Welfare Effects of Increasing Borrowing Limit in the Presence of Self Control Problem

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Abstract

How beneficial is the observed large increase in US borrowing limits over last three decades for consumers who suffer from the lack of self-control? This paper uses the dynamic self-control framework first to model the intertemporal consumption and borrowing profiles of consumers who are susceptible to temptation, and to analyze the welfare implications of the increase in the borrowing limit for different type of consumers: those with and without binding credit constraint. Contrary to the conventional model, I show that an increase in the credit limit does not not always benefit consumers' welfare, and provide conditions under which such increase even hurt consumers' welfare.

Keywords: Self-control, temptation, borrowing limit, positive welfare effect, negative welfare effect
JEL Classification: E2, E5, I3

1. Introduction

This paper [1] evaluates the welfare effects of the increase in the borrowing limit for agents who exhibit the self-control problem and aims to explain what seems to be a contradiction between the standard textbook model and empirical observations. Theory predicts that an individual cannot be made

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[1]The first draft for this paper was available on line in September 2009, and I presented this paper in University of Toronto Macro Workshop in December 2009.

worse off if offered an increased credit limit since borrowing from the future income allows for consumption smoothing and raises the current value of life-time utility. However, while credit limits in US were raised significantly - household's borrowing limits increased from 2% of GDP in 1980 to 10% in 2005 – the bankruptcy filing increased more than five-fold - to 1.5 million per year. The empirical facts show that increase in the borrowing limits over the last three decades in the US brought the overborrowing problems(credit misuse)[2,3]. These facts demonstrate that consumers have trouble smoothing their future consumption, and in the extreme cases, they even file for personal bankruptcy since in the future they could not pay back what they borrow today. Bankruptcy filing, in turn, isolates consumers from borrowing any resource from their future income. These evidence together imply that increased credit limit does not facilitate consumption smoothing contrary to the prediction of the standard theory.

To account for the most widely reported reason for bankruptcy filing – credit misuse (or debt mismanagement)[4] – I apply the dynamic self-control model (DSC form now on)[5] to analyze the implications of increased credit limits for the life-time welfare of agents who exhibit the self-control problem[6].

[2]An intuitive explanation for the credit misuse (debt mismanagement) phenomenon might be the lack of financial literacy, however, empirical literatures show that agents are general familiar with financial knowledge and informed about the financial consequences of the debt mismanagement.

[3]Many empirical literature support my surmise here that two forces potentially create credit misuse problem,for instance, Littwin (2007) found that consumers relied too heavily on credit debt and the increasing availability of borrowing limits plays an important role in providing incentives for agents to spend more than they should. However, even the majority of credit takers are fully aware of their propensity to accumulate debt under an expansionary credit environment,they still accumulate too much debt. Furthermore,in Littwin (2007)'s survey, nearly two-thirds of participants cited avaliable borrowing limits to them are tempting, the majority of participants found it is easy to spend money they did not have. Therefore, the central issues for agents are about what is the way increasing credit limits influence their spending and borrowing patterns, and the welfare.

[4]Chakravarty and Phee (1999) classified the reasons for the US bankruptcy filings and found that credit misuse accounts for up to 41.3% of annual personal bankruptcy fillings.

[5]Gul and Pesendorfer(GP from now on), 2001, 2004a.

[6]I chose to employ the DSC framework as it is well-suited to incorporate the preferences of individuals who suffer from temptation/self-control problem; and the recursive formulation of the model allows for the intertemporal welfare analysis. For the application of other models to explain the credit misuse phenomenon, see, for instance, Strotz, 1956,

I consider two driving forces behind the poor debt management: the increase in the availability of credit which creates temptation for some agents to over-borrowing, and inability of agents to resist temptation – lack of self-control[7]. I show the effect of the increase in the borrowing limit on agents' welfare. I find that an increase in the credit limit for agents who are not bound by their borrowing constraint makes them worse off. This finding contradicts the basic principle of the conventional model stating that an agent can not be made worse off by having more options. Most strikingly, I find that for agents whose borrowing constraints were originally binding, increase in the credit limit may still decrease their welfare. I find two opposite effects of an increase in the borrowing limit for consumers whose credit constraint was originally binding. One is that relaxing the binding borrowing constraint helps agents to smooth their intertemporal consumption and has a positive effect on welfare. Another one is that increasing the borrowing limit creates temptation to over-consume, and an agent with the self-control problem needs to spend additional resources to resist temptation which reduces his welfare. The overall effect on welfare will depend on which of those two effects dominates and this in turn, depends on what are the agent's specific time preference rate and his self-control costs, as well as the market equilibrium interest rate. Such prediction is fundamentally different from the prediction of the standard theory which implies consumption smoothing and increase in welfare when the borrowing constraint is relaxed.

