Journal of Behavioral Economics for Policy, Vol. 2, No. 2, 25-29, 2018

Quantifying satisfaction with regard to preferences – A spatial model

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Abstract
Each monetary decision that any individual partakes in involves a level of satisfaction that has been derived from the same. The primary goal of this paper is to create and implement a model that allows for the quantification of that very satisfaction that an individual may experience when a monetary based decision has been made. Such a decision could vary from buying an apple to donating some money to a juggler on the street. The model created here is set on a number of qualitative and quantitative assumptions which display an individual's movement through an economic space that is filled with infinite preferences to choose from. The movement of the individual is based on the satisfaction that is derived from engaging in a finite set of preferences which when looked at, represents a wave. To successfully quantify and capture the amount of satisfaction that the individual is experiencing from a certain monetary decision, a sine wave equation has been used (equating the mathematical parameters to behavioural ones) to come to a fixed value which is known as the satisfaction numerical (Sn). The basis of assuming the individual to be an economic entity and using the principles of physics to understand behaviour is inspired from Asghar Qadir's paper "Quantum Economics" published in 1978 (ASGHAR QADIR, 1978).

JEL Classification: C0; D01; D11; D12; D90

Keywords
bounded rationality — consumer satisfaction — revealed preference — nudge effects — utility theory

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Introduction

Ever since the advent of utility theory (Staff, 2003), behavioural economists have attempted to quantify the idea of satisfaction or happiness when consumers make consumerist decisions. This model is one of the many attempts at doing so by using the principle of understanding the individual to be a point moving along a three-dimensional space filled with infinite preferences.

Consider a buy-and-sell market place wherein an individual is at the entrance. The individual has several different stalls to choose from but will only go to the ones that he/she needs to go to. As the individual moves from stall to stall, buying items and possibly selling old ones, the individual naturally experiences several amounts of satisfaction with each monetary decision being completed. Naturally, the only "directions" that the levels of satisfaction can go are up and down, therefore, we can safely conclude that the individual faces varying levels of satisfaction which move in an oscillating up-down motion.

These levels of satisfaction can be depicted in the form of a wave.

As seen in Figure 1, the satisfaction levels move between up and down as the individual continues to satisfy preferences

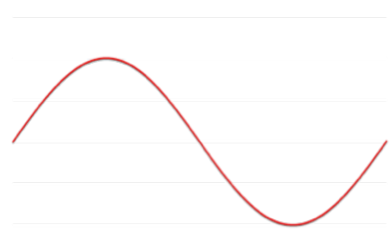

Figure 1. Wave formation

(positive or negative)[1]. The model that is being created in the heart of this paper takes this fundamental assumption and creates an economic space wherein an individual is a point moving in the aforementioned wave formation of satisfaction levels. Once this is definite, using the equation, the amount of satisfaction one is experiencing at a certain point on the wave can be determined. The next section of the paper looks at the list of assumptions that make such a model possible.

[1] Positive preferences are defined as those preferences that a consumer would willingly take up and would not cause harm or duress to the consumer. Negative preferences are those preferences that a consumer would not choose to take up immediately and would either have to forced, coerced or put into a situation wherein taking up that preference was the only option available. These types of preferences could cause duress.

The model

1. The space that is being defined in this model is a three-dimensional economic space that is filled with infinite preferences and choices for an individual to make. The three dimensions of this space are the three axioms of bounded rationality –time limitations to make a decision, cognitive limitations of the individual and finally, information limitations that the individual faces (Simon, 1982). These form the boundaries of this space as it is only within these three boundaries that an individual may make successful decisions.

2. As described in the introduction, the individual forms a wave pattern as he/she moves through the finite preferences, experiencing different levels of satisfaction. This wave pattern strongly resembles a sine wave ("Sinusoid - Encyclopedia of Mathematics", n.d.).

3. The individual satisfies several preferences one after the other beginning from a point of being dormant, till the individual is dormant once more.

4. A new wave pattern will come about when the individual steps out of the state of being dormant.

These assumptions form the basic qualitative framework for the functioning of the model. However, for the model to display empirical validity, the following assumptions have to be made through a quantitative perspective.

1. A sine wave is being used to mathematically represent the various levels of satisfaction because:

   (a) They begin from the point (0,0) indicating a state of being dormant.

   (b) They are smooth oscillating waves, which are continuous in nature, representing the continuous nature of experiencing different levels of satisfaction.

