Review of European Studies; Vol. 9, No. 1; 2017
ISSN 1918-7173 E-ISSN 1918-7181
Published by Canadian Center of Science and Education

Holding Cash and Spontaneous Behavior: A Modification of the Baumol Equation

Limor D. Gonen[1], Michal Weber[2,3], Tchai Tavor[4] & Uriel Spiegel[3,5]

[1] Department of Economics and Business Administration, Ariel University, Ariel, Israel

[2] Faculty of Business Administration, Ono Academic College, Kiriat Ono, Israel

[3] Department of Management, Bar-Ilan University, Ramat Gan, Israel

[4] Department of Economics and Management, Yezreel Valley College, Yezreel Valley, Israel

[5] Department of Economics, University of Pennsylvania, Philadelphia, USA

Correspondence: Limor D. Gonen, Department of Economics and Business Administration, Ariel University, Ariel, Israel. Tel: 97-254-234-6782. E-mail: limord.gonen@gmail.com

Received: September 6, 2016 Accepted: September 18, 2016 Online Published: February 12, 2017

doi:10.5539/res.v9n1p209 URL: http://dx.doi.org/10.5539/res.v9n1p209

Abstract

During the decades following the presentation of the original Baumol equation (1952) the role of holding cash was significantly changed. The original Baumol equation considered the two elements of (i) the value of transactions, positively affecting cash holding; and (ii) the interest rate, negatively affecting cash holding. A third element that was not considered is the economic behavioral aspect of the availability of money that may lead to spontaneous purchasing. This element reduces the inclination of customers towards holding cash.

The present paper develops various kinds of loss functions due to spontaneous purchasing behavior and presents several different modified Baumol equations that are more reliable and realistic than the original Baumol equation.

An important implication of our paper relates to the ineffectiveness of monetary policy. When the interest rate is very low, in the original Baumol model we approach the liquidity trap range in which monetary policy is ineffective. However, according to our new model the monetary policy still remains effective, even at low or zero interest rates. This is the case even in an environment in which the monetary policy seems to be totally inefficient, as we recently find in several industrial countries throughout the world. In some sense, this reminds us of the idea of an automatic stabilizer that supports fiscal policies. The new modified Baumol equation in the current paper reveals an automatic stabilizer which accelerates the effectiveness of monetary policy, and avoids the phenomenon of the liquidity trap, even in cases of zero interest rates.

Keywords: Baumol equation, liquidity, yields**,** transactions, spontaneous purchases

1. Introduction and Literature Review

Baumol (1952) developed a model in which the money demand is for transaction purposes. The theory relies on the tradeoff between holding cash for commodities transactions and the resulting loss of interest. Therefore, the main variables of the demand for money are the interest rate and the income level impacting the amount of money for transactions activities. The variables affecting the demand for money that were used first by Baumol (1952) and Tobin (1956) have continued to be used for decades (See for example Krueger, 2012).

In the traditional approach of Baumol, the total cost of holding money assumes two contradictory effects: (a) The cost of each withdrawal is assumed to be b dollars including the fee for each withdrawal, waiting time on line, etc. Thus, the total withdrawal cost per period is $b \cdot \frac{Y}{m}$ where $\frac{Y}{m}$ indicates the number of withdrawals over a given period of time, Y indicates the total value of commodities transactions during each period, and m is the monetary amount of each withdrawal.

(b) By holding on average more money during a given period of time $\frac{m}{2}$, the increased interest loss is *r* per average dollar cash holding. Thus, the cost is $r \cdot \frac{m}{2}$.

Adding the two elements of the money holding cost to be minimized is expressed as

$$Min\,TC = b \cdot \frac{Y}{m} + r \cdot \frac{m}{2}$$

The derivative of this equation with respect to *m* leads to the optimal withdrawal of money m^* such that

$m^* = \sqrt{\frac{2bY}{r}}$. We refer to this as the original Baumol equation.

The original Baumol equation considered the value of transactions that positively affects cash holding; and the interest rate that affects it negatively. It did not consider the economic behavioral aspect of the availability of money that may result in spontaneous purchasing and decrease the inclination of customers towards holding cash.

