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Temptation and the efficient taxation of education and labor

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Abstract

This paper studies efficient tax policies in Ramsey's tradition when consumers face temptation and self control problems in intertemporal decision making. We embed the class of preferences developed by Gul and Pesendorfer into a simple two-period life-cycle model and show that education should be effectively subsidized if the elasticity of the earnings function is increasing in education *and* if temptation problems are sufficiently severe. By contrast, if temptation problems are not sufficiently severe, efficient education policy calls for taxing education. Moreover, efficient labor taxation calls for subsidizing qualified labor if the strength of temptation is sufficiently large.

1 | INTRODUCTION

Individuals face self control problems and temptation in intertemporal decision making. The analysis of these phenomena has recently received much attention in both the experimental and theoretical literature.[1] Many experimental studies, for example, have documented preference reversals for intertemporal choices (see Frederick, Loewenstein, & O'Donoghue, 2002 for an overview). Specifically, if subjects are asked to choose between a large and delayed reward and a smaller immediate one, they tend to prefer the latter whereas for two delayed rewards subjects are more likely to prefer the later and larger one. Provided that the subjects' preferences are stationary, this evidence implies that the same intertemporal trade-off is resolved differently depending on when the decision is implemented (on what date the reward is received). From a theoretical point of view, Gul and Pesendorfer (2001, 2004, 2005) introduce a new class of utility function which may explain preference reversals over time using time consistent preferences.[2] More precisely, to model temptation and self control problems, the utility function by Gul and Pesendorfer consists of two parts: a commitment utility and a temptation utility. While the first part measures individual preferences on actual consumption choices, the second one

[1] See Lipman and Pesendorfer (2010) for a survey.

[2] A second modeling approach where agents have time inconsistent preferences has been developed by Laibson (1997), who in turn builds on the earlier work by Strotz (1956) and Phelps and Pollak (1968).

measures the preference on consumption that would have been chosen had the individual succumbed to temptation. The individual's actual choice is then a compromise between the commitment utility and the cost of self control, resulting from deviations from the temptation utility. As a result, the presence of temptation biases individuals' choices toward current consumption which, in turn, implies that they over-discount the future.

The aim of the present paper is to study optimal tax policies using the preference representation by Gul and Pesendorfer. More specifically, the present paper extends the inverse elasticity rule of optimal taxation, being usually attributed to Ramsey (1927), when individuals face temptation and self control problems in intertemporal decision making. In a first step, we study efficient education policies. To do so, we set up a simple two-period life-cycle model of a representative taxpayer who has to make a static decision on education, saving, and labor in both the first period (nonqualified labor) and the second period (qualified labor). Education causes a monetary cost and, as it takes time, a cost in the forgone income earned by nonqualified labor. The source of temptation (the need for immediate gratification) is to over-discount the future. It reduces individual's incentive to save, to invest into education and to have high levels of future consumption. Hence, the agent is over-consuming, under-saving and under-investing in education in the first period of life.

Recently, Richter (2009, 2011) has shown how the inverse elasticity rule extends to the context of efficient education policy: Education should effectively be subsidized if the elasticity of the earnings function is increasing in education.[3] The present paper qualifies this conclusion and shows that it only holds if self control problems are sufficiently severe. Then, the effect of temptation is to increase effective subsidization of education relative to nonqualified labor provided the social costs of taxation are large. By contrast, if self control problems are not too severe, efficient education policy calls for taxing education.[4]

The rationale behind this result is the following. The cost of self control is defined as the difference between the temptation utility of the 'most tempting option', that is, the utility of the preferred consumption choice of an individual exerting no self control when it comes to intertemporal decision making, and the temptation utility of the chosen option. Since the temptation utility of the "most tempting option" is independent of individuals' decisions, they will always suffer from a (noncontrollable) loss of utility. Consequently, a welfare-maximizing planner trades off the following objectives: Maximization of the social ability rent, minimization of the efficiency loss resulting from distorted choices of the utility-generating quantities (standard optimal taxation targets) *and* the efficiency gains resulting from reductions in the cost of self control (temptation target). While the first two targets are addressed by classic optimal taxation criteria, the temptation target works differently: In the present framework, the social planner can reduce the cost of self control by transferring resources from the first period to the second one, for example, by taxing current labor in the first period and, simultaneously subsidizing consumption (and/or saving or education) in the second one. Specifically, taxing income in the first period makes the value of the agent's choices worse, but since agents are over-consuming and under-investing in education, they may also benefit from reductions in their cost of self control. In particular, the tax can make over-consumption/under-investing less attractive, thereby reducing the temptation. If this effect is large enough, a tax on current labor makes the agent better off.

