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Would a rational underage binge-drink?

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Abstract

This paper provides a utility-based definition of binge drinking and examines the compatibility of this phenomenon with rational decision making. Prohibition of young people's consumption of alcohol is frequently violated with binge-drinking in groups. The analysis considers the roles of peer-pressure, full price of alcohol and crowding in underage group-drinking sessions and identifies the conditions for binge-drinking by expected utility maximizing members. Rational binge-drinking occurs when the impact of the peer-pressure on the individual member's utility exceeds the loss of utility from the forgone spending on all other goods associated with the expected full marginal cost of consuming alcohol.

***JEL* Classification:** D1

Keywords: Alcohol; Minimum Age; Peer Pressure; Rationality; Binge Drinking

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1. Introduction

The optimal level of public investment in controlling the prevalence of alcohol consumption is linked to the choice between prohibition and accommodation. Tragler et al. (2001) and Levy et al. (2006) have demonstrated that the likely non-concavity of the public planner's optimal control problem's Hamiltonian in the prevalence of consumption of an intoxicating substance gives rise to unstable steady states. It also implies the existence of a threshold number of consumers beyond which accommodation and permitting convergence to the high-prevalence and low-control steady state along the only stable manifold is socially optimal. Prohibition of alcohol had been decreed in several countries during the early part of the twentieth century, including the United States (1920-1933). In view of the very large initial number of alcohol consumers and the aforementioned threshold-based argument, prohibition was not socially optimal in the United States. It became less desirable as bootlegging and organised crime had taken control of the supply of alcohol. Consequently, the prohibition was replaced by accommodation, but with a minimum-age restriction.

Age restrictions tend to lead to formation of groups that facilitate their violation by the affected individuals. The focus of the theoretical analysis presented in this paper is on the possible link between underage binge-drinking and participation in group-drinking session. In particular, the analysis considers aspects of affiliation to a group of alcohol consumers that are relevant to the investigation of whether binge-drinking can be an outcome of an individual member's decision making that is oriented to maximize her/his expected utility. On the one hand, affiliation to a drinking group moderates the personal price of alcohol for the underage individual members. In addition to the acquisition cost, the personal price of alcohol includes the moral costs of breaking the law and the costs of risk bearing of involvement in accident and violent exchange. Naturally, the larger the group, the greater is its bargaining power as well as its ability to provide moral support, care and protection to members. Namely, the size of the group lowers the personal price of alcohol and, *ceteris paribus*, the increases the quantity of alcohol demanded by the members. Yet, as demonstrated in the ensuing sections, the moderating effect of group on personal price cannot by itself prove binge drinking to be rational in the said von Neumann-Morgenstern sense. The individual member's level of alcohol consumption might be further intensified by peers' expectations of displaying good drinking companionship. Our analysis demonstrates the crucial role of the individual utility's sensitivity to such peer pressure in rendering binge-drinking as a possible rational choice. On the other hand, an income effect should be taken into account. Due to intoxication there can be a negative relationship between earning and alcohol consumption. In addition, crowding increases the probability of being noticed by law-enforcers and, consequently, fined.

To set the stage to the analysis of the group's overall effect on rational members' consumption of alcohol, sections 2 and 3 firstly consider the case of solitary drinkers—individuals whose utility is not affected by externalities generated by shared drinking sessions—in a society free of age restrictions on alcohol consumption. Section 2 offers a formulation of the utility from alcohol and, subsequently, a utility-based definition of binge drinking. Section 3 provides a relationship between earnings and consumption of alcohol and, consequently, the budget for all other goods. It shows that, at any age, binge-drinking is not optimal for lone rational drinkers. Section 4 formulates the effects of minimum-age restriction and participating in underage group-drinking sessions on members' expected utilities. Subsequently, it identifies the conditions for rational binge-drinking.

2. Utility-based definition of binge drinking

To provide a utility-based definition of binge-drinking let us consider a setting where the individual's utility from consuming alcohol is not tainted by external effects; namely, drinking in solitary. The formulation of utility from consuming alcohol in solitary at any given age is based on the following assumptions. A week is the relevant unit of time as it is neither too short, nor too long, for accounting the individual's cycle of drinking, work, study and consumption of other goods and services. The individual's weekly cycle commences with drinking in a private session that starts on Saturday night and finishes by early Sunday morning. During the rest of the week the individual refrains from consuming alcohol (due to work, care and/or study duties). By the next Saturday night the individual is fully recovered from the adverse effects of alcohol.

