A dynamic model of Gambling addiction with social costs: theory and policy solutions

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Abstract

We investigate the effects of gambling addiction in a dynamic model where wellbeing crucially depends on the accumulation of relational goods which is weakened by the consumption of gambling. We outline conditions under which gambling may become addictive leading to a suboptimal equilibrium from a social point of view. We examine the relative effectiveness of different policy solutions (tax on gambling, gambling restrictions) in bridging the distance between the equilibrium without intervention and social optimum.

Keywords:addiction, gambling, social costs.

JEL Classification Numbers:L83, D21

1 Introduction

In the neuroscience literature (see among others Potenza, 2008 and Ross, 2010) Pathological Gambling (from now on PG) is considered as a form of addiction (and violation of the rationality paradigm) since the pathological gambler "takes pains to engage in an activity that transparently has negative expected returns if utility varies positively with money. He also, typically, spends further resources on commitment devices designed to interfere with her gambling"(Ross, 2010). The association between PG and classic (substance) addiction is therefore particularly strong and, consequently, the more general addiction literature may be an important background to study the PG phenomenon.

The origins of the economic literature on addiction trace back to the pioneering contributions of Stigler and Becker (1977), Iannacone (1986) and Becker and Murphy (1988) who actually start from the consideration that addiction and economic rationality are not necessarily mutually exclusive.

In Becker and Murphy (1988) rational agents, despite recognizing the addictive nature of their choices, still perform them because future addiction makes expected gains from gambling higher than their costs. Nevertheless, paying the full price of addictive consumption goods acts as a deterrent since it represents not only a current monetary cost but also a permanent expected decrease in wealth due to the future expected gambling expenditure generated by addiction.

Gruber and Koszegi (2001) develop a model of addiction with time-inconsistent agents, while Gul and Pesendorfer (2007) a model where consumption of the addictive good is a tempting choice that erodes self-control in the future. Both papers agree with Becker and Murphy and document the effectiveness of interventions based on raising the price of addictive goods such as smoking, alcohol and heroin when they successfully reduce the demand for them.

In the past two decades there has been a significant increase in academic interest concerning gambling behavior and, with it, the economic and social impacts of legal gambling, as a special case of the addiction literature. However, to our knowledge, only a relatively small portion of gambling research has been performed in economic disciplines (see, among others, Walker, 2008). In this respect Bardsley (1998) devises a dynamic game in continuous time between the seller and the consumer of an addictive substance while Hartley and Farrell (2002) investigate the ability of the expected utility theory to account simultaneously for gambling and insurance.

We aim to contribute to this literature with a model of rational addiction applied to gambling by taking into account the different effects that addiction has on both the consumption of the addictive good and, at the same time, the consumption of relational goods/stimulus goods[1]. Based on this theoretical background, our paper also analyzes the relative effectiveness of different policy remedies to the gambling problem and, in doing so, it deals with the well-known and general issue of paternalism and of the boundaries between what should be legal and what not. With this respect our work is related to some recent papers specifically analyzing the role of the state and gambling legalization. An example is the contribution of Walker and Jackson (2011) who examine the overall impact of legalized casino gambling on government revenues. The authors show that, despite the economic benefits that casinos provide in terms of additional tax revenues, a relevant amount of social costs is also generated. According to Layton and Worthington (2011) the United States successfully extracted more than 9.78% of total state taxation from gambling. Unfortunately, these revenues are not produced without some undesirable socio-economic problems such as the relative detriment of low income individuals and the increasing need for public support programs (Szakmary and Szakmary, 1995; Madhusudhan, 1996; Rivenbark and Rounsaville, 1996, Kearney, 2005). Furthermore, there is evidence that certain forms of gambling may create compulsive gambling and major addiction, attract criminal elements and foster corruption (Mason, Shapiro and Borg, 1989; Mikesell and Pirog-Good, 1990). Treating addicts, supporting families in difficulty, fighting crime structured around PG, are activities that generate high financial costs which are mainly supported by local structures (municipalities, local health authorities, police forces), but the same activities may also cause a

[1] In doing so we substantially develop a Scitovskian intuition (Scitovsky, 1976) on the correlation between *comfort goods* (goods that are not limited to, but may include also those producing dependence) and wellbeing from *stimulus goods* which can be enjoyed only after proper consumption/investment on the latter, while weakened by the consumption of comfort goods

decrease in the national budget as the epidemic progresses.