2. The amplitude (A) of the wave can be defined as the willingness to pay of the individual when making monetary decisions. This is more of a limit on how much the individual will decide to spend (during the entirety of the life of one wave movement) on monetary transactions than an income limitation or "budget". This can be measured in the form of currency.

3. The wavelength (λ/L) can be defined as the 'cognitive distance' between one point of the highest level of satisfaction to another. This can be measured in a metric known as cognitive meters or (cme).

4. (x) is the position of the individual in the 3D space of preferences from the point of origin. This can be measured in meters.

5. The period (T) of the wave can be defined as the 'cognitive time' that the individual requires to cover the 'cognitive distance'. This can be measured in seconds.

6. (t) is the amount of time the consumer has passed in the 3D space of preferences from the time he/she has moved from the point of being dormant. This can be measured in seconds.

Now that the parameters have been equated to the behavioural prerequisites of making a decision, a few side notes are required:

a. The cognitive distance and cognitive time are fixed in the life of one wave. Consider an individual who experiences the highest level of satisfaction at 5Sn. For this individual to experience the exact same amount of satisfaction, (for such a unique experience to replicate itself), a certain amount of time must pass and a certain amount of distance must be covered. This time and distance are naturally fixed, since any extra time/distance or any less time/distance will not create the same experience of satisfaction, much less mathematically. Both amounts however might change from wave to wave and even more so, from person to person.

b. One may observe that to reach one point of satisfaction on the wave, the individual does not necessarily have to travel through the highest or the lowest level to reach a point that is possibly on the next cycle. However, satisfaction is sometimes misinterpreted as happiness or pleasure and a low level of satisfaction is misunderstood as being sad or depressed. It is due to this, that the first observation maybe made. Nonetheless, since satisfaction is purely based off of the amount of productivity that the decision derives for the individual, the "lowest low" or the "highest high" of the satisfaction wave do not have to necessarily "feel" that way. The individual will experience the satisfaction dips and climbs to reach that point on the next cycle, but it will not be necessarily expressed in the form of extreme changes in the individual's feelings.

Now that the assumptions that the model rests on have been articulated, the next part of this paper discusses the equation, how it can be applied and the results of the same.

Calculations and results

The equation that has been so thoroughly discussed over the course of this paper is as follows:

$$Y(x,t) = A \cdot sin(2\pi x/\lambda \pm 2\pi t/T) \tag{1}$$

A few points about the equation must be made:

i. 2 is the period of the sine function which equates to the number of radians in a circle.

ii. The equation's sign depends on the type of preferences that the individual is assumed to be engaging. For positive preferences, a + sign is used and for negative, a - is used. These equate to the individual moving towards the right from the origin and towards the left, respectively.

iii. In wave physics however, the sign depicts the direction in which a wave would move. However, in this case the wave is only formed with the direction in which the individual moves.

iv. The satisfaction numerical calculated can only fall between the amplitude and its negative limit. When the Sn value hits the amplitude's value it represents that the individual is deriving the maximum amount of satisfaction given the parameters. When the Sn value hits the negative limit, it represents the least amount of satisfaction that can be derived with the set parameters.

To put the equation to the test, two hypothetical scenarios are drawn up:

1. *When the individual is engaging in positive preferences:*

   An individual wishes to buy an ice cream cone, her favourite –chocolate. To calculate how much satisfaction, she is deriving from buying this cone, the following parameters need to be taken into consideration:

   The maximum amount she is willing to pay - $2, the point in time that she made the decision – 5.8s, the amount of distance she covered physically – 5.4m, the cognitive time – 3.2s and finally, the cognitive distance – 3.3m. By mathematically calculating the value, the individual is experiencing a satisfaction amount of **0.63Sn**. This can be seen in Figure 2.

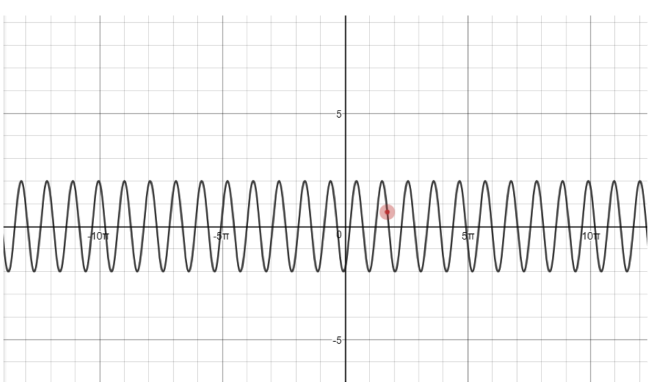

Figure 2. Individual satisfying positive preferences

2. *When the individual is engaging in negative preferences:*

   An individual is ill and has to travel in the heat to work in the steel factory during the summer. The individual has paid for the ticket. The parameter values here are kept the same, and the satisfaction numerical has been calculated at: **-1.78Sn**. This can be seen in Figure 3 –the point at which the individual has bought the ticket.