This paper develops a modified Baumol equation that is more reliable and realistic than the original Baumol equation.

An important implication of the paper concerns the ineffectiveness of monetary policy. According to the original Baumol model, when the interest rate is very low, monetary policy is ineffective in the liquidity trap range. In the new model, however, monetary policy remains effective even at low or zero interest rates.

According to the original Baumol approach, one may expect that during a given time period a significant amount of money will be withdrawn at each of relatively few withdrawals. In reality, we find that people act differently. They more often make withdrawals of smaller amounts of money than expected by using the original and basic Baumol formula described above, especially today when the interest rate approaches zero in many Western countries. Furthermore, at an interest rate of zero we may face an infinite demand for cash, also referred to as the liquidity trap range in which monetary policy is totally inefficient.

The claim in this paper is that people do indeed depart in their behavior from the original Baumol formula due to a new factor recently raised by behavioral economists. By observing the behavior of people who hold small amounts of cash, these economists assert that people actually do behave very efficiently and carefully. They claim that in determining how much money to withdraw and how often, people most likely consider additional factors that the Baumol formula did not address.

In an unpublished paper (Tavor et al., 2016), we conducted empirical research concerning consumer preferences with regard to withdrawing cash. The study is based on 257 questionnaires that were distributed during the 2015-2016 academic year to students at two Israeli colleges. Among other issues, it considers the sensitivity of the students towards holding more cash and its effect on their inclination to use cash more spontaneously. Among some of the consumers interviewed, the most frequent immediate response to the question concerning cash withdrawals can be concluded as follows: The increased availability of money held by a consumer creates the illusion of being someone of means, and thus encourages spending more quickly or perhaps even carelessly, impulsively and spontaneously. Furthermore, Chang, Chang, Lai and Wang (2007) found that when the ratio of consumer purchases to cashable deposits increases, it will also increase the real cost of cash withdrawals. Accordingly, a typical consumer recognizes that he, and more frequently she, may spend money faster and inefficiently. Individuals who have less available cash devote greater planning and consideration to how they spend it. Therefore spending with limited availability ultimately leads to greater satisfaction. The recent studies of Badgaiyan and Verma (2014) and Amir, Zahur, Qureshi, Akbar and Amin (2014), further support these "findings" concerning impulsive behavior. Amir et al. examine it with respect to the purchase of women's apparel by Pakistani women. In contrast, Badgaiyan and Verma who research impulsive behavior in India, do not find significant differences between men and women.

The impact of liquid assets on personal consumption expenditure has been considered in the scholarly literature (e.g., Modigliani & Brumberg, 1954; Zellner, 1975).

The following example can illustrate the above mentioned literature. When an individual is given a high availability of accessible and affordable candy, then he desires and is tempted to use that availability more frequently, even if not in a way that is most efficient, valuable, or rational. Since an individual is aware of his human weaknesses, he seeks to avoid the results by avoiding the availability, and thereby preventing unreasonable actions.

A similar analogy applies to holding cash. An individual prefers to keep his liquid assets in a checking account instead of in his pocket due to his concern that accessibility of cash may cause spontaneous and impulsive purchasing, lacking sufficient self-control. This tendency in human nature is expressed in the Bible, "Do not muzzle an ox while it is threshing".

According to Baumeister (2002), the availability of food motivates a hungry person to impulsively eat it. Similarly, the availability of cash results in a habit of "compulsive use". One avoids the accessibility and availability of food in order to avoid habits of overeating. The same is true with respect to cash. Limited availability leads to less spending and less compulsive use of money. This kind of presumption is not too strong to use and may lead to a change in the formula of Baumol and Tobin. Furthermore, consumers who avoid carrying too much cash often do so in order to avoid careless spending.

How can an individual prevent his own impulsive purchasing? Different payment measures restrain impulsive purchasing in different ways. Thus, if one is aware that the efficiency of his purchases is negatively correlated with holding cash, he will limit himself from doing so by instead using several means of payment with differing degrees of liquidity.

Baumeister (2002) claims that currency conversion from dollars to other foreign currencies and vice versa may affect purchasing by tourists abroad. This argument supports the present approach that difficulties in performing transactions, such as limitations in available cash, indeed reduce spontaneous purchases.

