Antecedents Factors that Influence Soy Consumption: A Structural Equation Modeling Approach

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Abstract

We propose a structural model of antecedent factors that affect the frequency of soy consumption. This model, suggests that soy-general knowledge influences perceptions about nutrition concern, health benefits of soy, soy related personal beliefs and personal attitudes toward soy. Health benefits of soy, in turn, impacts soy-related personal beliefs and personal attitudes toward soy. Additionally, soy-related personal beliefs influence personal attitudes toward soy. Finally, both nutrition concern and personal attitudes toward soy drive the frequency of soy consumption.

Elaborate tests with calibration and validation samples (derived from a large and nationally representative survey) provide robust empirical support for the proposed model. Implications for consumers and food industry are discussed.

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Introduction

Soyfoods have generated considerable media and public attention over the last decade. In October 1999, FDA authorized health claims on labels of certain foods containing soy protein. More specifically, this ruling extended to soyfoods containing at least 6.25 grams of soy protein per serving (FDA 1999). Scientific research indicates that soy protein included in a diet low in saturated fat and cholesterol may reduce the risk of coronary heart disease by lowering blood cholesterol levels. According to emedicine.com, coronary heart disease is a major cause of death and disability, and "claims more lives in the United States than the next 7 leading causes of death combined."

Despite this development, soyfood consumption has not reached its full potential. The research goal of this study is to propose and validate an elaborate structural model of antecedent factors that influence the frequency of soy consumption.

Exploratory Factor Analysis/Scale development for the model constructs

Research on the antecedent variables that influence soy food consumption remains largely unexplored. The prior literature may provide preliminary guidance on potential constructs that influence consumption, but well establish measurement scales to capture these constructs do not exist. Guided by the available literature and Churchill's (1979) paradigm to developing scale items, we assembled an initial set of 53 scale items to be included in our survey. Following Churchill's recommendation, these items were refined through iterative steps.

Next, we performed an exploratory factor analysis (EFA). An eight-factor solution that explained 66.65% of the total variance was obtained, after retaining factors with eigenvalues exceeding 1. These eight factors were respectively labeled as follows:

Soy general knowledge, Nutrition concern, Health benefits of Soy, Soy-related personal beliefs, Personal attitude toward Soy, Frequency of Soy consumption, Physical activity, and Fruit & Vegetable consumption. The first six constructs correspond to the model constructs in Model 1 (the last two constructs – Physical activity and Fruit & Vegetable consumption were not used in this study). The specific set of measurement or indicator items corresponding to each model construct is depicted in table 1. The reliabilities (Cronbach's alpha) of these constructs/factors were acceptably high -- ranging from 0.68 to 0.93 (see Table 1 for alpha values for specific constructs).

Model Development and Hypotheses

The proposed model (see Figure 1) suggests depicts the six constructs listed earlier. More specifically, it shows that soy-general knowledge influences perceptions about nutrition concern, health benefits of soy, soy related personal beliefs and personal attitudes toward soy. Health benefits of soy, in turn, impacts soy-related personal beliefs and personal attitudes toward soy. Additionally, soy-related personal beliefs influence personal attitudes toward soy. Finally, personal attitudes toward soy drive the frequency of soy consumption. The next sections discuss the rationales for advancing specific hypotheses.

Linking Soy General Health Knowledge to Health Benefits of Soy

The model identifies several antecedent factors and describes inter-relationships among these constructs. At the outset, soy general-health knowledge is linked to another construct labeled Health Benefits of Soy. Although the research on soyfood consumption is somewhat limited, prior research suggests that lack of knowledge about soy may act as major barriers to soy consumption (Wenrich & Cason 2004). Under the circumstances, individuals' awareness of health benefits of soy may be adversely affected. Conversely, consumers with high soy general health knowledge may have more positive perceptions about the health benefits of soy.

H1: Soy General Health Knowledge construct positively influences Health Benefits of Soy construct.