In the second part of our paper we aim to take into account the role of government against the adverse effects of gambling. In this respect, we focus on two possible alternative government policies. The first one is based on a price increase while the second one on limitations to gambling opportunities. We found that the second alternative can lead to more efficient results when the government is not myopic and takes into account social losses from gambling.

The paper is organized as follows: in Section 2 we describe the main features of our model and discuss its equilibrium characteristics. In Section 3 we model the social costs of gambling for "passive" members in the same household. In Section 4 we compare the two possible alternative policies and in Section 5 we argue how the policymaker trade-off between gambling revenues and wellbeing may be affected in favour of the latter by the bottom-up action of citizens. Section 6 concludes.

2 The Model

Our model borrows extensively from Dragone et al. (2015) and assumes that a rational agent chooses, given her budget constraint, how much to consume of:

i) a good s which creates addiction (i.e. gambling with slot machines)[2];

ii) a relational good r;

iii) a standard composite *numerary* consumption good q with unit price.

From a dynamic point of view the agent's utility also depends on a variable a representing addiction to gambling and the accumulation of well-being from the good w depending on past and current consumption of (investment in) r and decreasing over time with the consumption gambling. Assuming that both $a(t)$ and $w(t)$ have the same positive rate of decay δ we have that a evolves over time depending on current gambling choices and addiction from

[2]For convenience we consider p_s a positive price by reasonably assuming that the expected value of gambling is negative as it usually occurs when playing with slot machines (ie. if playing 10 euros gives a 1/1000 probability of winning 1000 euros, the expected loss of such play is 9 euros and p_s=9).

gambling activity accumulated in the past: $\dot{a}(t) = s(t) - \delta a(t)$[3] while w is ruled by: $\dot{w}(t) = r(t) - \delta w(t) - \varepsilon s(t)$, where ε is a positive constant.

In particular, we analyze the different preferences of individuals characterized by greater attachment to the pleasure of gambling, considering the total utility as a quasi-linear weighted sum of three parts

$$\alpha U(s(t), a(t)) + \beta U(r(t), w(t)) + U(q(t))$$

where individuals give higher weight to the utility from gambling ($\alpha > \beta$) and as in Dragone (2015), $U(q(t)) = q(t)$ for simplicity. $U(s(t), a(t))$ and $U(r(t), w(t))$ are assumed to be continuously differentiable, with negative second order derivatives ($U_{ss}, U_{aa}, U_{rr}, U_{ww} < 0$). For simplicity and without lack of generality preferences for gambling are incorporated in the $U_s > 0$ assumption.

Following Dragone et al.(2015), we define reinforcement the case where, the more a person is addicted to gambling, the more he desires to consume the addictive good, so that the marginal utility of consuming an addictive good increases with past consumption of that good, that is, $U_{sa} > 0$. On the other side, tolerance means that utility from a given amount of consumption is lower when past consumption is greater, implying that $U_a < 0$ for $a > 0$. We also assume that r displays "virtuous" reinforcement effects in well-being accumulation, hence $U_{rw} > 0$.