The individual's alcohol consumption in the weekly session at t years of age (c_t) has an age-dependent tolerance upper-bound ($\overline{c}_t$), which indicates her/his *incapacitating intake* at that particular age. Reaching this tolerance upper-bound nullifies the individual's productivity and, in turn, income and spending on goods services during the following seven days. The consumption of alcohol might also directly decrease the individual's utility from some goods and services and increase the utility from others. As the aggregate direct effect is not clear, and for simplicity, overall neutrality is assumed and displayed by separability between the utility from alcohol and the utility from all other goods and services. That is, at any age t, the individual's (overall) weekly utility (u_t) is equal to the sum of the weekly utility from alcohol (u_t^a) and the weekly utility from all other goods and services (u_t^g):

$$u_t = u_t^a + u_t^g. \tag{1}$$

The weekly utility from alcohol is taken to be equal to the difference between the pleasure from drinking and the discomfort associated with alcohol intoxication (impaired balance, loss of muscle coordination, drowsiness, nausea, etc.). At sufficiently low levels of consumption, the t-year old individual's marginal pleasure from drinking exceeds the marginal discomfort. But while the marginal pleasure diminishes with the quantity of alcohol consumed, the marginal discomfort is increasing and eventually becomes dominant. At the consumption level $\hat{c}_t$ within the physiologically feasible range $(0, \overline{c}_t)$ the marginal discomfort is equal to the marginal pleasure, rendering the marginal weekly utility from alcohol to be zero. This property can be captured by the following polynomial:

$$u_t^a = \alpha_t c_t - \beta_t c_t^{\,2} \tag{2}$$

where the age-dependent coefficients are such that $\alpha_t > \beta_t > 0$. This specification can be viewed as a second-order approximation of a general, single-peaked, function of weekly utility from alcohol: $u_t^a(c_t) \approx u_t^a(0) + u_t^{a\prime}(0)c_t + 0.5u_t^{a\prime\prime}(0)c_t^{\,2}$ with $u_t^a(0) = 0$, $\alpha = u_t^{a\prime}(0) > 0$ and $-\beta = 0.5u_t^{a\prime\prime}(0) < 0$. As $u_t^{a\prime}(\hat{c}_t) = 0$, $\hat{c}_t = \alpha_t / 2\beta_t$ and, consequently, $\beta_t = 0.5\alpha_t / \hat{c}_t$. In turn, Eq. (2) can be expressed as:

$$u_t^a = \alpha_t[c_t - 0.5(c_t^{\,2} / \hat{c}_t)]. \tag{3}$$

Since $u_t^{a\prime} \gtreqless 0$ as $c_t \lesseqgtr \hat{c}_t$ then, from the perspective of generating weekly utility from alcohol *per se*, $\hat{c}_t$ is the individual's *bliss intake* of alcohol in a weekly drinking session at t-years of age. Consumption of alcohol beyond $\hat{c}_t$ is excessive and represents *binge drinking*. In contrast to the rule of thumb that regards consumption beyond four shots, in the case of females, and five shots, in the case of males, as binge drinking (Courtney and Polich, 2009), this proposed definition is sensitive to individual variations. The intensity of binge drinking can be measured by $[(c_t - \hat{c}_t) / (\overline{c}_t - \hat{c}_t)] \in (0,1)$ for any $c_t \in (\hat{c}_t, \overline{c}_t)$.

3. Income effect and solitary consumption of alcohol in the absence of age restrictions

The consumption of alcohol reduces productivity and, consequently, the budget available for buying goods. We take all other goods as an aggregate and let $p > 0$ denote the relative price of alcohol and I_t the individual's weekly income, or performance-based budget allocated by parents in the case of non-working adolescents. We assume that the individual's marginal weekly utility from spending on all other goods ($I_t - pc_t$) is constant, but can be age dependent ($\gamma_t > 0$). We further assume that the individual's current weekly income declines from an alcohol-free age-dependent level I_t^f proportionally to the individual's degree of incapacitation by alcohol, i.e., $I_t = (1 - c_t / \overline{c}_t) I_t^f$. Hence, the individual weekly utility from all the other (non-alcoholic) goods is:

$$u_t^g = \gamma_t [(1 - c_t / \overline{c}_t) I_t^f - pc_t]. \tag{4}$$

Recalling (1), (3) and (4), the weekly utility of a solitary consumer of alcohol is:

$$u_t = \alpha_t [c_t - 0.5(c_t^{\,2} / \hat{c}_t)] + \gamma_t [(1 - c_t / \overline{c}_t) I_t^f - pc_t]. \tag{5}$$