Access to and availability of cash are important for understanding whether the nature of consumption is thoughtful or impulsive. Obstacles such as interest on liquid assets or fees on transactions between accounts reduce the availability of money for purchase of unnecessary items and thus purchases decrease. That is the reason that individuals deliberately impose on themselves limited accessibility and availability of cash. This understanding was not considered in the original work of Baumol and Tobin. This perspective will bring about the development of a modified version of holding cash that significantly differs from the original Baumol formula. The new formula is referred to as the modified Baumol equation.

Rao and Kumar (2011) estimated different characteristics of the demand for money and examined its stability in the U.S. during the period from 1960 to 2008. They found that by including additional variables besides the rate of interest introduced in the original Baumol paper (1952), the effects of the cost of holding money are useful, can be determined in a better way, and improve the relationship between the dependent and interdependent variables. The fundamental claim is that the customer's attitude is to minimize the cost of holding cash by reducing impulsive purchases. With the addition of this consideration, a new and modified Baumol equation is presented.

Soman (2001) shows that credit card users tend to buy goods inefficiently or to spend more than cash users. Soman (2001), Prelec and Semester (2001) and others support the approach presented in this paper with regard to cash holding. It is indeed possible that credit card availability encourages more purchases in comparison to cash availability, but the idea that availability of a payment device leads to extensive purchases (spontaneous or otherwise) is similar to the present approach. Thus, in order to avoid overspending, the present study suggests that one should always carry less cash or other available means of payment. "...willingness to pay is significantly greater in the credit-card condition as compared with the cash condition". In this quotation Soman (2001) describes the conclusion in the paper of Prelec and Semester (1998). Although all the authors believe that credit card payment even accelerates more purchases than cash payment, they all agree that availability of any payment device such as cash, debit cards, credit cards, or money orders, creates a more significant attitude of "willingness to pay".

Alvarez and Lippi (2015) deal with the demand for credit cards as compared to cash with respect to the costs of these devices. In contrast, this study considers from a different perspective how spending and especially spontaneous purchasing is affected by the availability of cash. It considers the attitude and actual behavior of customers regarding the well-known idea that supply creates its own demand and that since more available cash leads people to use it, they do not necessarily behave in a rational way. They prefer to maintain barriers by holding less available cash.

Xiao, Xie, and Ming (2011) explained the difference in "mental satisfaction" when paying with a credit card or with cash and its influence on consumer behavior. Using questionnaires, they showed that consumers believe the two payment options differ. However, the payment methods did not lead to a significant variance in consumer price sensitivity and impulsive buying. One difference revealed by their study is that consumers prefer to purchase non-essential goods using credit cards and essential goods by using cash.

In addition, Karbasivar and Yarahmadi (2011) analyzed consumer impulse buying using tools such as window displays, credit cards, and other promotional devices (cash discounts and free products). They used a survey format and a small sample size (n=275) to determine an essential relationship between these four external tools and consumer impulse buying behavior. Their research suggests that sellers and marketers should have and advertise ATMs in their shops. Furthermore, marketers can encourage the consumer buying impulse by offering complementary products and decorating their stores in modern styles that incorporate attractive lights and colors (For the most recent further studies on impulsive buying behavior, see also Harwani & Singh, 2014; Moayery, Zamani, & Vazlfehoost, 2014; Rizwan, Vishnu, & Muhammad, 2014).

The conclusion from the literature referenced above is that a greater amount of liquid money held by a consumer creates an illusion that he is wealthy and "strong" and thus encourages him to purchase more quickly. Rapid spending also referred to in some earlier studies as impulsive purchasing, eventually leads to inefficient use of monetary resources. Less available money in the hands of a consumer causes him to purchase less spontaneously and more cautiously. The real benefit of purchasing more cautiously while maintaining the same amount of annual spending is that it creates greater satisfaction from those purchases. Therefore, the original Baumol equation overestimates the optimal amount of cash held by a customer.

The next section presents a modification of the original Baumol equation. It is followed by some specific functions including several loss functions resulting from cash availability. The last section sets forth conclusions and implications. The gap between an efficient and an inefficient purchase becomes greater as the average amount of money available to the consumer increases.

