, 2012; Hermann et al, 2013), there appears to be a favourable consequence with subtractive framing, leading to a selection of more options, compared with additive framing. In line with previous researches on option framing applied on products , the study aims to empirically verify whether or not subtractive framing, in comparison with additive framing, leads to final *service* configurations with more selected options. The study applies option framing in a particular *service* customization for an actual scenario. The key questions are:

- Which framing leads to final service configurations with more options?
- How different are the final choices in the 2 frames?

The primary objective of the study is to present option framing as a form of a finite Markov chain. The decision structure is treated as a stochastic process, in an attempt to present an alternative way of describing option framing. As an initial application of stochastic modeling in option framing, a simple finite Markov chain is used. From the basic simple Markov model, one can make appropriate modifications to accommodate complex structures.

The study involves a vehicular inspection service package, which is offered by a local Swedish company. This package is specified by two components:

1 Essential minimum or base features.

2 Optional alternatives.

The essential minimum includes all of the necessary inspection protocol required by Swedish laws. Three options of extra special inspection services are appropriately chosen for the study. The final service inspection package ranges from the base model of essential inspection protocol to a full model which covers the base and all of the optional services. The details regarding optional framing features are presented in the subsequent section *Study Structure*.

The company's clients comprise the target population, and the sample is randomly drawn from the updated company client database. With a sufficient sample size n, half of the random sample is assigned to additive framing, and the other half, to subtractive framing. Considering the intricacy of the framing exercise, a web-design survey is pragmatically suitable. The process of selection and deselection of options can be neatly programmed in web platform, making the interview much smoother for the respondents and less costly, as opposed to other data collection methods.

In additive framing, the initial offer is the basic package composed of required inspection protocol. Generally, there is a specified number k of options, and the bottom-up task involved is selecting specific options for the final configuration. In subtractive framing, the start-off point is the complete set of basic package plus the k optional features. The top-down task calls for deselecting or removing items from the set of k optional features.

Additive framing

The initial or reference point for additive framing is defined by the set of minimum essential m features for the product or service and is referred to as the base model. There are k optional features and the bottom-up task involved is selecting or adding a number of options for the final configuration. Let X_i be the indicator function for choosing the i^{th} optional feature:

$$X_i = \begin{cases} 1, & \text{if the feature i is selected} \\ 0, & \text{otherwise.} \end{cases}$$

The bottom-up task is done on the assumption that the customer is positive towards availing such service package. Lumping the essential services in the basic model as one component, the total number of features a_x in the final configuration is:

$$\alpha_x = 1 + X, \quad \text{where} \quad X = \sum_{i=1}^{k} X_i. \tag{1}$$

Subtractive framing

The reference point for subtractive framing is the basic package and all of the k optional features. This top-down task calls for deselecting items from the set of k optional features, given that the consumer is positive towards the product or service involved. Let Y_i be the indicator function for deselecting the i^{th} optional feature:

$$Y_i = \begin{cases} 1, & \text{if the feature i is deselected} \\ 0, & \text{otherwise.} \end{cases}$$

After doing the top-down task, the total number of features α_y in the final configuration, aggregating the essential basic services into one component, is set as:

$$\alpha_y = 1 + k - Y, \quad \text{where ,} \quad Y = \sum_{i=1}^{k} Y_i. \tag{2}$$

Markov chain

The first step in transforming option framing to a finite Markov chain is the specification of the decision phases. In this study, a simple chain is constructed according to the following stages:

Stage(n)	Description
n=0	The service concept is presented and the respondent evaluates whether or not the concept is to be considered.
n=1	Given that the respondent is positive towards the service concept, the initial package is presented and the respondent then evaluates the options, following the framing structure.
n=2	Should the respondent wish to modify the initial package, a final configuration of the service package is done.