We postulate that a rational t-year old solitary person sets c_t to maximize her/his weekly utility. The first-order condition for maximum weekly utility is:

$$u_t' = \alpha_t - \alpha_t \frac{c_t^*}{\hat{c}_t} - \gamma_t [p + (1 / \overline{c}_t) I_t^f] = 0. \tag{6}$$

As the second-order condition is satisfied ($-\alpha / \hat{c}_t < 0$), the optimal weekly alcohol consumption in solitary for a t-year old person is

$$c_t^* = \left[1 - \frac{\gamma_t}{\alpha_t} \left(p + \frac{I_t^f}{\overline{c}_t} \right) \right] \hat{c}_t. \tag{7}$$

Proposition 1. A rational person who drinks alone does not binge.

Proof: From equation (7), $c_t^* \le \hat{c}_t$ as $p + I_t^f / \overline{c}_t \ge 0$.

At any age, the individual's utility maximizing consumption of alcohol in solitary is lower than her/his current age bliss intake by a proportion that is equal to the product of the full price of alcohol $[p + (I_t^f / \overline{c}_t)]$ and the relative marginal utility from all other goods (γ_t / α_t). Even when alcohol is freely available, a rational person drinks in solitary less than $\hat{c}_t$ as long as drinking has an adverse effect on her/his earning ability.

4. Minimum-age restriction, group influence and alcohol consumption

The analysis presented in the previous section suggests that rational young people do not binge-drink in solitary. It is demonstrated in this section that this outcome does not necessarily prevail when they face a minimum-age restriction and, as frequently observed, drink in groups. The present section incorporates the effects of minimum-age restriction and groups into the formulation of the expected utility function of underage consumers of alcohol and identifies the conditions for rational underage people to binge-drink.

As in the previous section, a weekly cycle is considered with a drinking session that starts on Saturday night and finishes on early Sunday morning and, therefore, affects the participants during the following seven days. But now the drinking session is shared with similarly under-aged companions and the participants are facing a risk of being noticed by law-enforcers and, subsequently, punished. In addition to the direct satisfaction from consuming alcohol, a person who participates in a group drinking session can gain (loose) utility from increased (diminished) reputation of being an invaluable drinking companion proportionally to the product of the deviation of her/his alcohol consumption from an expected minimum norm, $c_t^e > 0$, and the relative size of the group of the rest the drinking-session's members:

$$R_t = r_t((n_t - 1)/\overline{n}_t)(c_t - c_t^e) \tag{8}$$

where $r_t \geq 0$ is an age-dependent coefficient, $\overline{n}_t$ is the largest possible group of affiliation for the underage under consideration, and n_t is a predetermined number of the drinking-session's members. In this specification, $n_t - 1$ indicates the number of drinkers accompanying the individual under consideration, $0 \leq (n_t - 1)/\overline{n}_t < 1$ indicates the intensity of peer pressure and r_t the sensitivity of the individual's weekly utility to peer pressure.

There are other disadvantages and advantages from drinking in group. On the one hand, the probability of being noticed by law enforcers and, in turn, punished, increases with crowding—namely, the number of companions. With $0 < \varphi_t < 1$ denoting the probability of being noticed by law-enforcers for the largest possible group of t-year old underage drinkers, the probability of being noticed for a t-year old underage drinker in a group of $n_t \leq \overline{n}_t$ is $\varphi_t(n_t/\overline{n}_t)$. Since similarity to eligible-age consumers increases with age, it is possible that φ_t diminishes as t converges to the minimum age. The punishment for drinking is assumed to be a fine that is proportional to the level of alcohol consumption: $\mu_t c_t$, where $\mu_t \geq 0$ is an age-dependent fine per unit of alcohol. The underage alcohol consumer expects a portion $0 \leq \varepsilon_t \leq 1$ of the fine to be borne by her/his parents, depending on their degree of leniency.