2. A Further Extension of the Baumol Approach

In order to easily complete a transaction, one requires a liquid asset such as cash. However, a contrasting effect of cash availability is found among people who realize that an increased amount of cash in hand causes them to make more transactions, including among them less important and non-valuable purchases. This human weakness motivates people to avoid holding available cash. The two conflicting effects may lead to the development of a more modified demand for money in comparison to the original Baumol equation that did not consider the latter effect.

A primary innovation is presented in a paper published by this journal (Gonen, Weber, Tavor, & Spiegel, 2016), herein after referred to as "our earlier (2016) paper". It introduces a new element in the holding cost of cash by considering losses due to spontaneous and inefficient purchases. This kind of cost changes the attitude of the private individual who reduces the amount of cash that he holds, regardless of whether the interest rate is zero or positive.

Moreover, in our earlier (2016) paper we suggest reducing the holding cost of cash with an intermediate means of payment that is a less liquid asset with some positive interest rate. It thus reduces the amount of liquid cash, so that the individual gains a benefit of spending less spontaneously, although less liquid assets also prevent a customer from performing transactions. Nevertheless, several issues that remained unresolved in our earlier (2016) paper require further modifications as presented below. During a period when the interest rate is significantly positive, either the original Baumol model (1952) or the modified model in our earlier (2016) paper can be applicable.

However, in his original version, Baumol did not consider the possibility of zero interest. A decade ago, this possibility was theoretical for Baumol and other economists. The possibility of the liquidity trap at a very low interest rate was ignored for many years after the 1929 economic crisis. In recent years, when in most Western countries the yield even on nonliquid financial assets has approached zero, the original Baumol equation is absolutely insufficient and cannot be maintained in its basic form. For yield that is zero, we get with the original Baumol equation cash holding that approaches infinite value or a corner solution of a periodic withdrawal of total money, m, which is either available or equal to the total transaction Y. Moreover, if the yield, r, is zero there is no way to reduce spontaneous purchases by allowing intermediate r_M, which is introduced in our earlier (2016) paper. In a case when r>0 we can define $r \geq r_M \geq 0$, but when $r \to 0$, r_M cannot be in between r and zero. If optimal m according to the Baumol equation is indeed so large, then in relevant years we should identify a significant increase in cash holding by individuals.

When we consider that during the last decade the interest rate was almost zero in many countries, we find that the habits of individuals do not reveal large and significant cash holding as we would expect according to the original Baumol equation as well as our (2016) paper. In our view, this means that both articles lack another important factor that restrains the inclination to hold too much cash. We refer to this element as the loss factor that is due to holding more available cash and that motivates individuals to spend carelessly. In the present paper, we introduce this factor of loss with several forms of losses, and thus, allow for the use of a modified Baumol equation. Such an equation can be very helpful in periods during which the interest rate is zero or even negative. It also limits the holding of cash, even in an environment of very low interest rates, close to the liquidity trap range.

We introduce, below, several losses that are due to cash holding. The conclusion from all of them is that individuals have the tendency to make frequent withdrawals of less cash at each withdrawal.

The present paper develops the new modified version of the Baumol equation (1952). We provide a formal and basic presentation of both the original and the modified Baumol equations.

The original equation determines that the optimal withdrawal amount of money, *m* is

$$m = \sqrt{\frac{2bY}{r}}$$

The modified optimal *m* is:

$$m = \sqrt{\frac{2bY}{r + 2\gamma}}$$

The former value of *m* is very large for r=0.

The latter value of *m* is still "normal" even when *r*=0, due to other losses represented by coefficient γ and that may occur when more money is held for transaction motives. This loss element can include several items representing the cost of cash holding, even if we exclude yields, r , from financial assets which are held instead of cash. We introduce, below, various kinds of loss factors. The first one that we discussed in our earlier (2016) paper is loss from spontaneous purchases due to holding "too much" available cash. Another loss that can be included is the higher probability of robbery or other loss of money, when carrying a larger amount of available cash.