This paper proceeds as follows: next section lay out the theoretical model and present welfare analysis. In section 3 I present the results of the numerical exercise, and section 4 concludes with the policy implications.

2. Model

2.1. Setup

Consider a deterministic exchange economy with complete markets. Each period, an infinite-lived representative agent chooses current consumption c and next period asset holdings $a^{'}$ subject to an intertemporal budget constraint $B_t(y, a)$. The exogenously given credit limits $\{m_t\}_{t=0}^{\infty}$ with $m_t \geq 0$

Phelps and Pollak ,1968, and Laibson, 1994.

[7]See, for instance, Littwin (2007) for empirical evidence of the existence of temptation and self-control problem.

be the maximum allowed borrowing limit each period which assumed to be constant m over time when taking interest rate r as given. Let $W(a, m)$ denote the corresponding value function which is conditional on the endogenous state variable a (current assets) and the exogenous state variable m (borrowing limit). The sequence of wages $\{y_t\}_{t=0}^{\infty}$ is bounded and is exogenously determined by a stochastic process. In order to eliminate the welfare effects related to wages, y_t is assumed to be constant over time. Household preferences follow the dynamic self-control preferences featuring temptation for the agent to liquidate all financial holdings in a given period. $u(\cdot)$ is the utility of being able to commit to a singleton choice. $v(\cdot)$ is the value of temptation, which ranks tempting singleton over the choice set. $u^{'}(\cdot) > 0$, $v^{'}(\cdot) > 0$. $u(\cdot) + v(\cdot)$ is assumed to be concave to ensure that maximization problem has a unique interior solution. If an agent consumes less than his entire endowment, he incurs the self-control disutility $v(c) - \max\ v(\tilde{c})$. The term $u(c) + \delta W(a^{'}, m^{'})$ represent the commitment utility of the agent with discount factor δ. The model allows agent to borrow up to an exogenously given credit limit m. The borrowing constraint is therefore $a^{'} \geq -m$. With the borrowing limit, consuming the maximum available resources in a given period implies $a^{'} = -m$ and therefore $\tilde{c} = (1 + r)a + y + m \in B_t(y, a)$. At the optimum, the agent's choice trades off the long-run object $u + \delta W$ and the self-control cost $v(c) - v(\tilde{c})$. The decision problem of an agent can be formulated recursively as:

$$W(a, m) = \max_{c\,, a^{'} \in B_t(y,a)} \{u(c) + v(c) + \delta W(a^{'}, m^{'})\} - \max v(\tilde{c}) \tag{1}$$

s.t. $B_t(y, a) := \{(c, a^{'}) \mid c + a^{'} \leq (1+r)a + y,\ a^{'} \geq -m,\ m \geq 0,\ \tilde{c} = (1+r)a + y + m\}$

Agent's maximization problem is:

$$\begin{aligned}\mathcal{L} = \max_{c\,, a^{'} \in B_t(y,a)} &\{u(c) + v(c) + \delta W(a^{'}, m^{'}) \\ &- max v[(1 + r)a + y + m]\} + \lambda[(1 + r)a + y - a^{'} - c] + \sigma(a^{'} + m)\end{aligned} \tag{2}$$

λ and σ are Lagrangian multipliers for intertemporal resource constraint and borrowing limit constraint respectively. The corresponding first order condition for equation (2) with general utility functional form is:

$$u^{'}(c) + v^{'}(c) - \sigma = \delta(1+r)[u^{'}(c^{'}) + v^{'}(c^{'}) - v^{'}((1+r)a^{'} + y + m)],\ \ \sigma(a^{'} + m) = 0 \tag{3}$$

1) If $a^{'} > -m$,the credit limit is not binding and the first order condition is :

$$u^{'}(c) + v^{'}(c) = \delta(1+r)\{u^{'}(c^{'}) + v^{'}(c^{'}) - v^{'}[(1+r)a^{'} + y + m]\} \qquad (4)$$

In steady state $c = c^{'}$and $a = a^{'}$, (4) becomes:

$$\frac{\delta(1+r)-1}{\delta(1+r)}\{u^{'}(c) + v^{'}(c)\} = v^{'}((\frac{1}{r}+1)(c-y) + y + m)^{8} \qquad (5)$$

If and only if $\delta(1+r) > 1$, there exist a steady state equilibrium.

