Management of Household Expenditure by Using Value Decomposition Technique

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Abstract

The aim of the paper is to provide the financial decision making mechanisms used by households for management their expenditure with the mathematical proof enabling quantitative evaluation of purchase alternatives through vector decomposition of the aggregate value of goods and/or services. The match between the properties of goods purchased and the specific consumers’ needs represented by the vector of his preferences is expressed by comparing spatial orientation of the two vectors in “n” dimensional space, where “n” is a number of non-substitute value components important for the consumer. A method for calculation of spatial angle between the vectors is presented for the 3-dimensional space.

Keywords: household expenditure management, household economics, aggregate value, vector decomposition.

Introduction

Expenditure planning and management is one of key elements in household economics (Medova et. al. 2008). By efficiently planning and managing its expenditure a household can achieve maximum utility and successfully implement life-long wealth building plans and vice-versa. The flow of household-related expenditure in Lithuania makes approximately 2/3 of country’s GDP (Ministry of Finance of the Republic of Lithuania, 2014), therefore its influence on economics is huge on both micro and macro levels.

Currently any good or service purchased by the household is usually estimated based on its aggregate value. A deeper look at the aggregate value shows that it is usually composed of a bunch of virtual components, each capable of satisfying different consumers’ needs, e.g. in accordance with the levels present in Maslow’s pyramid of needs: physiological (basic), safety, belonging, esteem and self-actualization. The more needs a good or service addresses, the higher its aggregate value and so is the price. For example, nutrition provides a human being with the calories, needed to compensate the burnt ones as well as with microelements and vitamins needed for the body. Many alternatives exist for satisfying nutrition needs- from purchasing basic products on the market till having meals in an expensive restaurant. The price for the same amount of calories produced by same basic food products in both cases may differ dramatically only meaning that restaurant would provide additional value components and charge with extra price accordingly. Additional value and its price in some cases can be dozens and even hundreds of times higher than its basic value and the price. That’s why it is important for a rational consumer to analyze the value components of goods/services in order to realize if he will get the right product and pay for it the right price.

The aim of this paper is to provide the financial decision making mechanisms applied by households when satisfying their needs with the mathematical proof enabling quantitative evaluation of alternatives through decomposition of aggregate value of the good and/or service purchased.
Expenditure management is closely related to other processes within household economics. Numerous economic theories have been developed to handle various issues within consumers’ behavior and are relevant to the expenditure management too.

**Overview of Related Theories**

Households are important integral part of economic system of every country, therefore the processes related to households’ finances are permanently in focus of numerous scientists (Campbell, 2006; Altfest, 2009; Vahidov and He, 2009; Abreu and Mendes, 2010; Hite et. al., 2011; Finke and Smith, 2012; Almenberg and Gerdes, 2012; Carlin and Robinson, 2012; Bosshardt and Walstad, 2014) and institutions, such as: Consumer Federation of America (2012), Certified Financial Planner Board of Standards (2012), Members Equity Bank (2013), International Monetary Fund (2013), Wealth Management Institute (2015), Princeton Survey Research Associates International (2015).

There are many theories that analyse the processes related to consumption and household economics: 1) Ernst Engel (1897) - an investigation about the reliance on income level and expenditure composition in households (Chai and Moneta, 2008) 2) Hazel Kyrk (1920) - incorporating the insights of economics into the field of home economics (Beller and Kiss, 1999). 3) Frank P. Ramsey (1928) - one of the pioneers in formation of consumer theories (Duarte, P. G.). 4) Margaret Reid (1934) - one of the pioneers in investigating household behavior related to consumption decisions (Hira, 2009). 5) John M. Keynes (1936) - absolute income hypothesis. Consumption depends only on current income level (Baranzini, 2005). 6) Paul Samuelson (1938) - Revealed preference approach, a method by which one can discern a consumer's utility function, by observing their behavior. 7) Abraham Maslow (1943) - Maslow’s Hierarchy of Needs. People are motivated to achieve certain needs. When one need is fulfilled a person seeks to fulfill the next one, and so on. It includes five motivational levels of needs, often depicted as hierarchical levels within a pyramid. 8) Herbert Simon (1947) - investigation on how individuals make financial decisions. Suggested that the decision maker possessed limited knowledge and did not always seek the best potential choice because of limited resources and personal inclinations. 9) Franco Modigliani, Richard Brumberg, Albert Ando (1950) - the life-cycle theory of consumption and savings. Consumption depends not only on current income level, but also on future changes. Consumption must be balanced and equal throughout the all life-long period of time. 10) Milton Friedman (1957) - permanent income hypothesis. Consumption depends on permanent income. 11) Garry Becker (1960) - he put the family on the economics profession's research agenda. Best known for modeling household's decisions and resource allocation, while considering the household both a producing and consuming unit. 12) R. E. Hall (1978) - rational expectations permanent income hypothesis, where consumption is described as random wandering (Runkle, 1991). 13) Consumer theory – it is concerned with how a rational consumer makes consumption decisions. It’s a study on how people decide what to spend their money for on given their preferences and budget constraints. The idea is that the consumer chooses a vector of goods \( x = (x_1, ..., x_n) \) to maximize his utility subject to a budget constraint that says he cannot spend more than his total wealth (Levin and Milgrom, 2004). 14) Rational Choice Theory - People make consumption choices so as to maximize their happiness, or utility. It mandates just a consistent ranking of the alternatives (Blume and Easley, 2008). Individuals choose the best action according to their personal preferences and the constraints facing them. Rational choice theorists do not claim that the theory describes the choice process, but rather that it predicts the outcome and pattern of choices (Levin and Milgrom, 2004). 15) Behavioral Finance Theory - is the study of the influence of psychology on the behaviour of financial practitioners and the subsequent effect on markets (Investopedia). 16) Utilitarianism - the greatest good could be achieved by bringing the most happiness to the largest number. The theory is very similar to Rational Choice Theory, in fact both describe happiness as measurable in units - called Utils. (Rosen, 2003). 17) Value Theory - Studies the structure of financial decisions, analyzes the influence of prices, and examines the efficiency of the resulting allocation of resources (Baumol, 2015).
Performed analysis shows that despite of huge efforts put into research of financial decision making processes in households and numerous theories developed, the decisions made by households in real life almost totally depend on human psychology and the personalized, mood-based instantaneous motives. The lack of objective quantitative criteria while making financial decisions, first of all those related to everyday spending, often leads to unbalanced allocation of resources and results in either excessive spending or irrational restriction of consumption, or the mixture of both. Neither is desirable, therefore any possibility to make the household’s expenditure management process more transparent and efficient would benefit to improvement of the household’s wealth with no need for increased resources.