On the other hand, affiliation to a group reduces the personal price of alcohol for the underage individual consumer. The larger the group, the greater are its bargaining, supportive, caring and protecting capabilities. We assume that the personal price of alcohol for a group member is $[1-\theta_t(n_t/\bar{n}_t)]p_t^s$, where p_t^s is the personal price of alcohol for a lone t-year old person facing age restrictions and $0<\theta_t<1$. Due to limited access to alcohol, $p_t^s > p$. Yet it is possible that p_t^s decreases and θ_t increases with t.

In view of these assumptions and Eq. (5), the distribution of the underage consumer's weekly utility is:

$$\tilde{u}_t = \begin{cases} \alpha_t[c_t - 0.5(c_t^2/\hat{c}_t)] + r_t((n_t-1)/\bar{n}_t)(c_t - c_t^e) + \gamma_t\{(1-c_t/\bar{c}_t)I_t^f - [1-\theta_t(n_t/\bar{n}_t)]p_t^s c_t - (1-\varepsilon_t)\mu_t c_t\} & \varphi_t(n_t)/(\bar{n}_t) \\ \alpha_t[c_t - 0.5(c_t^2/\hat{c}_t)] + r_t((n_t-1)/\bar{n}_t)(c_t - c_t^e) + \gamma_t\{(1-c_t/\bar{c}_t)I_t^f - [1-\theta_t(n_t/\bar{n}_t)]p_t^s c_t\} & 1-\varphi_t(n_t)/\bar{n}_t) \end{cases} \quad (9)$$

and her/his expected weekly utility is:

$$\begin{aligned} E(\tilde{u}_t) &= \alpha_t[c_t - 0.5(c_t^2/\hat{c}_t)] + r_t((n_t-1)/\bar{n}_t)(c_t - c_t^e) \\ &\quad + \gamma_t\{(1-c_t/\bar{c}_t)I_t^f - [1-\theta_t(n_t/\bar{n}_t)]p_t^s c_t\} - \varphi_t(n_t/\bar{n}_t)\gamma_t(1-\varepsilon_t)\mu_t c_t \end{aligned} \quad .(10)$$

A rational, in the von Neumann-Morgenstern sense, underage person chooses an alcohol intake in the weekly group-drinking session that maximizes her/his expected weekly utility. As $E(\tilde{u}_t)$ is concave in c_t, that underage's optimal alcohol consumption must satisfy the following necessary condition:

$$\alpha_t[1-(c_t^o/\hat{c}_t)] + r_t((n_t-1)/\bar{n}_t) - (\gamma_t/\bar{c}_t)I_t^f - \gamma_t[1-\theta_t(n_t/\bar{n}_t)]p_t^s - \varphi_t(n_t/\bar{n}_t)(1-\varepsilon_t)\mu_t = 0 \,. \quad (11)$$

Consequently,

$$c_t^o = \left[1 + \frac{[r_t(n_t-1)/\bar{n}_t) + \gamma_t\theta_t p_t^s - \varphi_t\gamma_t(1-\varepsilon_t)\mu_t](n_t/\bar{n}_t) - \gamma_t[p_t^s + (I_t^f/\bar{c}_t)]}{\alpha_t}\right]\hat{c}_t \,. \quad (12)$$

As indicated earlier, the size of the drinking group is taken to be exogenous: namely, the underage person under consideration neither has the power to form her/his own group, nor the opportunity to select one from a set of groups with variable size. Of course, a rational person joins an existing group of $n_t - 1 > 0$ veteran members, or quit her group of $n_t > 1$ members, if, and only if, $E(\tilde{u}_t(c_t^o(n_t>1))) - E(\tilde{u}_t(c_t^o(n_t=1)))$ is larger, or smaller, than zero, respectively. As shown in the Appendix,

$$
\begin{aligned}
&E(\tilde{u}_t(c_t^o(n_t > 1))) - E(\tilde{u}_t(c_t^o(n_t = 1))) = r_t[(n_t - 1)/\bar{n}_t)][c_t^o(n_t > 1) - c_t^e] \\
&\quad + \left([\alpha_t - \gamma_t I_t^f / \bar{c}_t]\{[r_t(n_t - 1)/\bar{n}_t - \varphi_t\gamma_t(1-\varepsilon_t)\mu_t]((n_t - 1)/\bar{n}_t)\}/\alpha_t\right)\hat{c}_t \\
&\quad - \gamma_t\{[1-\theta_t(n_t/\bar{n}_t)]p_t^s + \varphi_t(n_t/\bar{n}_t)(1-\varepsilon_t)\mu_t\}c_t^o(n_t > 1) \\
&\quad + \gamma_t\{[1-\theta_t(1/\bar{n}_t)]p_t^s + \varphi_t(1/\bar{n}_t)(1-\varepsilon_t)\mu_t\}c_t^o(n_t = 1) \\
&\quad - (0.5\alpha_t/\hat{c}_t)[c_t^o(n_t > 1)^2 - c_t^o(n_t = 1)^2]
\end{aligned}
\tag{13}
$$