Linking Soy General Health Knowledge to Personal attitude toward Soy with Soy Related Personal Beliefs as an intervening variable

Generally, research suggests that soyfoods suffer from an image problem (Moon, Balasubramanian & Rimal 2005), especially in terms of perceptions about taste (Wansink, Westgren & Cheney 2005) and as a substitute food for individuals with certain types of food allergies (Schyver & Smith 2005). Wenrich & Cason (2004) conclude that education is a means to improve soyfood consumption. Moreover, Schyver & Smith (2005) report that two factors act as barriers to soy consumption: a lack of familiarity with the steps to prepare soyfoods, and perceptions that soyfoods are inadequate substitutes for animal-based foods, especially from a flavor perspective. Many of their participants did not know why soy was considered "healthful." Finally, Wansink (2003) found that using health claims on food packages strategically is an effective way to increase the believability of health claims. Taken together, these findings suggest causal links between soy general health knowledge, soy-related personal beliefs and personal attitude toward soy. We therefore posit:

H2: Soy general health knowledge impacts personal attitude toward soy directly.

H3: Soy general health knowledge impacts personal attitude toward soy indirectly (via the construct Soy-related Personal Beliefs).

Linking Soy Health Benefits of Soy to Personal attitude toward Soy

Scientific evidence (e.g., FDA-allowed health claims for soyfoods that satisfy the protein content criterion described earlier) and perceptions about soy (Fang, Tseng & Daly 2005) leverage specific health benefits of soy in order to change consumers' attitudes and behavior. Moorman & Matulich (1993) also posit that health motivation influences desirable behaviors. Following Wansink (2003), it is reasonable to argue that these two preceding constructs are related, in the context of this study, to health benefits of soy, soy-related personal beliefs, and personal attitude toward soy. Therefore, we propose that:

H4: Health benefits of Soy has a positive influence on Soy-related Personal Beliefs.

H5: Health benefits of Soy has a positive influence on Personal Attitudes toward Soy.

Linking Personal Attitudes Toward Soy with Frequency of Soy Consumption

Following the literature linking attitudes to behavivor in the spirit of Rah et al (2004), we hypothesize a direct positive link between Personal Attitudes toward Soy and Frequency of Soy Consumption.

H6: Personal Attitudes toward Soy has a positive influence on Frequency of Soy Consumption.

Linking Soy General Health Knowledge to Nutrition Concern, and Nutrition Concern to Frequency of Soy consumption

Wansink, Westgren & Cheney (2005) report that individuals' nutritional knowledge level was related to their soy consumption. Others (e.g., Wenrich & Cason

2004) have suggested that a lack of soy knowledge may adversely affect soy consumption. At a more general level, researchers (e.g., Balasubramanian and Cole 2002) have observed that concern about nutrition may influence healthful behaviors. As previously noted, Moorman & Matulich (1993) acknowledge the critical role of health motivation (a factor closely related to nutrition concern construct) in stimulating desirable behaviors from a health perspective. In the spirit of these cited studies, we propose a positive causal link between Soy General Health Knowledge and Nutrition Concern, and another positive causal link between Nutrition Concern and Frequency of Soy Consumption.

H7: Soy General Health Knowledge has a positive influence on Nutrition Concern.

H8: Nutrition Concern has a positive influence on Frequency of Soy Consumption.

Research Approach

As previously stated, the proposed hypotheses (and its related theoretical rationales supported in previous research) are expressed in the network of inter-relationships among model constructs depicted in Figure 1. We empirically validated this model using the Structural Equation Modeling (SEM) approach.

The SEM research method is especially useful when the researcher's focus is on a set of relationships between one or more independent variables, either continuous or discrete, and one or more dependent variables, either continuous or discrete (Tabachnik and Fidell 2001). Any given relationship between a pair of latent constructs included in a SEM model should have strong theoretical support. The model assumes that each relationship has a linear character. Typically, many such relationships are embedded in a

SEM model that, when taken together, constitute a complex network of inter-relationships among the latent constructs included in the SEM model.

A critical component of SEM analysis is the development of a structural model that reflects inter-relationships among model constructs that are compatible with findings in prior research. This specification draws on strong prior theory, so this process is confirmatory. The model is then estimated, evaluated, and perhaps modified. The researcher may wish to test the model, test specific hypotheses within the model, modify the model, or test a set of related models.

Typically, SEM applications employ a two-step approach to model estimation. The first develops and estimates the measurement model, where the ability of a given set of items to capture or measure a specific latent construct is systematically assessed. A confirmatory factor analysis is conducted. The second involves specifying and estimating the structural model.