In a continuous-time infinite horizon optimization problem, the individual chooses the optimal levels of s and r, by solving the following intertemporal problem

$$\max_{(s,r)} \int_0^\infty e^{-\rho t}[\alpha U(s(t), a(t)) + \beta U(r(t), w(t)) + U(q(t))]dt \tag{1}$$

constaint to

$$M = q(t) + p_s s(t) \tag{2}$$

$$\dot{a}(t) = s(t) - \delta a(t), a(0) = a_0 \tag{3}$$

$$\dot{w}(t) = r(t) - \delta w(t) - \varepsilon s(t), w(0) = w_0 \tag{4}$$

[3]The negative depreciation rate in the law of motion of addiction implies that addiction may slowly fall and be eliminated if it is not reinforced by further gambling "investment".

$$s(t) \geq 0,\ w(t) > 0 \text{ and } a(t) > 0.$$

Equation (2) is the usual budget constraint where M represents the individual's income (that we assume is the only source of wealth) and p_s is the price to partecipate to game s.

The differential equations (3) and (4) represent the stock-flow dynamics related to the two goods. In essence, the difference between the two are that, while the effect of accumulation of r produces a utility, the effect of addiction produces per se both a disutility and a reinforcement of the utility arising from further consumption for a.

For simplicity, omitting the time index, we obtain the following current-value Hamiltonian function and the related first order conditions on the state and costate variables[4]:

$$H = \alpha U(s,a) + \beta U(r,w) + M - p_s s + \mu(s - \epsilon a) + \lambda(r - \epsilon s - \delta w)$$

$$\beta U_r = -\lambda \tag{5}$$

$$\alpha U_s - p_s = -\mu + \lambda\varepsilon \tag{6}$$

$$\dot{\mu} = (\rho + \delta)\mu - \alpha U_a \tag{7}$$

$$\dot{\lambda} = (\rho + \delta)\lambda - \beta U_w \tag{8}$$

and the transversality condition:

$$\lim_{t\to\infty} e^{-\rho t}[\mu(t)a(t) + \lambda(t)r(t)] = 0$$

Differentiating equations (5) and (6) with respect to time t, we get

$$\beta(U_{rr}\dot{r} + U_{rw}\dot{w}) = -\dot{\lambda} \tag{9}$$

$$\alpha(U_{ss}\dot{s} + U_{sa}\dot{a}) = -\dot{\mu} + \dot{\lambda}\varepsilon. \tag{10}$$

Since in steady state $\dot{a} = 0, \dot{w} = 0$, substituting $\dot{\lambda}$ from equation (8) and λ from equation (5) in (9) and proceding in the same way on equation (10) exploiting equations (7) and (6) we derive the following system

$$\dot{r} = \frac{1}{U_{rr}}[(\rho + \delta)U_r + U_w]$$

[4]The costate variables μ and λ, associated to a and w respectively, represent the shadow value of past gambling experiences and of well-being arising from the enjoyment of r, i.e. how much the value of the objective function changes when there is a marginal variation in those variables

$$\dot{s} = \frac{1}{\alpha U_{ss}} \{-\beta\varepsilon[(\rho+\delta)U_r + U_w] + \alpha U_a - (\rho+\delta)(-\alpha U_s + p_s - \beta U_r \varepsilon)\}$$

$$s(t) = \delta a(t)$$

$$r(t) = \delta w(t) - \varepsilon s(t)$$

which in steady-state reduces to

$$-(\rho+\delta)U_r = U_w \tag{11}$$

$$U_a = \frac{1}{\alpha}\{(\rho+\delta)(p_s - \alpha U_s) + \varepsilon\beta U_w\} \tag{12}$$

$$s(t) = \delta a(t) \tag{13}$$

$$r(t) = \delta w(t) - \varepsilon s(t) \tag{14}$$

Condition (12) states that the marginal utility of addiction is equal to a weighted sum of the utility from gambling and utility from wellbeing arising from the ability generated by consumption of the r. Finally, conditions (13) and (14) obviously derive from the lack of accumulation/depletion of both addiction and wellbeing from the consumption of r in steady state[5]. From conditions (11)-(14) it is also clear that an agent rationally converges to a stable situation where both the well-being is maximized and he is not addicted to gambling ($U_a = U_w = 0$) in steady state, only when $U_s = \frac{p_s}{\alpha}$, that is, when the cost of gambling is equal to the marginal utility of gambling, see (11) and (12). A gambler is aware that $U_a < 0$, hence

$$\beta > -(\rho+\delta)\frac{p_s - \alpha U_s}{\varepsilon U_w} \qquad \text{if} \qquad U_w < 0. \tag{15}$$

$$\beta < -(\rho+\delta)\frac{p_s - \alpha U_s}{\varepsilon U_w} \qquad \text{if} \qquad U_w > 0 \tag{16}$$