More precisely, we show that the size of the reduction in the cost of self control depends on two offsetting mechanisms: First, a tax on nonqualified labor reduces earnings and consumption, implying a low level of both the temptation utility of the most tempting option and the temptation utility of the

[3]The earnings function is a concave function which accounts for the positive impact of education on the return to qualified labor. See also Kunze, Richter, and Schuppert (2013) for an analysis of efficient education policy in the presence of labor mobility.

[4]Note that our qualitative results are the same as in Richter (2011) when self control problems are absent.

chosen option. Second, it affects individuals' labor supply decisions: A decrease in the share of time spent working lowers individuals' disposable income and thus consumption but also reduces the disutility of labor (for both the temptation utility of the most tempting and the chosen option) which, in turn, moderates the utility losses resulting from the first mechanism.[5] As individuals smooth consumption over their life-cycle, the total reduction of the temptation utility of the 'most tempting option' will always be larger than the reduction of the temptation utility of the chosen option. Hence, the cost of self control declines, thereby increasing individuals' welfare. However, the strength of this latter effect depends on the sensitivity of labor supply to the tax rate and so, on the size of the reduction in earnings due to changes in labor supply. We show that if the elasticity of the marginal disutility of nonqualified labor, that is, the reciprocal of the wage elasticity, is sufficiently small, then the self control cost reduction is small as well. This would increase the incentive of the social planner to subsidize consumption in the second period and so, to subsidize education. By contrast, education should effectively be taxed if the elasticity of the marginal disutility of nonqualified labor is sufficiently large and the cost of self control decreases substantially.

Summarizing, the presence of temptation does affect the design of efficient education policies and results critically depend on how taxation affects the cost of self control.

In a second step, we derive an extended inverse elasticity rule for the efficient taxation of labor. Again, efficient taxation should increase second period consumption by subsidizing second period labor supply if the strength of temptation is sufficiently strong. The intuition behind this finding is that a subsidy to second period consumption lowers the attractiveness of temptation and thus the welfare loss implied by the cost of self control.

The present paper is related to a growing literature on optimal policy design in the presence of temptation: Kumru and Thanopoulos (2008, 2011) and Kumru and Tran (2012) study the normative implications of funded and unfunded public pension programmes[6] whereas Krusell, Kuruscu, and Smith (2010) and Bishnu and Wang (2013) examine optimal taxation of capital. These studies have demonstrated that temptation issues may play a crucial role in the design of optimal policies. For example, using a neoclassical growth model, Krusell et al. (2010) have shown that the optimal policy in this framework is to subsidize savings when consumers are tempted by impatience. Thus, a subsidy on savings can be used as an instrument to improve welfare because it makes surrender to temptations less attractive.[7] Similarly, the present paper highlights the role of temptation for efficient tax policies when

[5]Note that the term "disutility" refers to the commitment utility. As will become clear in Section 2, however, the disutility of labor will be the same for the temptation utility.

[6]See also Bucciol (2011) and St-Amant and Garon (2015).

[7]The temptation model (Gul-Peserdorfer's preferences) is not the unique mechanism to account for preference reversals. An alternative model that accounts for this type of behavior is the quasi-hyperbolic discounting model (Laibson, 1997). As noted by Aronsson and Sjögren (2016), however, the literature on optimal taxation and hyperbolic discounting is quite scarce. One explanation might be the recent popularity of the temptation model, which preserves the property of time consistency (see Bucciol, 2007) in contrast to Laibson's time inconsistent preferences. Bassi (2010) classifies the existent literature into two groups: the first group analyzes the effect of present-biased preferences on consumption-saving decisions (for instance, Krusell et al., 2010) whereas the second one studies optimal commodity taxation of addictive goods which are overconsumed by hyperbolic consumers (Gruber & Köszegi, 2004; O'Donoghue & Rabin, 2006). The first group includes a set of papers that extend the static Mirrlees (1971)'s model to a dynamic framework with heterogeneous agents and stochastic shocks (Guo & Krause, 2015; Kocherlakota, 2005; Mikhail Golosov & Tsyvinski, 2003 among others). In general, these papers show that it is optimal to discourage saving through taxes. In the second group, taxes act as commitment mechanisms that help individuals to behave "correctly" and to reduce the consumption of addictive goods.