To estimate a model, the maximum likelihood (ML) approach is often used to evaluate how closely the correlation/covariance matrix **C** for a set of trial values reflects observed data. Following the notations in Bollen (19890 and McArdle and McDonald (1984), the **C** matrix is given by:

(1) $$\mathbf{C} = \mathbf{F}\,(\mathbf{I}\text{-}\mathbf{A})^{-1}\,\mathbf{S}\,(\mathbf{I}\text{-}\mathbf{A})^{-1'}\,\mathbf{F}'$$

where matrix A contains model paths, matrix S includes correlations (or covariances) and residual variances, and matrix F selects out the observed variables from the total set of model variables (Loehlin 1998). Various goodness-of-fit criteria are used to assess model performance. These criteria capture different approaches to weight the differences between the observed and implied covariance matrices. They are represented as:

(2) $(\mathbf{s}\text{-}\mathbf{c})' \ \mathbf{W} \ (\mathbf{s}\text{-}\mathbf{c})$

where **s** and **c** represent the elements of the observed and implied covariance matrices **S** and **C** that are arranged as vectors, and **W** is a weight matrix. In order to estimate the SEM model, the goal is to minimize the expression in (2) iteratively such that the matrix **C** as close as possible to matrix **S**. Assuming a multivariate normal distribution for the variables in SEM, expression (2) under maximum likelihood becomes:

(3) $\frac{1}{2} \ \mathrm{tr} \, [(\mathbf{S} - \mathbf{C}) \, \mathbf{C}^{-1}]^2$

where tr represents the trace of the matrix. Model fit is evaluated using traditional goodness-of-fit measures such as chi-square (computed by multiplying the maximum likelihood by N-1 at the point of best fit to get an approximately distributed chi-square), and other metrics such as the Akaike's Information Criterion (AIC), and the Root Mean Square Error of Approximation (RMSEA) criterion (see Loehlin 1998 for a detailed discussion of these indices).

Survey Data Collection

This study reports analysis of a large survey database derived from a nationally representative sample. The survey was designed to collect data on the model constructs depicted in Figure 1, using the measurement items listed in Table 1.

The survey was administered online by Ipsos-Observer in the summer of 2007 to a sample of 9000 US households. Appropriately stratified by geographic regions, income, education, and age to correspond to the 2000 U.S. Census, a sample of 9,000 households were drawn from an online panel that is representative of the U.S. population. A total of 3456 panel members returned completed online surveys, resulting in an impressive 38.4 % response rate.

Empirical Work with the Structural Model

A 60%-40% random split of database was used for model calibration and validation purposes, respectively. Using the calibration sample, we initially conducted a CFA of the measurement model. The Mardia's coefficient exceeded 3.0, indicating multivariate normality could not be assumed. We therefore used the Robust Maximum Likelihood approach to estimating both measurement and structural models in all subsequent analyses. The CFA affirmed that all indicator items were related as expected i.e., they were linked only to the corresponding latent construct, and not with other latent constructs. The fit statistics for the CFA were acceptable: CFI = 0.926 and RMSEA = 0.041.

We then estimated the structural model for the calibration sample. The magnitude, sign and statistical significance of the path coefficients indicated that all nine model hypotheses were supported. The overall fit statistics for this structural model were acceptable: CFI = 0.922 and RMSEA = 0.042.

Moving to the validation sample, we conducted another CFA on this sample. Results affirm the conclusions from the prior CFA that all indicator items behaved as expected. The corresponding fit statistics were acceptable: CFI = 0.928 and RMSEA = 0.042.

Finally, using the coefficient estimates from the structural model for the calibration sample, we fit our structural model on the validation sample. The overall fit statistics for this model were also acceptable: CFI = 0.926 and RMSEA = 0.042.

Discussion and Conclusion

Methodologically, it is important to consider the sign and statistical significance of each path coefficient in the estimated structural model. As Figure 2 shows, all model paths or hypotheses in the estimated structural model have the right sign (i.e., direction and nature of influence), and are statistically significant. This is an important result in that it underscores empirical support for all the theoretical relationships incorporated into the model. While exploring the potential for improving model fit, we followed Byrne's (2006) approach to incorporate links between specific pairs of error covariances for the indicator items shown in Figure 2. An examination of the indicator items corresponding to each of these pairs in Table 1 confirms that the structure of these measurement items are similar, thereby underscoring the appropriateness of this adjustment step.