In each of the stages, particularly at the last phase, the key measure is the number of features in the configuration. The transition probabilities from the first to the last stage can be readily estimated from resulting frequency distributions. These probabilities indicate the intensity of choice of number of options. Separate Markov chains are evaluated for additive and subtractive framing, with the final configurations of the service package, along with the corresponding number of options, as main results.

For this basic 3-stage decision structure, let $Z_n, n = 0, 1, 2$, be defined as the number of features at stage n, which takes values in the finite set $S = \{0, 1, 2, ..., k+1\}$. The possible values which Z_n can take are referred to as the states of the option framing system. In additive framing, $Z_0 = 0$, the state at the stage where the product or service concept is presented and the consumer has yet to make a choice whether or not to accept it. If the consumer reacts negatively and does not wish to purchase the product or avail the service in whatever configuration, then the succeeding state $Z_1 = 0$. The probability of consumers who are not interested in the service is represented by the conditional probability

$$P(Z_1 = 0|Z_0 = 0) = v_{00}.$$

If the consumer is interested with the service, then the succeeding state $Z_1 = 1$, representing the essential or basic service component. The corresponding probability is defined by

$$P(Z_1 = 1|Z_0 = 0) = v_{01}.$$

Subsequent to this stage, the task of adding features begins. If the consumer does not want to go beyond the base model, then the succeeding state $Z_2 = 1$, the initial package, with associated probability

$$P(Z_2 = 1|Z_1 = 1) = v_{11}.$$

Should the consumer desire to add j options into the base model, then the state $Z_2 = 1 + j$, with a probability defined by

$$P(Z_2 = 1 + j|Z_1 = 1) = v_{1,1+j}.$$

The states $2, 3, ..., k + 1$ are absorbing states, indicating that the consumer has reached a final configuration of the product or service. The transition probability matrix for additive framing is then as follows:

	0	1	2	3	...	k+1
0	V_{00}	V_{01}	0	0	...	0
1	0	V_{11}	V_{12}	V_{13}	...	$V_{1,\mathrm{k+1}}$
2	0	0	1	0	...	0
3	0	0	0	1	...	0
.	.	.	.	.	...	.
.	.	.	.	.	...	.
.	.	.	.	.	...	.
k+1	0	0	0	0	...	1

In subtractive framing, the starting state is still $Z_0 = 0$, at the stage where the product or service concept is presented and the consumer has yet to decide whether or not to accept the service concept. If the consumer reacts negatively and does not wish to purchase the product or avail the service in whatever configuration, then the succeeding state $Z_1 = 0$. Similar to additive framing, the probability that a consumer is not interested in the product or service is represented by the conditional probability

$$P(Z_1 = 0|Z_0 = 0) = v_{00}.$$

If the consumer is interested in the product or service, then the succeeding state $Z_1 = k + 1$, the fully loaded model, with corresponding probability defined by

$$P(Z_1 = k + 1|Z_0 = 0) = v_{0,k+1}.$$

The next stage is the task of deselecting optional features. If the consumer decides to maintain the fully loaded model, then the succeeding state $Z_2 = k + 1$, the maximum number of features, with associated probability

$$P(Z_2 = k + 1|Z_1 = k + 1) = v_{k+1,k+1}.$$

If the consumer desires to remove j features from the fully loaded model, then the state $Z_2 = k + 1 - j$, with a probability defined by

$$P(Z_2 = k + 1 - j|Z_1 = k + 1) = v_{k+1,k+1-j}.$$

Following the top-down structure, the states $1, 2, ..., k$ are absorbing states, indicating that the consumer has reached a final configuration of the product or service. The transition probability matrix for subtractive framing is then as follows:

	0	1	2	3	...	k	k+1
0	V_{00}	0	0	0	...	0	$V_{0,\mathrm{k+1}}$
1	0	1	0	0	...	0	0
2	0	0	1	0	...	0	0
3	0	0	0	1	...	0	0
.	.	.	.	.	...	.	.
.	.	.	.	.	...	.	.
.	.	.	.	.	...	.	.
k	0	0	0	0	...	1	0
k+1	0	$V_{\mathrm{k+1},1}$	$V_{\mathrm{k+1},2}$	$V_{\mathrm{k+1},3}$	...	$V_{\mathrm{k},\mathrm{k+1}}$	$V_{\mathrm{k+1},\mathrm{k+1}}$

The expected value of the number of features in the final configuration is:

$$E[\alpha_j] = \sum_{i=0}^{k+1} iP(\alpha_j = i)$$

where $j = x, y$ and $P(a_j = i)$ is the probability of a respondent having i features in the final configuration.