two simultaneous intertemporal decisions are subject to temptation, namely savings and educational investments.

This paper is structured as follows. Section 2 sets up the model. Section 3 extends the elasticity rule for education and labor taxation when consumers face self control problems. Section 4 shortly concludes.

2 | A REPRESENTATIVE-HOUSEHOLD MODEL

2.1 | Preferences and temptation

We start by briefly describing the time consistent model of temptation provided by Gul and Pesendorfer (2004). More precisely, they propose a simple two-period model where, in the first period, the agent takes an action that affects the set of alternatives available in the second period. Thus, in period 2, the agent must pick a consumption alternative from the set determined in period 1.

The model takes as given a preference relation over sets of consumption lotteries. Let $c \in C$, p and B denote consumption in the second period, a consumption lottery and a set of consumption lotteries, respectively. Gul and Pesendorfer (2004) show that under standard axioms of preferences and the assumption of *set betweenness*, there are two von Neumann-Morgenstern utility functions $u(.)$ and $v(.)$ such that the expected utility of B is defined as

$$U(B) = \max_{p \in B} \int (u(c) + v(c))dp - \max_{p \in B} \int v(c)dp \tag{1}$$

The function $u(.)$ represents the agent's ranking over alternatives when she is committed to a single choice, whereas her welfare is affected by the temptation utility represented by the function $v(.)$ when she is not committed to a single choice (note that the v-terms in the above formula drop out when B is a singleton). However, if the choice set B consists of two elements, that is, $B = \{c, c'\}$, with $u(c) > u(c')$ and $v(c') > v(c)$, and the following inequality holds

$$u(c') + v(c') > u(c) + v(c), \tag{2}$$

then c' is called a temptation. In this case, the agent succumbs to the temptation and chooses c' in the second period. She had wished having c as the only available alternative. Similarly, if

$$u(c) + v(c) > u(c') + v(c') \tag{3}$$

c' is still a temptation. In this case, however, the agent exercises self-control: she chooses c in the second period but incurs a loss of utility, that is, $v(c') - v(c) > 0$, which is interpreted as the *cost of self-control*.

Hence, the main idea being formalized with self control preferences is that intertemporal decisions consist of compromising between the temptation utility and the commitment utility. In terms of the present paper, an alternative will be a bundle of consumption and nonleisure. Moreover, the commitment utility will be represented by standard intertemporal preferences and thus the household's desire to smooth consumption over the life-cycle. By contrast, the temptation utility ranks bundles of a household only according to the immediate utility level they provide in the present time. Compromising between these two utilities implies that time-consistent deviations from the household's own long-term interest are mentally costly. Consequently, households have incentives to choose immediate consumption bundles in order to reduce the cost of self control. The source of temptation is to over-discount the future in intertemporal decision making.

2.2 | The model

We consider a representative household living for two periods and facing self control problems in intertemporal decision making.[8] The household's utility function is assumed to be quasi linear in first-period consumption and additive separable in periodic subutilities and second-period consumption. This is a standard assumption in the literature on optimal taxation which implies that there are no income effects, see for example, Diamond (1998) and Bovenberg and Jacobs (2005). Furthermore, it allows one to derive simple elasticity rules which is not feasible in the present framework with more general preferences (Richter, 2009). Hence, the household's utility function is:

$$U = C_1 - V_1(L_1) + u(C_2) - V_2(L_2) + \lambda(C_1 - V_1(L_1)) - \lambda \max_{\tilde{C}_1, \tilde{L}_1} (\tilde{C}_1 - V_1(\tilde{L}_1)) \tag{4}$$