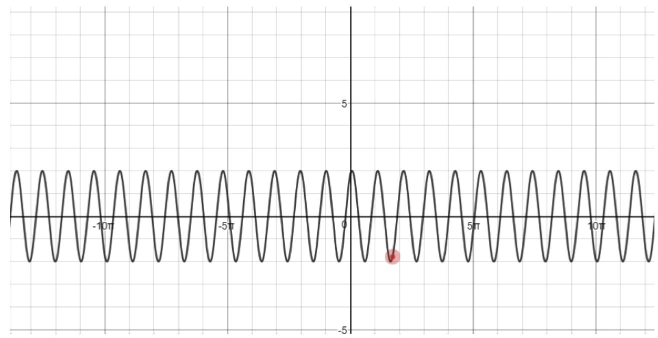

Figure 3. Individual satisfying negative preferences

The above simulation was created through a Desmos wave simulator ("Trigonometry", n.d.). The difference between the two calculations lies in the sign that has been used within the equation –a plus sign for the first and a minus for the second.

Discussions and further applications

The model described above faces a few limitations, including:

1. The cognitive distance, and the cognitive time are assumptive values. None of these can be accurately quantified yet but can be assumed to a point.

2. The model does not account for cognitive costs that one may incur in making non-monetary decisions.

3. The model is fairly rudimentary and requires development through trial on larger scales of people and institutions.

The findings of this paper can be applied in two broad areas:

1. *Consumer/producer markets:*

This model can be used to quantify satisfaction in various ways. For example: if a restaurant wishes to know how much satisfaction a customer has experienced after consuming a meal, the values for the parameters can be estimated on survey results and then a calculation can be made using the equation as a framework for a software algorithm. This may also apply in deriving the satisfaction one might attain from watching a movie or engaging in a TV Show. The further development of this equation and the parameters of it can vastly change the customer relationship management (CRM) industry by allowing corporates to explore consumer minds to understand and quantify how much satisfaction they would've gained or lost from consuming a certain product.

2. *Policy making and the public sector:*

The model and its results can also aid in the formation of policy. For example: one of the most common monetary decisions that people make by rule of law, is the payment of taxes. Although this does not involve any buying or selling of a commodity, this is still considered a monetary transaction or activity, allowing the model to calculate how much satisfaction one can derive from paying one's taxes. Naturally, a large proportion of people aren't quite satisfied with paying taxes (Comoreanu, n.d.) as it means that a cut out of their hard earned money goes to the government. Moreover, it is a longstanding belief within the population that it is ambiguous as to where taxpayer money really goes as equivalent results are not always observed when money is paid, or that tax brackets are too high for the lower rungs of the population.

In light of this, governments and public officials can apply the model to understand how much satisfaction (or lack thereof) an individual derives from engaging in such a monetary activity. This opens up opportunities for governments and other public sector bodies such as the Nudge Unit in the United Kingdom for example, to influence people in deriving greater satisfaction in paying taxes or when indulging in any such monetary transaction. By using satisfaction derived as a base, policy makers could provide incentives/benefits through reward systems (social credit for example) to push people towards paying their taxes so as to avoid a default. This augments the amount of satisfaction that is derived when such a monetary activity is partaken in. To better understand this, let us take a look at Game 1.

Game 1

As seen in Figure 4, in this game an individual derives -5Sn when paying her taxes (a negative preference). The government observes this as a trend among the female population of the country and decides to provide a credit-based system that gives women a large subsidy on sanitary napkins if they pay their taxes without a default. The awareness that such a credit system exists and the hope of receiving said credit increases the satisfaction derived from paying taxes without a default from -5Sn to 10Sn. In this manner, satisfaction derived from paying taxes not only increases but also changes the nature of the activity from a negative preference to a positive one. However, in case of a default it is likely that the satisfaction derived from paying taxes is -5Sn as the individual is now aware that she will not receive the credit that subsidizes the sanitary napkins.

It has already been seen in literature (August, n.d., p. 27) that public sector bodies tend to influence behaviour of citizens via nudge effects - behaviour in this context refers to people signing up for organ donations, expecting mothers quitting their smoking habits and people donating to charities.