This expected value includes those consumers who are not generally interested in availing the service. Among those who are interested in availing the vehicular inspection package, the expected counts of features in the final configuration are as follows. In the succeeding discussions, these mean values are termed as truncated expected counts.

For additive framing:

$$E^*[\alpha_x] = \frac{\sum_{i=1}^{k+1} iP(\alpha_x = i)}{\sum_{i=1}^{k+1} P(\alpha_x = i)} = \sum_{i=1}^{k+1} iV_{1i}.$$

For subtractive framing:

$$E^*[\alpha_y] = \frac{\sum_{i=1}^{k+1} iP(\alpha_y = i)}{\sum_{i=1}^{k+1} P(\alpha_y = i)} = \sum_{i=1}^{k+1} iV_{k+1,i}$$

Study structure

The mandatory vehicular inspection in Sweden has been deregulated and opened up for private competition. One of the leading companies that offer vehicular inspection services as required by law agreed to do this option framing study. Apart from the basic mandatory inspection, the company offers 3 extra services or additional options to customers, as follows:

1) Additional control of electronics.
2) Additional fluid control.
3) Additional tire control.

These 3 extra services are options which can be combined with the basic service, which is referred to earlier as the base model. The full model is the complete selection of the 3 options and the basic service.

A random sample is taken from the company list of customers, where the target is 500 complete interviews. The selected respondents are randomly assigned to 4 groups:

1) Additive framing, not showing prices for the options.
2) Additive framing, showing prices for the options.
3) Subtractive framing, not showing prices for the options.
4) Subtractive framing, showing prices for the options.

The prices set are 100 SEK for additional control of electronics and 50 SEK each for additional fluid control and additional tire control. For each type of framing, 2 independent subgroups are designed. In one subgroup the prices of the options are shown, while in the other subgroup, no prices are indicated along with the description of options. It is of interest to see if the prices do affect the choices of options.

It is expected that around 125 respondents are obtained for each group. In the absence of information about the respondents other than email addresses, which could be utilized for stratification, the assignment of respondents is done randomly. The random assignment to the 4 different frame groups is done once the respondent decides to avail a vehicular inspection package.

The critical questions that the study hopes to answer are:

a) What is the proportion of respondents who are positive towards the service concept?

b) What are the popular final service packages based on additive and subtractive framing?

c) Do the framings lead to different final packages?

d) Do the prices affect the choices of options?

e) Which options are attractive based on both additive and subtractive framing?

Descriptive statistical methods, particularly frequency distributions and standard tabulations, should provide the necessary summary information needed to find answers to the above-mentioned questions. Markov chain modeling is used as an alternative way of describing the option framing decision structure and results.

Results

A total of 715 customers responded to the web-survey, where 587 (82,1%) could think of availing at the very least the base service of vehicular inspection, priced at 395 SEK. Only 128 (17,9%) reacted negatively to such offer. This result indicates that a fairly large proportion of customers are positive towards basic vehicular inspection. Among the 587 respondents who positively responded to the basic vehicular inspection offer, a total of 503 customers completed the questionnaire, while 84 respondents had incomplete responses. The 503 respondents were randomly assigned to the 4 option framing groups as follows:

Group	Frequency	Percent
1	127	25.2 %
2	124	24.7 %
3	126	25.0 %
4	126	25.0 %
Total	503	100.0 %

The final choices made by respondents assigned to Group 1 (additive framing, not showing prices for the options) are shown in Table 1. A predominant portion of this subgroup did not choose any option in addition to the base model. Roughly 70% of this additive framing group chose only the basic service package, while 30% opted for at least one additional option.