Definition: *Under condition, (15), a Pathological Gambler is an individual aware that* $U_a < 0$*, but nonetheless choosing an amount of gambling leading to that harmful addiction level* $U_s < \frac{p_s}{\alpha}$.

[5] Notice as well that equation (11) shows that well-being from w is maximized only if the consumption of r is maximized, too. Moreover, since for $U_r < 0$ the agent is consuming r in excess (as decreasing time devoted to r and engaging in comfort goods would increase her utility), this means that utility from w would increase only for high values of r. In other words, in order to increase her well-being accumulation, the only possibility for the agent is to consume as more r as possible or equal to the maximum level.

We define as Pathological Gambler an individual that, even knowing that gambling addiction is harmful (since $U_a < 0$ by assumption) nonetheless he increases addiction by gambling more and choosing low levels of r since he gives high weight to the utility from gambling and low weight to the utility from the enjoyment of the relational good. From (12) we find that there are three feasible equilibria satisfying the assumptions $U_a < 0$.

Case 1: Assume that $p_s - \alpha U_s > 0$, that is $U_s < \frac{p_s}{\alpha}$. Since $U_a < 0$ by assumption, the second part of the sum in (12) has to be negative implying that U_w is also negative. Hence, by (11), $U_r > 0$ and therefore, as a consequence, the individual is below the maximum level of consumption of r. Hence $U_a < 0$ is possible only if (15) is satisfied. Case 1 may be defined as the case of a Pathological Gambler which consumes high quantities of s and low quantities of r.

Case 2: Assume $p_s - \alpha U_s < 0$ and assume that $U_w < 0$. This implies that $U_s > \frac{p_s}{\alpha} > 0$. We derive from (11) that $U_r > 0$. $U_a < 0$ is satisfied if (15) is satisfied. In this case the individual is consuming below the maximum levels of both goods s and r.

Case 3: Assume $p_s - \alpha U_s < 0$ and $U_w > 0$. This time $U_s > \frac{p_s}{\alpha} > 0$. In this case the individual consumes low quantities of s and high quantities of r. $U_a < 0$ is satisfied if (16) is satisfied.

Remark that the higher is β, the more difficult is to satisfy $U_a < 0$. This may be considered the case of a "mindful" or "conscious" gambler.

Notice that in the pathological gambler equilibrium steady state, see Case 1, we have that $s = \delta a$, that is, the consumption of s is high enough to compensate the decay of the consumption habit. Hence the process reducing dependence does not start and this players remain a pathological gambler[6].

The intuition behind Case 1 is that the individual overconsumes gambling beyond its maximum in terms of partial marginal utility due to the reinforcement effect ($U_{sa} > 0$)

[6]It is possible to show that (11)-(12) represent a not uncommon case of stable steady state solutions for high enough values of α versus β, corresponding to a stable saddle point, according to conditions for a modified Hamiltonian System as in Dockner and Feichtinger (1991), especially when we assume a quadratic specification which satisfies the assumptions made for the utility function and which allows for closed-form solutions (i.e., for instance, by assuming $(s(t), a(t)) = s(xa - \frac{s}{2}) - \frac{a^2}{2}$ and $U(r(t), w(t)) = r(yw - \frac{r}{2}) - \frac{w^2}{2}$. Full details on results from this specific functional form are available upon request)

which compensates the direct utility loss from addiction ($U_a < 0$) and the missed utility arising from under consumption of r. This may occur only for very low utility weights given to this last (β below a certain threshold). The negative side of pathological gambling therefore lies in the consumption of something which produces per se utility (the good s) but however generates a side effect (addiction) which produces a disutility to the same individual ($U_a < 0$). The net utility from the two effects remains however positive. Note that, even though we may think that it is not "healthy" to maximize in this way (due to addiction growth) the Pathological Gambler is still rational and maximising her "total" utility (where for total we mean the sum of its three parts). Why therefore we should stigmatize its choice? If instead of gambling we would examine smoking we could assume that the pathological smoker may underestimate the health costs of smoking. Again this should be a form of irrationality (due to the incapacity of incorporating such costs in her utility function).[7]