Substantively, it is useful to focus on the implications stemming from the estimated results. Of the nine paths depicted in the model, one stands out with a negative directional influence i.e., the path from 'soy general knowledge' to 'soy-related personal beliefs.' This finding indicates that negative personal beliefs result despite the general knowledge of soy. An implication is that the soy industry has to devise new ways to improve perceptions that soy foods are good for consumers, and that they can be consumed by everyone. However, such general knowledge does engender positive perceptions of health benefits that in turn improve 'soy-related personal beliefs.' Consistent with the notion that nutrition-related knowledge heightens nutrition-related concerns, the model estimation process suggested the addition of a new path from 'soy-general knowledge' to 'nutrition concern.' As predicted, both 'soy general knowledge' and 'health benefits of soy' constructs influenced 'Personal attitude toward soy,' both directly and indirectly. Given that soy foods suffer widely from negative perceptions (poor taste, poor texture etc), the industry has to combat these perceptions that drive soy-related attitudes by strengthening the links from 'health benefits of soy' to 'personal attitude toward soy.' Finally, the presence of direct link from 'nutrition concern' to 'frequency of soy consumption' underscores that it may be useful to pursue a segment of 'nutrition-concerned' consumers in order to promote soy food consumption. It remains an empirical issue whether this segment is distinct from the segment that consumes soy primarily because of the health benefits afforded by soy.

Table 1. Model Constructs, Related Measurement Items, and Reliability Information.

1. Soy General-Health Knowledge (Cronbach's alpha = 0.862)

Respondents answered the first three items below using this scale: 1=Disagree strongly; 2=Disagree somewhat; 3=Neither agree nor disagree; 4=Agree somewhat; 5=Agree strongly

SGHK1. I am aware of the term 'isoflavone'
SGHK2. I am aware of health claims on soy-based food packages in grocery stores
SGHK3. I am aware that the FDA allows health claims for soy foods that satisfy certain criteria

2. Nutrition Concern (Cronbach's alpha = 0.930)

Respondents answered the items below using this scale: 1=Not at all; 2=Slightly; 3=Somewhat; 4=Very well; 5=Extremely well

NC1. I am actively trying to consume less cholesterol in my diet
NC2. I am actively trying to consume less fat in my diet
NC3. I have changed my diet in the past to reduce the risk of certain diseases
NC4. I eat a well balanced diet that is low in cholesterol
NC5. I eat a well balanced diet that is low in fat
NC6. I eat a well balanced diet that is low in sodium
NC7. I am concerned about the amount of salt in my diet
NC8. I am concerned about linkages between diet and chronic diseases
NC9. I am concerned about nutrition
NC10. I read nutritional labels on food packages very carefully
NC11. I try to prevent health problems before I feel any symptoms

3. Health Benefits of Soy (Cronbach's alpha = 0.904)

Respondents answered the items below using this scale: 1=Disagree strongly; 2=Disagree somewhat; 3=Neither agree nor disagree; 4=Agree somewhat; 5=Agree strongly

HBS1. Soy may lower cholesterol level in your blood
HBS2. Soy may act as an antioxidant
HBS3. Soy may help retain bone mass, thereby reducing the risk of osteoporosis
HBS4. Soy may be good for menopause or other female diseases
HBS5. Soy may replace milk products
HBS6. Soy may replace meat products

Table 1 continued…..

4. Soy-related Personal Beliefs (Cronbach's alpha = 0.820)

Respondents answered the items below using this scale: 1=Not at all; 2=Slightly; 3=Somewhat; 4=Very well; 5=Extremely well (Note: items marked * were reverse-coded such that higher values indicate more positive soy-related personal beliefs)

*SPB1. Soy-based foods pose health risks to me
*SPB2. Soy-based foods are not good for me
*SPB3. Soy-based foods are unnatural
*SPB4. Only vegetarians eat soy-based foods
*SPB5. Food products made from genetically engineered soybeans present health risks

5. Personal Attitude toward Soy (Cronbach's alpha = 0.893)

Respondents answered the items below using this scale: 1=Disagree strongly; 2=Disagree somewhat; 3=Neither agree nor disagree; 4=Agree somewhat; 5=Agree strongly

PAS1. I like the texture of soy-based foods
PAS2. I like the taste of soy-based foods
PAS3. I have a favorable attitude toward soy-based foods
PAS4. Soy-based foods are convenient to cook
PAS5. Soy-based foods are convenient to eat
PAS6. I know how to prepare soy-based foods

6. Frequency of Soy Consumption (Cronbach's alpha = 0.816)

Please indicate how many times per month you consume each of these soy-based foods.
1= 0 times per month; 2=1 time per month; 3=2 times per month;
4=3 times per month; 5=4 times per month; 6=5 times per month;
7=6 times per month; 8=7 times per month; 9=8 times per month;
10=9 times per month; 11=10 times or over per month.