Sometimes the probability is not affected by the available cash but the expected loss for a given and constant probability increases when holding a greater amount of cash. The availability of more money may also influence increased theft and robbery. This can motivate an individual to hold less available cash out of a precaution that reflects his fear of losses, regardless of losses due to yield losses of r.

The following discussion introduces the formal equation of the model. In this paper we run different kinds of loss functions due to spontaneous purchases that are affected by cash availability. In all cases the optimal cash holding is smaller than expected by using the original Baumol equation.

The number of withdrawals, *n*, during a given period is equal to $\frac{y}{m}$, since Y is the total \$ value of transactions during the period and m is the amount of money at each withdrawal. The cost of each withdrawal is assumed to be constant and is equal to \$ b. The alternative cost of yield losses for the entire period due to cash holding is equal to $r \cdot \frac{m}{2}$, when r is the interest rate per period and $\frac{m}{2}$ is the average amount of cash held by the customer. These two elements of cost for the customer indeed exist in the original model of Baumol (1952).

It should be clarified that although short-term interest rates have presently reached the zero lower bound, long-term interest rates are currently still positive. Since the liquidity trap exists when interest rates are very low but positive, they may expand the probability of remaining in the liquidity trap range. However, implementing parameter β in the modified model does the opposite, thereby reducing the probability of remaining in the liquidity trap range. This has important implications for the efficiency of monetary policy as discussed below.

Another factor of cost that should be considered by the customer is based on the following presumption of behavioral economics. Availability of cash encourages customers to spend more spontaneously and carelessly. This realization motivates them to reduce the amount of cash they hold for transaction purposes in order to avoid wasteful activities, L. Each time that a consumer performs a transaction of Y dollars in nominal value, he is required to retain a certain amount of liquid assets. He also differentiates between the nominal value and the real value of actual transactions. According to the approach of behavioral economics, a gap exists between how much the consumer spends in dollar terms, Y, and the value he "subjectively" gains in real terms. The availability of more money held by a typical customer (especially one who is young and inexperienced) generates a subjective feeling of being rich and encourages one to spend more. Such spending is not necessarily efficiently used for real necessities. The opposite may happen if the customer holds less available money. Less money restrains one through careful spending and consequently even the spending itself gives the customer a higher level of satisfaction. This gap may be defined as a dollar loss, L, due to the "spontaneous and impulsive" nature of the purchase. The loss, L, is positively affected by the availability of liquidity, m, to the consumer. If money or any other liquid asset is not immediately accessible, the gap between the dollar amount of Y and the value of the "subjective" gains is minimized in real terms. Thus the loss, L, may be diminished. One may further assume that if no money is held then there is no loss and therefore L approaches zero.

The present model represents real value loss from purchasing due to the availability of cash. It presents the function $\gamma(m)$ that, as defined above, represents the loss of real value of a transaction due to cash availability and the waste of easily accessible money by spontaneous purchasing. Availability of money encourages careless purchasing among different groups within a population such as females, younger and immature individuals, and the uneducated. This is shown in our unpublished paper (Tavor et al., 2016).

This loss is formulated as a third element of the cost function $L = \gamma(m)$ where $\gamma'(m) > 0,$ and most likely $\gamma''(m) > 0$. The last three terms indicate the degree of sensitivity to losses due to spontaneous purchases that may increase by an increasing rate as a result of a larger amount of cash in hand. Again, this should be investigated empirically through further research by examining how, why and whether individuals are aware that resource availability promotes careless and value less purchasing.

Therefore, the cost of holding money for transactions in the new modified form can be written as:

(1) $$min_m\ TC = b\frac{y}{m} + r\frac{m}{2} + \gamma(m)$$

Taking the derivate of TC with respect to m leads to the F.O.C. as follows:

(2) $$\frac{dTC}{dm} = \frac{r}{2} - \frac{b}{m^2} + \gamma'(m) = 0$$

Using equation (2) we get an equation for optional m^* that is related to a specific function of the cost of L. For each specific function of L, we may find the optimal m*. Several examples of the loss function L are demonstrated below to find the optimal *m**.