Among the 3 options, the most popular is option 1 (additional control of electronics), chosen by around 24% of the Group 1 respondents, while the other two options (additional fluid control, additional tire control) have been selected by 8-9% of Group 1 respondents. In the first group, less than 4% of the respondents made a selection of any two options. Moreover, only 4% ended up selecting all options. Additive framing seemed to favor the base model, considering the disparity in percentages of final choice between the base and full models.

Table 1. Distribution of final choices in Group 1.

Choice of options	Sum	Percent
No additional option (BASE)	89	70.1 %
(1) Additional control of electronics	24	18.9 %
(2) Additional fluid control	3	2.4 %
(3) Additional tire control	2	1.6 %
(1)+(2) el fluid	1	0.8 %
(1)+(3) el tire	1	0.8 %
(2) + (3) fluid tires	2	1.6 %
All option (FULL)	5	3.9 %
Valid N (listwise)	127	100.0 %

The difference between Groups 1 and 2 is the inclusion of price for the options. Group 2 follows the additive framing scheme as in Group 1, with the price given for each option. Recall that 100 SEK was set for additional control of electronics and both additional fluid control and additional tire control were each priced at 50 SEK. A total of 124 respondents were randomly assigned to this additive option subgroup. The final choices of the respondents in this group are summarized in Table 2.

Table 2. Distribution of final choices in Group 2.

Choice of options	Sum	Percent
No additional option (BASE)	73	58.9 %
(1) Additional control of electronics	25	20.2 %
(2) Additional fluid control	8	6.5 %
(3) Additional tire control	4	3.2 %
(1)+(2) el fluid	4	3.2 %
(1)+(3) el tire	3	2.4 %
(2) + (3) fluid tires	2	1.6 %
All option (FULL)	5	4.0 %
Valid N (listwise)	124	100.0 %

A remarkable difference is that the proportion of respondents who ended up with basic service package drops by slightly over 10% to 59%. This implies that more respondents (41%) in this group, compared with the first group, tended to choose some options. The increase in choice of options could be possibly attributed to the prices which were likely deemed as not exorbitant. A fee within the range of 50 to 100 SEK for such extra vehicular inspection seemed acceptable for some customers, which could stimulate the choice of some options.

In comparison with the previous additive framing segment, the second group posts similar final choices. The most popular option is "additional control of electronics", selected by approximately 30% of the Group 2 respondents, followed by "additional fluid control" (15%) and "additional tire control" (11%). However, a slightly higher percentage of Group 2 respondents, at 7%, chose 2 additional options. The percentage of respondents who chose the complete package remains low at 4%.

For the subtractive framing scheme, the full model is presented and the respondents are requested to remove those options they do not wish to have. Two groups were formed, Groups 3 and 4, differentiated only by the inclusion of the prices for the additional services. In Group 4, the prices for the options were shown, whereas in Group 3, the price information was excluded. The summary of final choices for Groups 3 and 4 are presented in Tables 3 and 4, respectively. The results obtained for Group 3 present a resounding difference between subtractive framing and the previous additive framing. Of the 126 Group 3 respondents, 41% opted for the full or complete package, that is, basic vehicular inspection and all of the additional options. Both additive framing groups register a much lower corresponding full package percentage at 4%.

Table 3. Distribution of final choices in Group 3.