where $c_t^o(n_t > 1)$ is given by (12) and

$$
c_t^o(n = 1) = \left[1 + \frac{[\gamma_t\theta_t p_t^s - \varphi_t\gamma_t(1-\varepsilon_t)\mu_t](1/\bar{n}_t) - \gamma_t[p_t^s + (I_t^f/\bar{c}_t)]}{\alpha_t}\right]\hat{c}_t\,. \tag{14}
$$

Proposition 2

i. If r_t is greater (smaller) than $\gamma_t[\varphi_t(1-\varepsilon_t)\mu_t - \theta_t p_t^s]$, then a rational underage person consumes a larger (smaller) quantity of alcohol in group-drinking sessions than in seclusion. (Straightforward from comparing the right-hand side of equation (12) when $n_t > 1$ to that when $n_t = 1$.)

ii. If $r_t((n_t - 1)/\bar{n}_t) > \gamma_t\{\varphi_t(n_t/\bar{n}_t)(1-\varepsilon_t)\mu_t + [(1-\theta_t(n_t/\bar{n}_t))p_t^s + (I_t^f/\bar{c}_t)]\}$, then a rational underage person binge-drinks in group-drinking sessions. (Straightforward from equation (12).)

5. Conclusion

Rational binge-drinking presents a strong cognitive obstacle to overcome alcoholism. The analysis considers aspects of affiliation to a group of alcohol consumers that are relevant to the investigation of whether binge-drinking can be an outcome of an individual member's decision making that is oriented to maximize her/his expected utility. The first part of Proposition 2 reveals that switching from solitary drinking to drinking in company does not necessarily increase the alcohol consumption of a rational underage person. Her/his alcohol consumption can be reduced by participating in group-drinking sessions if the sensitivity of her/his utility to peer pressure is smaller than the difference between the forgone utility from spending on other goods associated with the intensifying marginal effect of crowding on the expected self-financed fine and the utility gains from spending on other goods associated with the moderating marginal effect of the group's bargaining power on the price of alcohol.

The second part of Proposition 2 says that, unlike rational consumption of alcohol in solitary, rational consumption of alcohol in company can exceed the personal bliss level. As

$0 < \theta_t < 1$ and $0 < n_t / \overline{n}_t \leq 1$, $\varphi_t(n_t / \overline{n}_t)(1-\varepsilon_t)\mu_t + \{[1-\theta_t(n_t / \overline{n}_t)]p_t^s + (I_t^f / \overline{c}_t)\} > 0$. That is, the moderating effect of the bargaining power of the group cannot by itself lead rational members of a drinking session to binge-drink. Rational binge-drinking occurs when the impact of the peer-pressure on the individual's weekly utility exceeds the loss of utility from the forgone spending on all other goods associated with the *expected* full marginal cost of alcohol which, in addition to the full price in the absence of age restrictions, includes the self-financed portion of the marginal expected fine. Peer-pressure, compounded by sensitivity of the individual's weekly utility to such a pressure, and sufficiently low marginal utility from spending on all other goods are essential for underage binge-drinking to be rational. The critical sensitivity (r_t) to peer pressure required for rational binge-drinking to take place decreases with the expected portion of the fine to be borne by the parents (ε_t), the moderating effect of the group's bargaining power on the purchasing price of alcohol (θ_t) and the individual's tolerance to alcohol ($\overline{c}_t$), and increases with the probability of being noticed by law-enforcers ($\varphi_t(n_t / \overline{n}_t)$), the ratio of the fine to the intake of alcohol (μ_t), the alcohol-free (potential) weekly earning (I_t^f), and the marginal weekly utility from all other goods (γ_t).

There may be a positive relationship between sensitivity to peer pressure and age during adolescence. The underlying rationale is that being initially responsive to parents' and/or educators' expectations, adolescents may become more and more sensitive to friends' expectations at the passage of years. The existence of such a relationship can be manifested by a greater prevalence of binge drinking within older cohorts of adolescents.