2.1 Case 1

Let's assume the L function is defined at equation (3) where β is defined as a coefficient that represents the sensitivity to losses of real value from inefficient purchasing. For cases in our specific loss function L of equation (3), β measures elasticity of the loss function with respect to money availability: the percentage of loss due to each percentage of change in increased cash in hand. A large value of β means a higher percentage of loss resulting from a percentage increase in available cash.

Let's discuss different values of β.

(1) $$L = \gamma(m) = \gamma m^{\beta}$$

Thus the objective function is to minimize TC of equation (4):

(2) $$min_m\ TC = b\frac{y}{m} + r\frac{m}{2} + \gamma m^{\beta}$$

By taking the F.O.C. for *m* we get:

(3) $$\frac{dTC}{dm} = \frac{r}{2} - \frac{by}{m^2} + \gamma\beta m^{\beta-1} = 0$$

For β=1 we get the optimal m* of the modified Baumol equation at equation (6):

(4) $$m^* = \sqrt{\frac{2bY}{r+2\gamma}}$$

and for β $\neq$ 1

(5) $$-by + \frac{r}{2}m^2 + \gamma\beta m^{\beta+1} = 0$$

From equation (7) we can solve m^* by using the Maple. For several values of β, we introduce the optimal m^* β in Table 1.

Table 1. Optimal m^* for different values of β

β	m^*
1	$m = \frac{\sqrt{2}\sqrt{(2\gamma + r)by}}{2\gamma + r}$
2	$\left[432by\gamma^2 + 12\sqrt{6}\sqrt{by(216\gamma^2 by - r^3)\gamma} - r^3\right]^{\frac{1}{3}}$ / 12γ − $\frac{r^2}{12\gamma\left[432by\gamma^2 + 12\sqrt{6}\sqrt{by(216\gamma^2 by - r^3)\gamma} - r^3\right]^{\frac{1}{3}}}$ − $\frac{r}{12\gamma}$
3	$m = \frac{\sqrt{3\gamma\left(r + \sqrt{48\gamma by + r^2}\right)}}{6\gamma}$

2.2 Case 2

This case introduces a different loss function of equation (8):

(1) $$L = \gamma(m) = \gamma(1 + \ln(m))$$

Thus, the cost function of holding money in this case is:

(2) $$\min_m TC = b\frac{y}{m} + r\frac{m}{2} + \gamma(1 + \ln(m))$$

The F.O.C. is introduced at equation (10):

(3) $$\frac{dTC}{dm} = \frac{r}{2} - \frac{by}{m^2} + \frac{\gamma}{m} = 0$$

We can rewrite equation (10) at equation (11):

(4) $$\frac{rm^2}{2} + \gamma m - by = 0$$

and optimal m* in the case of the loss function of (8) is:

(5) $m^* = \frac{-\gamma+\sqrt{\gamma^2+2rby}}{r}$

For a private case of γ=0 we get:

$$m^* = \sqrt{\frac{2bY}{r}}$$

That is the case of the original Baumol Equation (1952). However, if γ>0 but still $r \to 0$, we face the regular liquidity trap range.

2.3 Case 3

The last case assumes a different loss function. The loss of each dollar held as cash is increasing with m as follows:

(1) $L = \varepsilon(m) \cdot m$

Where $\varepsilon(m)$ represents a constant value ε for each level of m that is increasing with m.

Therefore the cost function in this case is:

(2) $\min_m TC = b\frac{Y}{m} + r\frac{m}{2} + \varepsilon(m) \cdot m$

The F.O.C. derived from equation (14) is:

(3) $\frac{dTC}{dm} = \frac{r}{2} - \frac{by}{m^2} + \varepsilon'(m) \cdot m + \varepsilon(m) = 0$

That can be rewritten as follows at equation (16):

(4) $\frac{r}{2} + \varepsilon(m) + \varepsilon'(m) \cdot m = \frac{by}{m^2}$

Or it can be written in a different way as:

(5) $\frac{r}{2} + \varepsilon(m) \cdot (1 + E_{\varepsilon(m)}) = \frac{by}{m^2}$

By defining Z as follows:

(6) $Z \equiv \varepsilon(m) \cdot (1 + E_{\varepsilon(m)})$

Z is defined as the elasticity of the demand for available cash due to the loss of a percentage in inefficient actual purchases.