2) If $a^{'} = -m$, the credit limit is binding and the first order condition is:

$$u^{'}(c) + v^{'}(c) - \sigma = \delta(1+r)\{u^{'}(c^{'}) + v^{'}(c^{'}) - v^{'}((1+r)a^{'} + y + m)\} \qquad (6)$$

In steady state $c = c^{'}$ and $a = a^{'} = -m$, from resource constrain $c + a^{'} \leq (1+r)a + y$, the steady state consumption is $c = y - rm$, here $y - rm \geq 0$,[9] (6) becomes:

$$[\delta(1+r)-1][u^{'}(c) + v^{'}(c)] - \delta(1+r)v^{'}(y - rm) = -\sigma \qquad (7)$$

2.2. Welfare analysis

I evaluate the welfare implications of the increase in the borrowing limits[10] for two different types of consumers and consider two cases. In the first

[8]Now consider the steady state: the term $v^{'}((\frac{1}{r}+1)(c-y)+y+m)$ represents the marginal temptation of consuming all available resources. Therefore, lower values of r increase temptation for agents with positive assets (i.e. $c > y$), while higher values of r increase temptation for agents with negative assets (i.e. $c < y$), and as a consequence, increase the current consumption for both type of agents. This finding helps to explain the use of promotional teaser rates for those individuals who do not demand a lot of credit (agents with positive assets (i.e. $c > y$)) and usury rates for those with high credit card debt (agents with negative assets (i.e. $c < y$)). In fact current credit card reforms in the U.S. advocate restricting the widely used teaser rate which potentially induces people to spend more, and usury rate for people with high credit card debt. Hence this finding sheds the light on U.S. President Barack Obama's announcement about credit card reforms in 2009 in a signing ceremony at the White House: "the reforms designed to protect consumers".

[9]Follow Aiyagari (1994), $a_0 = (1+r)^{-1}\sum_{t=0}^{\infty}(1+r)^{-t}(c_t - y)$, $m \leq \frac{y}{r}$, where $\frac{y}{r}$ is the natural debt limit, if $m < \frac{y}{r}$ is ad hoc debt limit.

[10]Here is uniformly increase borrowing limits from now on: from $m_1 = m_1^{'} = m_1^{''} = ...$ increase to $m_2 = m_2^{'} = m_2^{''} = ...$

case, agent is not bound by his current borrowing limit [11]. In the second case, the agent is bound by his current borrowing constraint.

1)Non binding constraint:$a^{'} > -m, a^{''} > -m, a^{'''} > -m...$[12]$(\sigma = \sigma^{'} = \sigma^{''} = ... = 0)$
Recall equation (2), the envelope condition for permanently increase in m is:

$$\begin{aligned}\frac{\partial W(a,m)}{\partial m} = \frac{\partial \mathcal{L}}{\partial m} &= -v^{'}(\tilde{c}) + \delta \frac{\partial W(a^{'},m)}{\partial m} \\ &= -v^{'}(\tilde{c}) + \delta \frac{\partial \mathcal{L}^{'}}{\partial m} = -v^{'}(\tilde{c}) + \delta[-v^{'}(\tilde{c^{'}}) + \delta \frac{\partial W(a^{''},m)}{\partial m}] \\ &= -v^{'}(\tilde{c}) - \delta v^{'}(\tilde{c^{'}}) + \delta^2[-v^{'}(\tilde{c^{''}}) + \frac{\partial W(a^{'''},m)}{\partial m}] \\ &= -(v^{'}(\tilde{c}) + \delta v^{'}(\tilde{c^{'}}) + \delta^2 v^{'}(\tilde{c^{''}}) + ...) \quad (8)\end{aligned}$$

Therefore, when the borrowing limit m increases, welfare unambiguously decreases.[13] It shows that an increase in the credit limit for agent who is not bound by his borrowing constraint makes him worse off. This finding contradicts the basic principle of the conventional model stating that an agent can not be made worse off by having more options.

2)Binding constraint: $a^{'} = -m, a^{''} = -m, a^{'''} = -m...$ $(\sigma, \sigma^{'}, \sigma^{''}... > 0)$[14]

[11] Assume credit limits are the same over time: $m = m^{'} = m^{''} = m^{'''} = ...$

[12] Here $m = m_1 = m_1^{'} = m_1^{''} = ...$ which is the original borrowing limits over time.

[13] Note here is the case after uniformly increase borrowing limits, agent is still not bound by the increased borrowing limits over time.

[14] Note here is the general case after uniformly increase borrowing limits, agent is not bound by the increased borrowing limits until some time later from now on.