FSC1. Meat substitutes
FSC2. Soy hot dogs
FSC3. Soy veggie burgers
FSC4. Soy cheese

Figure 1. Proposed model –Antecedent Factors for Frequency of Soy consumption.

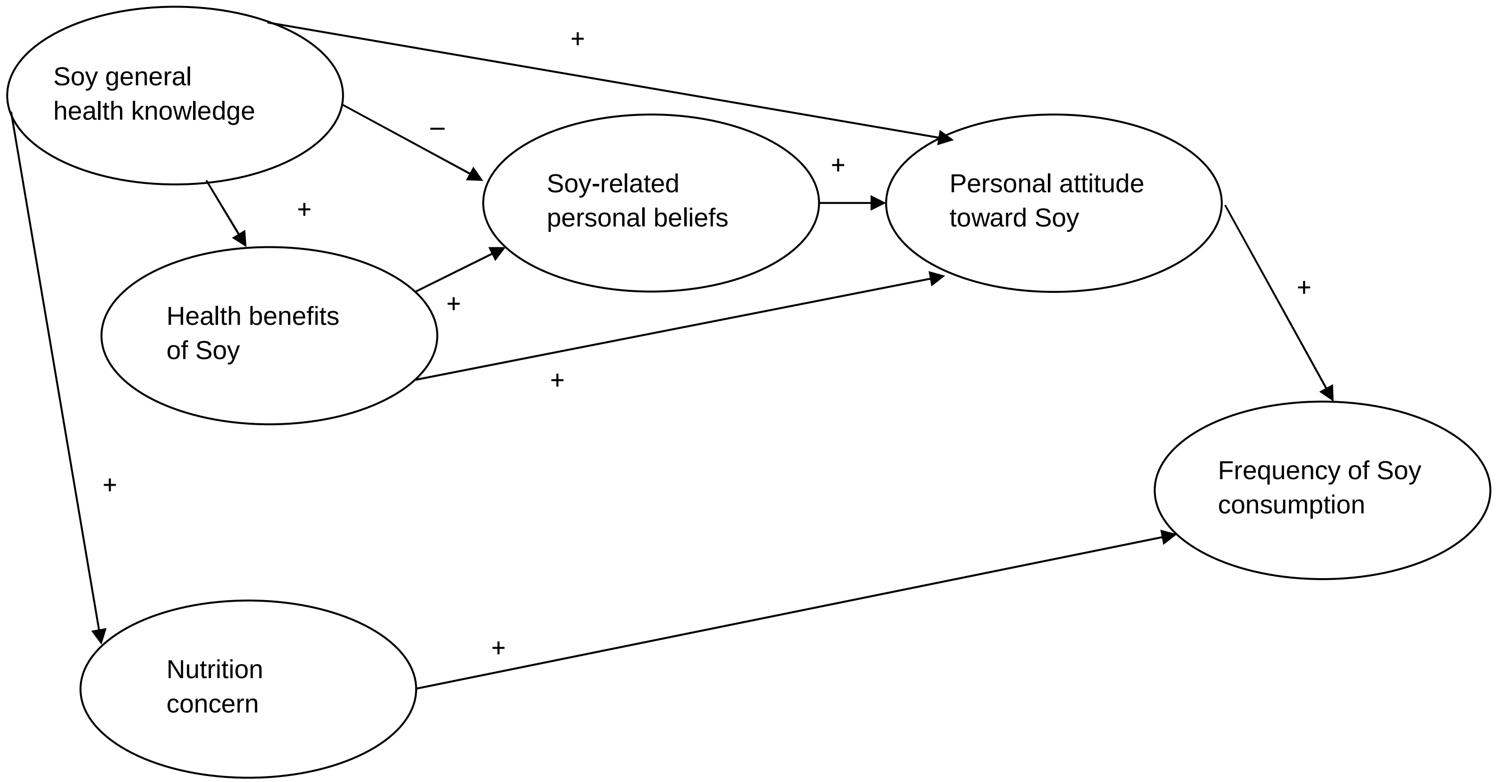
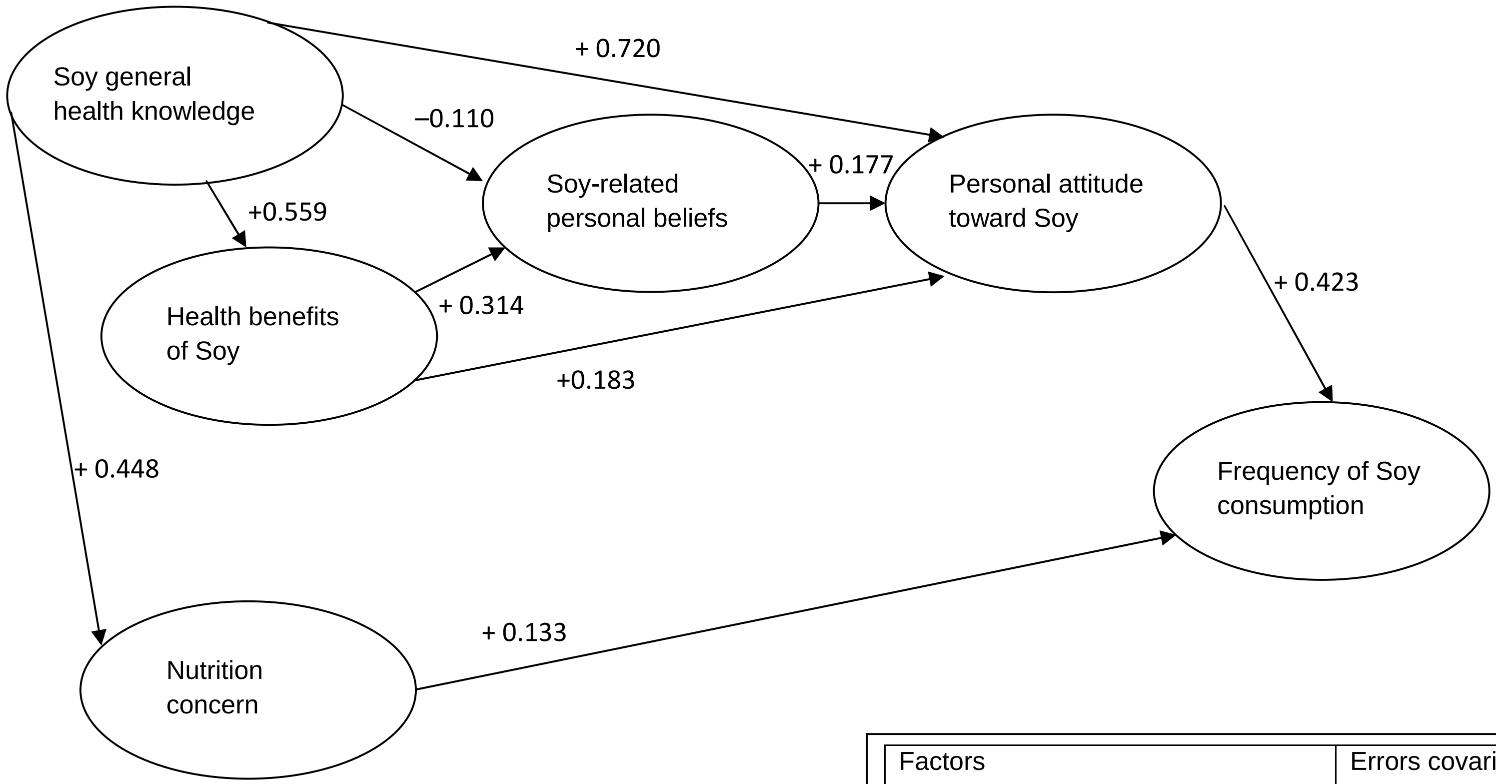


Figure 2. Final model with path coefficients – Antecedent Factors for Frequency of Soy consumption.



Note. All paths significant at the 0.05 level.

Factors	Errors covariances	
Soy General Knowledge	-	
Health Benefits of Soy	HBS6,HBS5	
Nutrition concern	NC5,NC4	NC2,NC1
Soy-related personal beliefs		
Personal attitude toward Soy	PAS2,PAS1	PAS5,PAS4
Frequency of Soy consumption	FSC1,FSC4	

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