We get optimal m* as an implicit function depending on elasticity of the money demand where:

(1) $$m^* = \sqrt{\frac{2bY}{r + 2Z}}$$

the main factors influencing the elasticity of the money demand are several socioeconomic characteristics such as gender, age, education, religious status, family status and size, income, employment status etc. In an unpublished paper (Tavor et al., 2016), we empirically examine the influences of these factors.

Again, for a private case of Z=0 we return to the original Baumol equation. However, for a positive and increasing value of Z, m^* is smaller and diminishing compared to the original Baumol equation. However, for positive values of γ the range of the liquidity trap does not exist due to the effect of losses from spontaneous purchases.

3. Conclusions

In 1952, Baumol presented a break through article analyzing the demand for cash for the transaction motive. He emphasizes that holding cash has a cost for the customer whose behavior is "rational" and Baumol's objective is to minimize that cost. He developed a type of inventory model and concluded with the famous square root formula in which the two elements of interest rate and value of transactions have negative and positive effects, respectively, on the demand for cash.

The implicit assumption at that time was that most transactions are paid for by cash, and that a given cost value is associated with every transaction, even with cash withdrawal. Since the 1950's, the prevalent payment environment has evolved considerably. Several innovative payment instruments that utilize advanced technology and affect cash requirements have been implemented in the commerce world. Included among them are debit and credit lines and cards, the electronic purse, and ATM machines which are installed on every corner. Although many studies were published from this perspective, the following important innovation was ignored.

In the traditional and conservative discussion, the demand for money is affected by the transactions made by individuals. However, a simultaneous effect must also be considered. The availability of money held for transactions may affect not only the volume but also the types of transactions that are made. These effects are both positive. The effect on the types of transactions is a reason to reduce or even to eliminate cash holding for the sake of decreasing spontaneous and unnecessary transactions. Rational individuals consider this element that should be implemented in the cost function of cash holding. More available money in hand encourages spontaneous, careless, and irrational spending and purchasing behavior.

We are presently investigating this with empirical evidence in a in an unpublished paper (Tavor et al., 2016).

In the present paper we run various kinds of loss functions due to spontaneous purchasing behavior. The paper presents several modified Baumol equations that contain those different types of loss functions. In general, each function may lead to different results in terms of (a) the optimal cash withdrawal; and (b) the frequency of the withdrawal. However, as expected, the number of items (a) and (b) in our modification is smaller for the former and larger for the latter, respectively, as compared with the prediction of the original Baumol equation. The results obtained seem more reliable today than what is continued to be taught for students to learn.

Finally and probably most importantly, our conclusion from the modified Baumol equation is that with the new approach the monetary policy of a central bank has a more powerful impact. If an increase in money supply encourages purchases, although they may be more spontaneous and less important, it indicates a greater effectiveness of the policy. Moreover, when the interest rate is very low, in the original Baumol model we approach the liquidity trap range in which monetary policy is ineffective. This also occurs in our earlier (2016) paper regarding spontaneous purchases that was published in this journal. However, according to our new model the monetary policy still remains effective even at zero or at certain negative interest rates. This is the case even in an environment in which the monetary policy seems to be totally inefficient, as we recently find in several industrial countries throughout the world.

In some sense, this reminds us of the idea of an automatic stabilizer that supports fiscal policies. We suggest that the new modified Baumol equation in the current paper on one hand reveals an automatic stabilizer which accelerates the effectiveness of monetary policy, and on the other hand avoids the phenomenon of the liquidity trap, even in cases of zero interest rates that presently exist in many Western countries.

Future research includes the modification and extension of the present approach with respect to additional payment devices, that while less liquid and costly may also establish buffers for impulsive purchases.

References

Alvarez, F., & Lippi, F. (2015). Cash burns: An inventory model with a cash-credit choice. *National Bureau of Economic Research, Working Paper No. 21110*. https://doi.org/10.3386/w21110

Amir, F. Z., Syed, F., Qureshi, A. N., Akbar, S. J., & Amin, M. F. (2014). Impulsive Buying Behavior of Women in Apparel Industry in Pakistan. *International Journal of Management Sciences*, *2*(7), 296-314.