3 The social costs of Pathological Gambling

Beyond the effect on the gambler itself, the simplest way to model the social costs of Pathological Gambling is by assuming, as we do, that the Pathological Gambler is part of a household and that her behavior has negative externalities on the household budget and relations. The simplest way to model it is to consider the presence of a second "passive" member (since now on pm), i.e. an individual in the household who suffers from the consequences of gambling of the other individuals. In fact, under the Pathological Gambling scenario, the money available for consumption of the numerary good is reduced and this fact has negative effects on the passive household member. Moreover, we may reasonably believe that r is a relational good which is also consumed jointly among passive household members. In this case sa swell, gambling has direct negative consequences on the wellbeing

[7]An alternative motivation for government action against gambling would be that of introducing utility misprediction in our theoretical framework. We might in other terms argue that α is overestimated, β is underestimated and, as a consequence, the utility of the maximizing individual falls below its optimal value due to misprediction. Theoretical rationales for utility misprediction which can be applied to our case are thoroughly explored by Frey and Stutzer (2004). We however provide in what follows a theoretical explanation which motivates social action without recurring to utility misprediction.

of the other household members. Pathological Gambling becomes suboptimal in presence of rational and maximizing gamblers when we consider their relational ties with other individuals who are negatively affected by their behavior. To take into account these possibilities we make some simplifying assumptions.

First of all we assume that only two individuals exist in a given household, that is one of them is a mindful/conscious player PM and the other one is a pathological player PG. We assume that the conscious player has a parameter α_{pm} in his utility of gambling which can also be null if he doesn't like to gamble at all. At the same time, he thinks that the relational goods are more important , so that his β_{pm} is higher than the threshold β found in Section 2.

The conscious player solves:

$$\max_{(s,r)} \int_0^\infty e^{-\rho t}[\alpha_{pm}U(s(t),a(t)) + \beta_{pm}U(r(t),w(t)) + U(q_{pm}(t))dt] \tag{17}$$

We denote by s^*_{pm} the optimal level of gambling which maximizes the utility function of PM (which it is null if he does not gamble at all), and the corresponding optimal value function $V^*_o = V(s^*_{pm}, r^*_{pm}, q^*_{pm})$. When PM is damaged by the behavior of the other individual PG, his optimal value function V^*_l is solving the new "passive" member problem given by:

$$\max_{(s,r)} \int_0^\infty e^{-\rho t}[\alpha_{pm}U(s(t),a(t)) + (\beta_{pm} - k(\alpha - \alpha_{pm}))U(r(t),w(t)) + U(q_{pm}(t))]dt. \tag{18}$$

The utility of the passive member is reduced in terms of relational goods for a share k proportionally to the greater devotion that the other player gives to gambling rather than taking care of the family $\alpha - \alpha_{pm}$. Moreover passive member's utility is less even to respect to the quantity of the numeraire good that he can consume after having paid gambling and consumption for the PG:

$q_{pm} = M_{pm} - p_s s^{pm} - p_s s^* - \underline{q}$. s^* is the optimum for the PG and $\underline{q}$ is the minimum quantity of necessary good for a PG that the pm will support for him. Here we are assuming that PG can consume $q = M - p_s s$ if he has his own monetary income $M > 0$, and a positive share of the other player's income otherwise. That is, if the PG has no income [8] he can

[8] The PG could also borrow money at a debt ratio i which should be paid by the pm, but for simplicity we assume that $i = 0$ as our results do not substantially chance with this assumption.

still consume at least a minimum necessary share $\underline{q}$ and the desired s at a price p_s if he is borrowing money by using the available income from the pm. PM takes as given the PG decision and he maximizes his consumption of q_{pm} as if he had only a limited amount of available income M^d_{pm} which remains after having paid q and s for the PG.