Value decomposition.

Suppose that an aggregate value vector V of the good or service is composed of virtual value vectors Vn:

\[ V = \sum_{n}^{N} V_n \]  

(1)

where “n” is a number of preference axis, representing the components of consumers’ needs.

The market price of good/service Pm is directly related to its aggregate value V, i.e.

\[ P_m = V \]  

(2)

It has been proved in [15th International Conference „Perspectives of Business and Entrepreneurship Development“] that the aggregate value of goods and services V is always higher than the utility U brought by them to the consumer unless vectors V and U are collinear. The latter case means equality between vectors V and U and maximum available utility U from the aggregate value V as only in this case the value vector V contains components, which exactly match the consumers’ needs in terms of both the content and the required proportions between them in reference to the axis representing the consumers’ preferences. The worst case is when angle between the two vectors is becoming close to 90º, meaning that consumers’ utility from the purchase makes only a tiny fraction from the aggregate value and turns 0, when angle is equal to 90º. Therefore, it is important for the rational consumer to always know about how the vectors V and consumers’ preference vector Up are mutually oriented in the “n” dimensional space of preferences. An angle φ between the two vectors in the case of n=3, can be calculated in the following way.

Let’s say the consumers’ preference vector

\[ U_p = \lambda \times \vec{p} + \mu \times \vec{c} + \nu \times \vec{f} \]  

(3)

Note. Utility vector U is a projection of vector V on the vector of preferences Up.

Value vector \( \vec{V} \) and utility preference vector \( \vec{U}_p \) make an angle \( \varphi \). If \( \varphi = 0° \), than vectors \( \vec{V} \) and \( \vec{U}_p \) are collinear, which means aggregate value of the good or service is composed exactly in a way customer prefers.

Calculating \( \varphi \):

\[ \vec{U}_p \cdot \vec{V} = \|\vec{U}_p\| \|\vec{V}\| \cos \varphi \]  

(4)

If \( \|\vec{U}_p\| = \|\vec{V}\| = 1 \), we get:

\[ \vec{U}_p \cdot \vec{V} = U_{px}V_x + U_{py}V_y + U_{pz}V_z = \lambda * b * V_x + \mu * c * V_y + \nu * p * V_z = \lambda * V_x + \mu * V_y + \nu * V_z \]  

(5)
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According to (4):

\[ |D_p| = \sqrt{(b \cdot \lambda + c \cdot \mu + e \cdot \nu)^2 + (c \cdot \lambda + d \cdot \mu + e \cdot \nu)^2 + (e \cdot \lambda + d \cdot \mu + e \cdot \nu)^2} \]  \hspace{1cm} (6)

\[ \cos \Psi = \frac{\lambda \cdot v_0 + \mu \cdot v_1 + \nu \cdot v_2}{|D_p| \cdot |P|} \]  \hspace{1cm} (7)

\[ \Psi = \arccos \left( \frac{\lambda \cdot v_0 + \mu \cdot v_1 + \nu \cdot v_2}{|D_p| \cdot |P|} \right) \]  \hspace{1cm} (8)

Conclusions

1. The theories and methods currently used for management of household expenditure are using aggregate value and the corresponding price of goods and services as a base for making financial decisions related to satisfying the households needs.

2. The offered vectoral decomposition of the aggregate value of goods/services and the consumers’ preferences enables establishing of relationship between the selected good/service and the specific consumers’ needs as well as the estimation of their match by calculating a spatial angle between the two vectors.

3. A method for calculation of spatial angle between the vectors of aggregate value and the consumer preferences has been presented.

Selected References