Badgaiyan, A. J., & Verma, A. (2014). Intrinsic Factors Affecting Impulsive Buying Behavior—Evidence from India. *Journal of Retailing and Consumer Services*, *21*, 537-549. https://doi.org/10.1016/j.jretconser.2014.04.003

Baumeister, F. (2002). Yielding to temptation: Self-control impulsive purchasing, and consumer behavior. *Journal of Consumer Research*, *28*(4), 670-676. https://doi.org/10.1086/338209

Baumol, W. J. (1952). The Transactions Demand for Cash: An Inventory Theoretic Approach. *Quarterly Journal of Economics*, *66*, 545-556. https://doi.org/10.2307/1882104

Chang, J. J., Chang, W. Y., Lai, C. C., & Wang, P. (2007). Equilibrium Dynamics in an Endogenous Growth Model of Money and Banking. *Journal of Money, Credit and Banking*, *39*(7), 1683-1710. https://doi.org/10.1111/j.1538-4616.2007.00083.x

Gonen, L. D., Weber, M., Tavor, T., & Spiegel, U. (2016). A Modified Baumol Approach-Optimal Withdrawal and Holding of Cash Liquid Assets. *Review of European Studies*, *8*, 8-21. https://doi.org/10.5539/res.v8n2p8

Harwani, S. V., & Singh, S. (2014). An Insight on Consumer Impulse Buying Behavior. *International Journal for Administration in Management, Commerce and Economics*, *2*, 124-130.

Karbasivar, A., & Yarahmadi, H. (2011). Evaluating Effective Factors on Consumer Impulse Buying Behavior. *Asian Journal of Business Management Studies*, *2*, 174-181.

Krueger, M. (2012). Money: A Market Microstructure Approach. *Journal of Money, Credit and Banking*, *44*(6), 1245-1258. https://doi.org/10.1111/j.1538-4616.2012.00530.x

Moayery, M., Zamani, S., & Vazlfehoost, H. (2014). Effect of Visual Merchandising on Apparel Impulse Buying Behaviors among Iranian Young Adult Females. *Indian Journal of Science and Technology*, *7*(3), 360-366.

Modigliani, F., & Brumberg, R. H. (1954). Utility Analysis and the Consumption Function: An Interpretation of Cross-section Data. In K. K. Kurihara (Ed.), *Post Keynesian Economics* (pp. 388-436). New Brunswick, NJ: Rutgers University Press.

Prelec, D., & Semester, D. (2001). Always leave home without it: A further investigation of the credit-card effect on willingness to pay. *Marketing Letters*, *12*(1), 5-12. https://doi.org/10.1023/A:1008196717017

Rao, B. B., & Kumar, S. (2011). Is the US demand for money unstable? *Applied Financial Economics*, *21*(17), 1263-1272. https://doi.org/10.1080/09603107.2011.568395

Rizwan, R. A., Vishnu, P., & Muhammad, A. A. (2014). Impact of Product Packaging on Consumer's Buying Behavior. *European Journal of Scientific Research*, *120*(2), 145-157.

Soman, D. (2001). Effects of payment mechanism on spending behavior: The role of rehearsal and immediacy of payments. *Journal of Consumer Research*, *27*(4), 460-474. https://doi.org/10.1086/319621

Tavor, T., Gonen, L. D., Weber, M., & Spiegel, U. (2016). *The Modified Baumol Equation: Theory and Evidence* (Unpublished Paper).

Tobin, J. (1956). The Interest-Elasticity of Transactions Demand for Cash. *Review of Economics and Statistics*, *38*(3), 241-247. https://doi.org/10.2307/1925776

Xiao, Z., Xie, Y. Q., & Ming, L. (2011). *A Comparative Analysis of Consumer Behavior with Payments of Shopping Cards and Cash* (pp. 539-544). Beijing Information Science & Technology, School of Economics and Management.

Zellner, A. (1975). Bayesian Analysis of Regression Error Terms. *Journal of the American Statistical Association*, *70*, 138-144. https://doi.org/10.1080/01621459.1975.10480274