Using envelope condition for permanently increase in m from equation(2) [15]:

$$\begin{aligned}
\frac{\partial W(a,m)}{\partial m} &= \frac{\partial \mathcal{L}}{\partial m} = -v^{'}(\tilde{c}) + \delta \frac{\partial W(a^{'},m)}{\partial m} + \sigma \\
&= -v^{'}(\tilde{c}) + \delta \frac{\partial \mathcal{L}^{'}}{\partial m} + \sigma = -v^{'}(\tilde{c}) + \delta[-v^{'}(\tilde{c^{'}}) + \delta \frac{\partial W(a^{''},m)}{\partial m} + \sigma^{'}] + \sigma \\
&= -v^{'}(\tilde{c}) - \delta v^{'}(\tilde{c^{'}}) + \delta^2[-v^{'}(\tilde{c^{''}}) + \frac{\partial W(a^{'''},m)}{\partial m} + \sigma^{''}] + \delta\sigma^{'} + \sigma \\
&= -(v^{'}(\tilde{c}) + \delta v^{'}(\tilde{c^{'}}) + \delta^2 v^{'}(\tilde{c^{''}}) + ...) + (\sigma + \delta\sigma^{'} + \delta^2\sigma^{''} + ...) \quad (9)
\end{aligned}$$

When the borrowing constraints are binding, the shadow values of the borrowing limit $\sigma, \sigma^{'}, \sigma^{''}...$ are positive and, from equation (9), we can see that increasing credit limit has two opposing welfare effects. The first is a positive effect represented by $\sigma + \delta\sigma^{'} + \delta^2\sigma^{''} + ...$ [16]: Relaxing the binding borrowing constraint helps agent to smooth his intertemporal consumptions for those periods when he is bound by the original borrowing limits and thus increases the present value of his utility. The second is a negative welfare effect represented by $-(v^{'}(\tilde{c}) + \delta v^{'}(\tilde{c^{'}}) + \delta^2 v^{'}(\tilde{c^{''}}) + ...)$: the increased borrowing limit provides more resources available for the agent to consume each period from now on. That, in turn increases temptation for the agent to over-consume and an agent with the self-control problem therefore needs to spend additional resources to resist temptation which reduces his welfare.

The overall effect on welfare will depend on which of those two effects dominates and this in turn, depends on what the agent's specific time preference rate, market equilibrium interest rate and agent's self-control costs are. In section 3 I conduct a numerical exercises varying the value of those parameters in the model in order to demonstrate their quantitative significance when relaxing agent's originally binding borrowing limits. The results show that for an agent whose borrowing constraint was originally binding, increase in the credit limit may still decrease his welfare. That prediction is strik-

[15] That is an extreme case after the uniform increase in the borrowing limits, agent is still bound by the increased borrowing limits over time.

[16] That is an extreme case after the uniform increase in the borrowing limits, agent is still bound by the increased borrowing limits from now on. Note for the general cases that agent is bound by the increased borrowing limits n period later from now on, this term becomes $\delta^n\sigma^n + \delta^{n+1}\sigma^{n+1} + \delta^{n+2}\sigma^{n+2} + ...$

ingly different from standard theory which implies consumption smoothing and increase in welfare when the borrowing constraint is relaxed.

3. Computational Results

In this section, I conduct numerical exercise to evaluate the welfare effects when relaxing agent's originally binding borrowing limits. In order to demonstrate the quantitative significance of the temptation parameter and market interest rate as well as the agent's discount factor, I calculate the present values of welfare for an agent who was bound by original credit limit faces an increase in the borrowing limits, and compare the welfare by changing the related parameters in order to investigate the economic meaning of the temptation parameter.

In what follows, I present the computational results in three circumstances: $\delta(r+1) < 1$, $\delta(r+1) = 1$, $\delta(r+1) > 1$. Each of the Figures 1-3 represents value of the lifetime welfare on the vertical axis starting from time t and magnitude of change in the borrowing limits,k, on horizontal axis. Before time t, the agent faces the binding borrowing limit m_1, at time t, the original binding borrowing limit increase k folds from m_1 to $m_2 = km_1$.

Figure 1 shows the case with $\delta(r+1) < 1$, when agents value future less or the market interest rate is relatively low. The graph demonstrates differential response to an increase in the borrowing limits for different values of τ, self-control parameters. In general, I observe that for all values of τ, small increases in k lead to improvement in welfare. But as τ increases, the self-control costs for an agent are high and negative welfare effects dominates positive effect when there are big increases in k. The graph also shows the critical points k above which negative effect dominates. The magnitude of the critical point depends on the value of self-control parameter: the higher the τ, the smaller the critical value of k at which an agent becomes worse off.