Implementing the findings of this model would result in the derivation of the satisfaction that people experience from engaging in positive preferences (such as donating to charities). This type of behaviour can be greatly encouraged by assessing ways and means to increase the satisfaction that individuals derive from activities such as donation. To better understand this, let us take a look at Game 2.

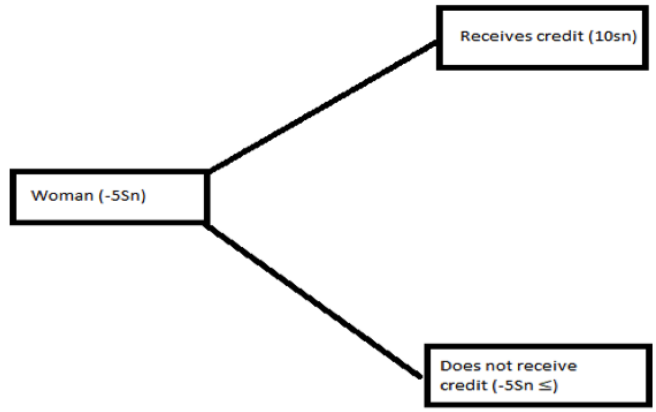

Figure 4. Increase/decrease in base satisfaction due to increase/decrease in receival of sanitary credit

Game 2

In this setting, an individual is deriving 15Sn from donating to the Mill and Belinda Yates Foundation (a government run fictional charity). By implementing a tax-break system in this instance, donors would receive a tax-break for themselves if they donated. The more the donors would give, the higher their tax-break. If the amount they donate is greater than the amount they paid last time, they would receive a higher tax-break. If the amount is lesser than the previous donation, the tax-break would lessen. If the amount remains the same, the tax-break remains neutral.

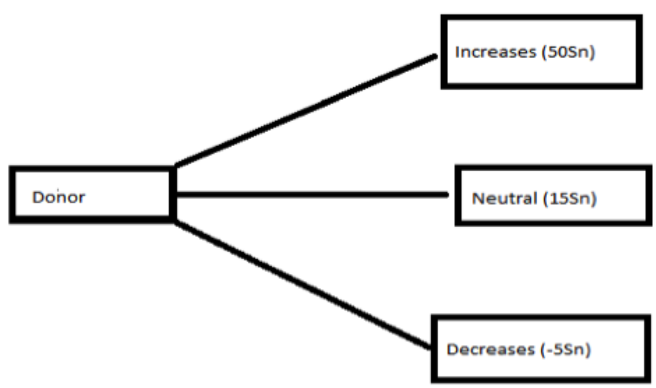

Figure 5. Increase/decrease in satisfaction due to increase/decrease in donation

As seen in Figure 5, the initial amount the donor gives derives a satisfaction level of 15Sn. If the donor increases their donation amount (thereby receiving a higher tax-break), they would end up increasing their satisfaction derived from donating, to 50Sn. If the donor decreases their donation amount (thereby receiving a lower tax break), they would end up decreasing their satisfaction derived from donating, to -5Sn (it can be seen here that decreasing the donation amount and thereby receiving a lower tax-break is a negative preference).

Due to this tax-break system, donation to charities is increased (as people would naturally prefer a higher tax-break) and receiving a higher tax-break due to the larger donation results in a greater level of satisfaction for the donor.

Policy makers can therefore employ the model to understand base satisfaction and how to decrease it (if individuals partake in activities that have negative effects on society) or increase it (if individuals partake in activities that have positive implications on society) –as left to the discretion of the government/policy maker.

Conclusion

The quantitative model described in this paper amalgamates several factors and aspects that are intrinsic to human behaviour and the basic decision-making process in the hope to quantify the satisfaction that an individual derives. The satisfaction unit created for this model is known as the satisfaction numerical (Sn). Although the framework of the model solely considers monetary transactions, activities and behaviour, it exhibits empirical validity when run in simulated environment and games but will face certain obstacles when tested in real-time.

The prospective applications of the model are in multitude and are not restricted to the private sector; the greater percentage of these applications lie within the policy making and social change sphere. The paper displays applications within the private sector through the Desmos wave simulator thereby exhibiting how satisfaction can be derived within the economic space on the wave formation. To show how the public sector can benefit from the model, two games are played wherein an individual is engaging in a negative preference and is then nudged by a credit-based system to pay her taxes, therefore increasing satisfaction simultaneously and wherein an individual is a charity donor and a tax-break ladder system encourages altruistic behaviour.

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