Choice of options	Sum	Percent
No additional option (BASE)	30	23.8 %
(1) Additional control of electronics	9	7.1 %
(2) Additional fluid control	3	2.4 %
(3) Additional tire control	2	1.6 %
(1)+(2) el fluid	10	7.9 %
(1)+(3) el tire	4	3.2 %
(2) + (3) fluid tires	16	12.7 %
All option (FULL)	52	41.3 %
Valid N (listwise)	126	100.0 %

Subtractive framing in this case led to a higher proportion of respondents who selected at least one additional option. In stark contrast with the previous 2 additive groups, around 76% of Group 4 respondents had at least one option. Moreover, 24% of this group chose 2 additional options, relatively more than the additive framing groups which obtained corresponding figures below 10%. The option additional fluid control turned out to be the most popular option, slightly edging out the other two options by approximately 4%. The results for Group 3 support the contention that subtractive framing leads to final packages with more options, since higher percentages for various options are observed. For the second subtractive framing segment, the summary of final choices made by the respondents is shown in Table 4. It is clear that the number of choices further supports the argument that subtractive framing leads to more selected options.

With option prices presented in the Group 4 study, the respondents tended to choose more options compared with all other groups. It is possible that the respondents perceived the prices as affordable in relation to the additional inspection quality. The same boosting effect is observed in additive framing with prices (Group 2). Showing the prices of options enhanced the number of chosen features in the final configuration.

A remarkable result for Group 4 is that slightly over 50% of the respondents chose the full vehicular inspection package. The three options are quite uniform in popularity, with option 3 (additional tire control) chosen by 68%, slightly edging out the other 2 options by a maximum of 2%. Around 14% chose any 2 options, with options 2 (additional fluid control) and 3 (additional tire control) as the most popular pair.

Table 4. Distribution of final choices in Group 4.

Choice of options	Sum	Percent
No additional option (BASE)	25	19.8 %
(1) Additional control of electronics	10	7.9 %
(2) Additional fluid control	1	0.8 %
(3) Additional tire control	5	4.0 %
(1)+(2) el fluid	4	3.2 %
(1)+(3) el tire	2	1.6 %
(2) + (3) fluid tires	12	9.5 %
All option (FULL)	67	53.2 %
Valid N (listwise)	126	100.0 %

The two framings had different final packages. For additive framing, the major tendency (64%) was to hold on to the base model. Some respondents (36%) added extra services, but largely with a single option (26%). Holding on to the initial model worked as well for subtractive framing, where the predominant choice is the full service package, with a combined proportion of 47%. Having 1 or 2 options was observed in 31% of the respondents who did subtractive framing.

For additive framing, option 1 (additional control of electronics) is most popular, selected by 27 % of Group 1 & 2 respondents. On the other hand, the subtractive framing groups have a more even distribution in the selection of options. Option 2 (additional fluid control) barely edged out the other options. Holding on to the initial full service package has contributed to a fairly even distribution of preference for the 3 options. Even among those who did not choose the full service package, option 2 (additional fluid control) appears to be the most popular extra service.

As mentioned earlier, showing prices had a positive push in the selection of options in both framing schemes. A possible explanation is that some respondents in Groups 2 and 4 perceived the prices as fairly commensurate to the benefits they can get from the additional options.

In representing the option framing scenario in a finite Markov chain, the focus is on the number of options selected. With the features defined in the base model considered as one lumped required option, the states for the finite Markov chain are as follows:

0 = No selection

1 = Base model (no additional options selected)

2 = Base model and one additional option

3 = Base model and two additional options

4 = Full model (all options selected)

The transformation of the final choice results presented in Tables 1-4 into transition matrices for the Markov chain is presented in Table 5. Note that the transition probability from state 0 to itself (V_{00}) is equal to 0,179 in all of the four framing groups. V_{00} is simply the proportion of selected respondents who are not interested in the vehicular inspection offered by the company. As mentioned earlier, out of the contacted 715 customers, 128 respondents signified no intention to avail of the service. Those who showed interest in the service were randomly assigned to the 4 framing groups.

Table 5. Transition Matrices.