In this case it is reasonable to assume he would prefer not to play at all in order to consume more q_{pm}. The loss, that would result, affects not only the co relational goods r and q but also his consumption of s^{pm} since he is conscious that he cannot consume anymore.

Anyway by considering only the most relevant social costs which a Social Planner should take into account, the passive member Welfare Loss may be measured by:

$$L_{pm} = V^*_o - V^*_l = \alpha k U(r) + p_s s * + \underline{q}.$$

4 To discourage the Pathological Gambling: two alternatives for the government's behaviour

In this Section we argue that the government may use two different strategies in order to tackle gambling addiction.

The first one aims to increase the gambling price, p_s through higher taxes. They would represent a permanent expected decrease in gambler's wealth to be taken into account in his maximization problem.

On the other hand the second strategy is to reduce the amount of available gambling opportunities (for instance by banning slot machines in the stores or creating limits to the maximum amount of bets from a given machine or related to a given individual) which implies setting up a maximum amount: $0 \leq s < \underline{s}$.

First of all, we consider the policy aimed at directly affecting the cost of gambling by raising its price, for instance through the introduction of excise taxes on sellers.

We analyze its long-run effects by focusing on stable steady states. We are going to show that when the price of gambling increases, addicted gamblers do respond to incentives and in the long-run they reduce the consumption of the addictive good when it becomes more expensive, i.e.

$$\frac{\partial}{\partial t}\frac{\partial s(t)}{\partial p_s} < 0. \tag{19}$$

To show that the above inequality holds true, following Becker ad Murphy (1988), we have

$$\frac{\partial}{\partial t}\frac{\partial s(t)}{\partial p_s} = \frac{\partial \dot{s}}{\partial p_s} = \frac{\partial}{\partial p_s}\frac{\partial s}{\partial a}\dot{a} = \frac{ds}{da}\frac{\partial \dot{a}}{\partial p_s} + \dot{a}\frac{\partial}{\partial p_s}\frac{\partial s}{\partial a}.$$

Cause of the reinforcement effect for an addicted gambler $\frac{ds}{da} > 0$ and since p_s has a negative effect on $s(t)$ given the budget constraint and on $\dot{a}$ we have $\frac{\partial \dot{a}}{\partial p_s} < 0$. Finally, observing that in steady-state $\frac{ds}{da}\frac{\partial \dot{a}}{\partial p_s} = 0$, we derive (19).

As far as the second strategy is concearned, we model the government taking into account its trade-off in dealing with the gambling problem. On one side, the government earns revenues from gambling activities while, on the other side, it may be concerned about the negative social externalities that gambling generates.

More specifically, we assume that a myopic government wants to earn a minimum amount of revenues from gambling, [9]

$$\gamma p_s s \geq \underline{E}$$

where γ is the tax rate calculated as a percent amount of the price p_s paid on each gambling play and the revenues cannot fall below a certain level $\underline{E}$.

In this case the minimum gambling opportunities fixed by the myopic government, cannot be lower than

$$\underline{s} \geq s_{pm} \geq \frac{\underline{E}}{p_s} \tag{20}$$

On the contrary, for a non myopic government, aware of the trade-off between gambling revenues and social externalities from gambling (which produce a level of welfare loss measured by L_{pm}, the previous constraint becomes

$$\gamma p_s \underline{s} + \theta L_{pm} \geq \underline{E}$$

where θ is a positive parameter and with

$$\underline{s} \geq s_{pm} \geq \frac{\underline{E} - \theta L_{pm}}{\gamma p_s} \tag{21}$$

[9] This is exactly what is stated in the agreement between the Italian government and the companies which sign the concession contract for installing slot machines in the country.