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APPENDIX

From (10),

$$\begin{aligned}&E(\tilde{u}_t(c_t^o(n_t>1)))=[\gamma_t I_t^f - r_t((n_t-1)/\overline{n}_t)c_t^e]\\&+\{\alpha_t + r_t((n_t-1)/\overline{n}_t)-\gamma_t I_t^f/\overline{c}_t-\gamma_t[1-\theta_t(n_t/\overline{n}_t)]p_t^s-\gamma_t\varphi_t(n_t/\overline{n}_t)(1-\varepsilon_t)\mu_t\}c_n^o\\&-(0.5\alpha_t/\hat{c}_t)c_n^{o2}\end{aligned}$$

and

$$\begin{aligned}&E(\tilde{u}_t(c_t^o(n_t=1)))=\gamma_t I_t^f+\{\alpha_t - I_t^f/\overline{c}_t-\gamma_t[1-\theta_t(1/\overline{n}_t)]p_t^s-\gamma_t\varphi_t(1/\overline{n}_t)(1-\varepsilon_t)\mu_t\}c_1^o\\&-(0.5\alpha_t/\hat{c}_t)c_1^{o2}.\end{aligned}$$

Hence,

$$\begin{aligned}&E(\tilde{u}_t(c_t^o(n_t>1)))-E(\tilde{u}_t(c_t^o(n_t=1)))=-r_t((n_t-1)/\overline{n}_t)c_t^e\\&+\{\alpha_t + r_t((n_t-1)/\overline{n}_t)-\gamma_t I_t^f/\overline{c}_t-\gamma_t[1-\theta_t(n_t/\overline{n}_t)]p_t^s-\gamma_t\varphi_t(n_t/\overline{n}_t)(1-\varepsilon_t)\mu_t\}c_n^o\\&-\{\alpha_t-\gamma_t I_t^f/\overline{c}_t-\gamma_t[1-\theta_t(1/\overline{n}_t)]p_t^s-\gamma_t\varphi_t(1/\overline{n}_t)(1-\varepsilon_t)\mu_t\}c_1^o\\&-(0.5\alpha_t/\hat{c}_t)[c_n^{o2}-c_1^{o2}].\end{aligned}$$

By collecting terms

$$\begin{aligned}&E(\tilde{u}_t(c_t^o(n_t>1)))-E(\tilde{u}_t(c_t^o(n_t=1)))=r_t[(n_t-1)/\overline{n}_t)](c_n^o-c_t^e)\\&+[\alpha_t-\gamma_t I_t^f/\overline{c}_t](c_n^o-c_1^o)\\&-\gamma_t\{[1-\theta_t(n_t/\overline{n}_t)]p_t^s+\varphi_t(n_t/\overline{n}_t)(1-\varepsilon_t)\mu_t\}c_n^o\\&+\gamma_t\{[1-\theta_t(1/\overline{n}_t)]p_t^s+\varphi_t(1/\overline{n}_t)(1-\varepsilon_t)\mu_t\}c_1^o\\&-(0.5\alpha_t/\hat{c}_t)[c_n^{o2}-c_1^{o2}].\end{aligned}$$

From (12),

$$c_t^o(n_t>1)=\left[1+\frac{[r_t(n_t-1)/\overline{n}_t+\gamma_t\theta_t p_t^s-\varphi_t\gamma_t(1-\varepsilon_t)\mu_t](n_t/\overline{n}_t)-\gamma_t[p_t^s+(I_t^f/\overline{c}_t)]}{\alpha_t}\right]\hat{c}_t$$

and

$$c_t^o(n=1)=\left[1+\frac{[\gamma_t\theta_t p_t^s-\varphi_t\gamma_t(1-\varepsilon_t)\mu_t](1/\overline{n}_t)-\gamma_t[p_t^s+(I_t^f/\overline{c}_t)]}{\alpha_t}\right]\hat{c}_t\,.$$

Hence,

$$c_t^o(n_t>1)-c_t^o(n=1)=\left[\frac{[r_t(n_t-1)/\overline{n}_t-\varphi_t\gamma_t(1-\varepsilon_t)\mu_t]((n_t-1)/\overline{n}_t)}{\alpha_t}\right]\hat{c}_t\,.$$