Additive framing without prices for options

S	0	1	2	3	4
0	0.179	0.821	0	0	0
1	0	0.701	0.228	0.031	0.039
2	0	0	1	0	0
3	0	0	0	1	0
4	0	0	0	0	1

Subtractive framing without prices for options

S	0	1	2	3	4
0	0.179	0	0	0	0.821
1	0	1	0	0	0
2	0	0	1	0	0
3	0	0	0	1	0
4	0	0.238	0.111	0.238	0.413

Additive framing with prices for options

S	0	1	2	3	4
0	0.179	0.821	0	0	0
1	0	0.589	0.298	0.073	0.040
2	0	0	1	0	0
3	0	0	0	1	0
4	0	0	0	0	1

Subtractive framing with prices for options

S	0	1	2	3	4
0	0.179	0	0	0	0.821
1	0	1	0.	0	0
2	0	0	1	0	0
3	0	0	0	1	0
4	0	0.198	0.127	0.143	0.532

The non-absorption stage 2 transition probabilities for the two types of framing differ. In additive framing, the larger probabilities tend to be near or in state 1. The largest transition probability is V_{11} for both additive frames, at 0,701 for the case where optional prices are not shown, and at 0,589, for the case with optional prices. This strongly indicates that in additive framing, the respondents tend to hold on to the basic service package. On the other hand, both subtractive framing cases have V_{44} as the most prominent transition. The first subtractive framing case (without prices for options) has $V_{44} = 0,413$, while the other subtractive case (with prices for options) has $V_{44} = 0,532$. This implies that subtractive framing leads respondents to maintain the initial full model, indicative of a stronger tendency towards not deselecting the 3 optional services. In general, all groups point out to a tendency of holding on to the initial model, be it basic or full. This is a possible indication of support for the anchor and adjustment theory.

How does the inclusion of prices for optional services affect the transition probabilities? Using Table 5, one can evaluate the change in probabilities of transition from state 1 to states 2 to 4. In additive framing, relatively more respondents chose additional options ($V_{12} + V_{13} + V_{14}$) in Group 2 (with prices for options) than Group 1 (without prices for options), from a subtotal of 0,298 to 0,411. The price effect on subtractive framing is reflected in the lesser degree of deselection of optional services. A considerably higher proportion of respondents chose the full model in the case where prices for the options are given. In whatever framing scenario, the prices of the optional features appear to have a positive effect on the number of options in the final configuration.

The state-space model of the consumer behavior in the option framing scenario is presented in Figure 1. The diagram for each of the four groups display the resulting transitions in states, following the Markov chain stages of this option framing. Figure 1 is essentially a graphical representation of the transition probabilities shown in Table 5 as well as the movement between states.