Therefore we have a more stringent threshold and the government which takes into account the trade-off will fix a lower share of maximum gambling allowance. What may determine this trade-off is that, on the one side, the government cares about tax revenues while, on the other side, it considers that the sensitiveness of the public opinion to the social costs of gambling may affect its re-election[10].

Notice as well that (20) and (21) coincide only when the long-run equilibrium and the desired level of well-being coincide.

In what follows we aim to compare the differences between a far-sighted government and a short-sighted/self-interested government. Moreover, we are interested in analyzing the most efficient strategy between a tax policy and a restriction policy.

With the tax policy in steady state, we notice a reduction in the consumption of s, when the government fixes a limit $\underline{s}$. In fact, using (20) and replacing the steady state level of s^* we have

$$s^* > \underline{s} \iff \delta a^* > \frac{\underline{E}}{\gamma p_s}.$$

The greater the addiction of the PG in equilibrium a^*, the higher is the gambling consumption chosen by the PG in steady state s^*. Hence, if the government fixes a minimum amount of gambling revenues E at high levels, there could not be too much difference between the implicit maximum level of gambling allowed by the government and the one desired by the PG. The latter is obviously much lower, the higher the price.

In the second strategy, it is much more likely that the restriction leads to a level of s lower than the desired one since we have

$$s^* > \underline{s} \iff \delta a^* > \frac{\underline{E} - \theta L_{pm}}{\gamma p_s}.$$

What matters, fixing the threshold, are three elements. First of all, the level of L_{pm}, a factor which impacts negatively on the threshold that a society considers important to preserve.

[10] To provide an example of the trade-off in practice, in December 2013 the Italian parliament voted an amendment to the Financial law where local administrations which enforced laws limiting gambling activities were asked to compensate the reduced fiscal revenues for the government budget. The bottom-up pressure from media and the public opinion forced the government to withdraw the amendment. Another example is the city of New York where in November the 5th 2013 the council directly investigated citizens preferences with a referendum on the creation of new video lottery.

Secondly, the minimum amount of revenue E that the government aims to achieve, which positively affects the threshold. Finally, the coefficients γ and δ which reduce the threshold since they increase the entries even when gambling is strongly limited.

Now we compare a tax policy versus a restriction policy. When the government opts for a price increase, the amount of gambling chosen in the steady-state reduces to

$$\delta a^*(1 - \frac{\partial s^*}{\partial p_s})$$

while with the second policy it is

$$\delta a^* - \frac{\underline{E} - \theta L_{pm}}{\gamma p_s}$$

Remark that the latter policy is more efficient, in terms of amount of gambling reduced, holding the same revenues $\underline{E}$.

In fact it implies a higher reduction of gambling if

$$\delta a^*(1 - \frac{\partial s^*}{\partial p_s}) - \delta a^* + \frac{\underline{E} - \theta L_{pm}}{\gamma p_s} < 0$$

or

$$\frac{\underline{E} - \theta(\alpha k U(r) + p_s \delta a^* + \underline{q})}{\gamma p_s} < \delta a^* \frac{\partial s^*}{\partial p_s}$$

Therefore, if the government is following a restriction policy, the above condition is certainly verified for high value of L_{pm}, for high value of addiction, for high values the passive member attaches to any additional unit of r instead of s with respect to the PG, (i.e. kU_r which will be lost as PG devotes more care to gambling), and for higher values of the mimimum amount $\underline{q}$ the PG needs to consume and he can't pay by himself.

In this case a restriction policy leads to a greater disincentive to the PG, so reducing losses for the passive member and allows the government to save money to support these losses.

The intuition behind our result is that gamblers' dependence reduces the effectiveness of higher prices vis-à-vis outright gambling limitations. The addicted gambler will try to gamble even if p_s is higher and the price increase may produce the paradox of further reducing wellbeing of passive household members without limiting gambling consumption.