Figure 2 and 3 display the discounted lifetime welfare at time t against k with $\delta(r+1) \geq 1$. Comparing to case when $\delta(r+1) < 1$, agents value current consumption less than future consumption,or the market interest rate here is higher, the negative welfare effect of relaxing the original binding borrowing limit dominates the positive welfare effect, then reduction in borrowing limit

is welfare improving under this circumstance. In particular, when agents are immune to temptation (i.e.$\tau = 0$), consistent with the conventional model, there is no welfare impact for agents' life-time welfare by relaxing the borrowing constrains, because agents' optimal lifetime consumption and asset decisions are independent of the borrowing limit they face. Same as in the previous case, these graphs indicate that when given the same borrowing limits, agents who have less self-control problems have higher life-time welfare.

4. Conclusion

This paper uses the dynamic self-control framework to model the intertemporal consumption and borrowing profiles of consumers who are susceptible to temptation, and to analyze the welfare implications of the increase in the borrowing limit for agents with and without binding credit constraint. Contrary to the basic principle of the conventional model stating that an agent can not be made worse off by having more options, I find that an increase in the credit limit for agents who are not bound by their borrowing constraint makes them worse off.

Most strikingly, I find that for agents whose borrowing constraint was originally binding, increase in the credit limit may still decrease their welfare, due to the two opposite effects. The overall effect on welfare depends on which of the two effects dominates. That prediction is fundamentally different from the prediction of the standard theory which implies consumption smoothing and increase in welfare when the borrowing constraint is relaxed. I also provide conditions under which such increase even hurts consumers' welfare.

The present research has a number of policy implications. Thus, it implies that when shaping the credit market reforms, the knowledge of the agents time preference, self-control cost to resisting available resources across population and market equilibrium interest rate are crucial for determining the direction of the welfare changes resulting from such reforms (i.e. expansionary credit policy or tightening credit policy).

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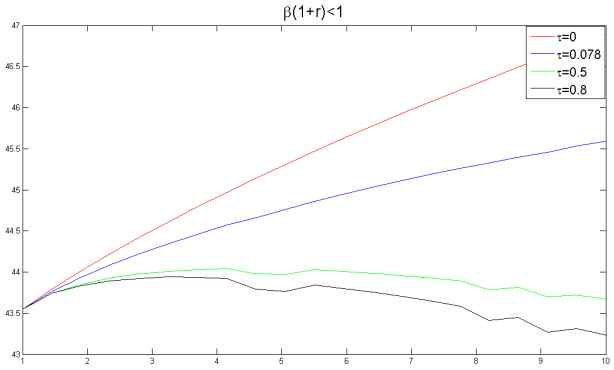

Figure 1: (Present Values of Lifetime Welfare against k when $\delta(r+1) < 1$)

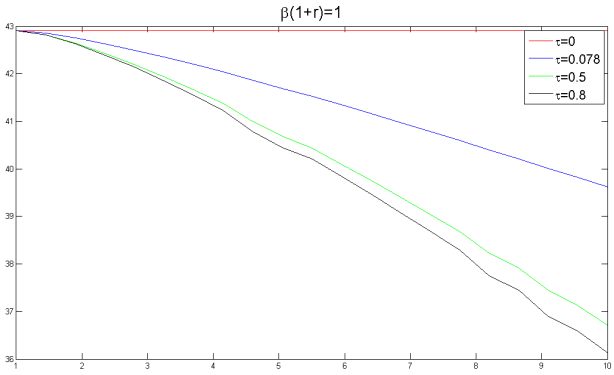

Figure 2: (Presents Values of Lifetime Welfare against k when $\delta(r+1) = 1$)

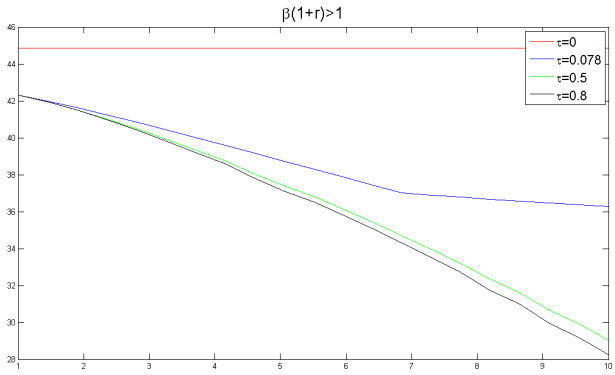

Figure 3: (Presents Values of Lifetime Welfare against k when $\delta(r+1) > 1$)