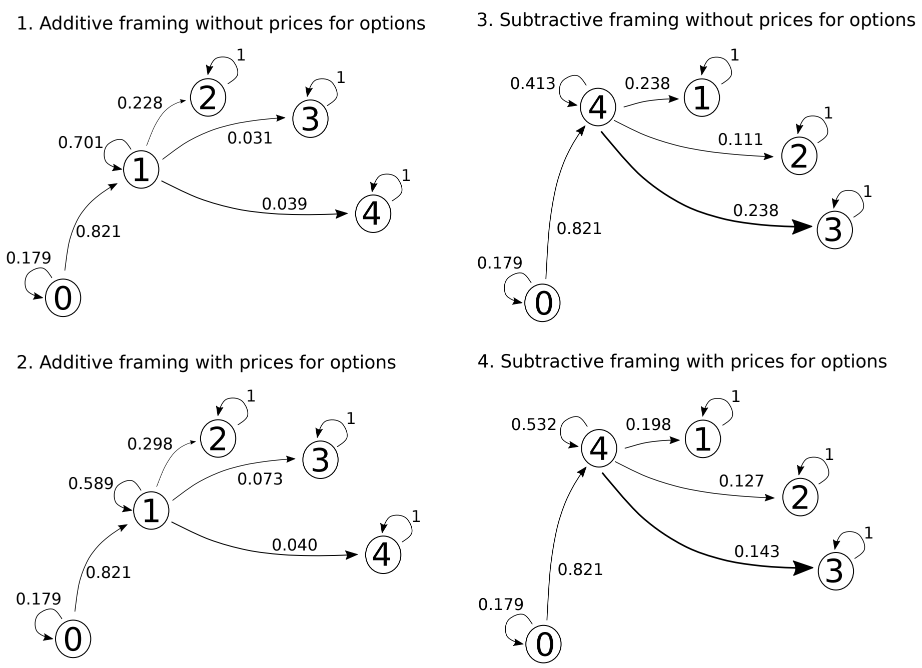

Figure 1: Final State-Space model of the customer behavior.

The truncated expected values of the number of features in the final configuration are as follows:
Additive framing (*without prices for additional options*):

$$E[\alpha_{x_1}] = \sum_{i=1}^{4} iV_{1i} = 1(0,701) + 2(0,228) + 3(0,031) + 4(0,039) = 1,406.$$

Additive framing (*with prices for additional options*):

$$E[\alpha_{x_2}] = \sum_{i=1}^{4} iV_{1i} = 1(0,589) + 2(0,298) + 3(0,073) + 4(0,040) = 1,564.$$

Subtractive framing (*without prices for additional options*):

$$E[\alpha_{y_1}] = \sum_{i=1}^{4} iV_{4i} = 1(0,238) + 2(0,111) + 3(0,238) + 4(0,413) = 2,826.$$

Subtractive framing (*with prices for additional options*):

$$E[\alpha_{y_2}] = \sum_{i=1}^{4} iV_{4i} = 1(0,198) + 2(0,127) + 3(0,143) + 4(0,532) = 3,009.$$

Index numbers can also be constructed to capture the relative attraction of the different options. The truncated mean values can be treated as indices of the number of features in the final configuration among those who can think of availing a vehicular inspection package. These truncated mean values range from 1 to 4. A truncated average of 1 signifies that the respondents would simply opt for the basic or essential inspection package, while a corresponding value of 4 would mean preferring the complete or full vehicular inspection service. Additive framing mean values are far lower than any of the two subtractive framing mean values. The mean values for additive framing are lower than 2, which indicate that most of the respondents in these frame segments tend to choose the base model, with a few choosing some of the optional services. Both subtractive framing groups have mean values close to twice the corresponding values of the additive frames. On the average, the respondents in the subtractive framing groups tend to choose 2 additional options, with a relatively large proportion choosing the full model.

Concluding remarks and other research directions

As the results show, the additive and subtractive framings lead to different number of options in the final service configuration. In subtractive framing, with or without prices for options, the number of selected options is more than the final count for additive framing. For this particular service configuration, showing prices for the options had a positive effect on the number of chosen features in the final packages in both frames.

The highlight of this study is introducing Markov chain modeling in describing the basic 3-stage decision structure of option framing. It would be interesting to explore further applications of Markov chain models in other scenarios or types of option framing. Depending on how the options are presented, one can specify non-zero probabilities for other cells in the transition matrix, with appropriate modification of the data collection stages for option framing.

For future studies, a useful analysis is measuring and evaluating the joint occurrence of any two options using a Markov chain. *Which options are chosen along with some other option, and in what order? If option A is chosen, how often does it occur that option B is subsequently chosen?* Answers to these questions can serve as input for promotion strategy, given the link among options based on the final consumer choices. These joint occurences can be extended to larger subsets of options. For this type of analysis, one can start off with cross-tabulations and conditional probabilities. Markov chains can be used to describe the decision structure for specific combinations of options, beyond the current approach of solely considering the number of options in the final configuration.

The current set-up can be further extended to a sequential study. This involves extending the stages to inclusion of upgrades. A random sample of customers who have availed the vehicular service package is taken after a year, with the framing redesigned to ask the respondents about the changes they wish to make on their current package. One can modify the states of the finite Markov chain to capture the changes in the new final configuration.

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