This result is in line with recent empirical analysis on the effects of restrictions policies on another kind of addiction, i.e. smoking addiction, Wakefield et al.(2000) determine the relation between extent of restrictions on smoking at home, at school and in public places and smoking prevalence among school students. Their results suggest that more extensive bans on smoking in public places and enforced bans on smoking at school may reduce the number of smoking teenagers. According to Farrelly et al.(1999) having a 100% smoke-free workplace would reduce smoking prevalence by 6% points and average daily consumption among smokers by 14% relative to workers subject to minimal or no restrictions. Fichtenberg and Glantz (2002)compare the effects of restriction policies with those of an increase in excise taxes and find that smoke-free workplaces not only protect non-smokers from the dangers of passive smoking, but also reduce consumption in more significant portion. To obtain the same effect cigarette taxation should increase by 300%.

5 The revolution "slot mob" as a government substitute

In this Section we argue that a contribution to solve the gambling problem may be found devising "bottom-up" initiatives by which "socially responsible citizens" contribute with their action to produce "nudging" effects on myopic governments . In essence, as explained in footnote 11, the bottom up action of the public opinion may modify the government perception of the parameter θ, thereby affecting its trade-off and leading to a stronger engagement of the latter against gambling. There are several works (see for instance, Becchetti et al., 2011; Becchetti et al.,2013) showing how a small share of consumer choices affected by social and environmental concerns significantly influence the behaviour of profit maximizing firms whose economic and financial success depend on small changes in market shares, revenues and profits. Institutions are nonetheless affected as politicians try to represent issues of these groups not to lose their political support.

One of these important bottom-up approaches which has been recently experienced is that of the so-called "slot-mobs"($http : //www.nexteconomia.org/slots - mob$. The idea is to create the largest possible group of citizens and to bring them to reward with their shopping actions cafeterias which made the choice to remove slot machines from their shops.

Since 2013 a coalition of over 70 organizations in Italy organized slot-mobs in several Italian cities with the goal of raising awareness of the population against the risk of gambling. After the beginning of the slot mob initiative several laws restricting gambling have been taken in the cities in which slot-mobs were operated. What may be inferred is that slot-mobs have raised the sensitivity of voters on the issue and thereby increased the relevance of the parameter θ in (18), leading the government to give relatively more weight to the social costs of gambling than to its tax revenues.

6 Conclusions

In an intertemporal continuous time model we defined pathological gambling and discussed conditions under which pathological gambling, even representing the optimal choice for the gambler in terms of aggregate utility, produces "painful" addiction for him plus social costs.

Based on this theoretical framework we further address the issue of the optimal policies needed to tackle this phenomenon.

In our model the pathological gambler is a rational and maximizing individual who compensates the disutility arising from increasing addiction with the utility of gambling which is enhanced by the reinforcement effect of past gambling choices. Our model however provides a theoretical framework which properly takes into account social costs of pathological gambling.

The pathological gambler is part of a household composed by a second "passive" member whose utility depends on the other two goods available to him and the pathological gambler (a standard numerary consumption good and a complimentary relational good). Consumption of the above mentioned two goods is however reduced by the pathological gambler's overconsumption of gambling.

A long sighted government may act on the problem in two ways. First of all, it may increase the cost of gambling thereby reducing gambling consumption for the pathological gambler. Secondly, it may directly reduce gambling opportunities.

In our model we demonstrate why and under which conditions the second policy is to be preferred.

We also discuss the role played by bottom up action of a minority of "gambling concerned" individuals (as occurred with the recent wave of slot-mobs) which can raise government sensitivity on the issue, thereby affecting the trade-off of the latter between tax revenues from gambling and gambling restrictions.

Our theoretical framework may be a benchmark for future research on the issue. In our model we demonstrate that the pathological gambling equilibrium occurs only when the individual attributes extra weight to gambling activity. Since it is reasonable to assume that advertisements on gambling may significantly affect such preference weight, a third policy action of banning gambling propaganda may be effective in prevent pathological gambling. Also mixed policy options affecting both sides of the trade-off such as those of taxing gambling advertisements could be further explored.

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