where C_i, L_i, $\tilde{C}_1$, and $\tilde{L}_1$ denote consumption, nonleisure time in period $i = 1, 2$, respectively, as will be further explained below.[9] The functions V_i $(i = 1, 2)$ are strictly increasing and strictly convex while u is strictly increasing and strictly concave. The parameter $\lambda > 0$ captures the strength of temptation. The commitment utility and the temptation utility of the choice as well as the maximum temptation utility are given by $C_1 - V_1(L_1) + u(C_2) - V_2(L_2)$, $\lambda(C_1 - V_1(L_1))$ and $\lambda(\max_{\tilde{C}_1, \tilde{L}_1} (\tilde{C}_1 - V_1(\tilde{L}_1)))$, respectively. Hence, the cost of self control (SCC) is defined as:

$$SCC = \lambda(\max_{\tilde{C}_1, \tilde{L}_1} (\tilde{C}_1 - V_1(\tilde{L}_1)) - (C_1 - V_1(L_1))) \tag{5}$$

Clearly, the utility function is increasing in the commitment utility of the choice but decreasing in the self-control cost.

Denote by $\hat{C}_1$ and $\hat{L}_1$, respectively, the consumption and labor supply choices of a young household that decides to exert no self control when time comes to make intertemporal decisions. This allocation $(\hat{C}_1, \hat{L}_1)$ is called the 'most tempting option'. Formally, $\hat{C}_1$ and $\hat{L}_1$ are thus the solution to

$$\max_{\tilde{L}_1, S, E} \lambda(\tilde{C}_1 - V_1(\tilde{L}_1)) \quad s.t. \quad \tilde{C}_1 = \omega_1 \tilde{L}_1 - S - (\omega_1 + \varphi)E \tag{6}$$

where ω_1 is the constant first period wage rate and S and E denote individual savings and time spent on education when young, respectively. Note that education causes an opportunity cost in forgone earnings, $\omega_1 E$, and a monetary cost of tuition, φE, and that both costs are assumed to be linear in time. As with this maximization problem, the household does not derive any utility from future consumption, it follows $\hat{S} = \hat{E} = 0$. Consequently, the 'most tempting option' is implicitly determined by the following first order condition with respect to $\tilde{L}_1$

[8]The basic model is taken from Richter (2009, 2011). It is extended to allow for self control preferences in order to study the impact of self control problems on efficient tax policies.

[9]Note that Equation 4 implicitly accounts for discounting of future utility. Redefining $u(C_2) = \beta\bar{u}(C_2)$ and $V_2(L_2) = \beta\bar{V}_2(L_2)$ to introduce an explicit discount factor β would leave the results unchanged. Note further that the specification of the utility function implies a quasi concave temptation ranking, which is consistent with the findings in Banerjee and Mullainathan (2010), Shah, Mullainathan, and Shafir (2012), and Bernheim, Ray, and Yeltekin (2015). It implies that the cost of self control is more important for poorer than for richer households. Our findings could be generalized, however, to allow for more complex functional forms of the temptation ranking, as for example, in Noor and Takeoka (2010). While it can be shown that our main carries over to such a framework, analytical complexity increases dramatically. Hence, in order to derive our main result analytically, we stick to the quasi concave formulation and leave a more thorough investigation of alternative cases for future research.

$$\omega_1 = V_1'(\hat{L}_1) \tag{7}$$

and by $\hat{C}_1 = \omega_1 \hat{L}_1$. Clearly, even though $\hat{C}_1$ is never chosen, households derive some disutility from this option being available at all. Furthermore, it affects welfare through changes in ω_1: A decrease in ω_1 (e.g., by taxing nonqualified labor) reduces the temptation utility of the 'most tempting option' as the possible level of immediate consumption decreases. In order to explicitly determine the cost of self control, however, we first need to characterize the households' optimization problem.

The representative household maximizes utility (4) by choosing L_1, L_2, S, and E subject to $L_1 \geq E$ and the first and second period budget constraints:

$$C_1 = \omega_1 L_1 - (\omega_1 + \varphi)E - S = \omega_1(L_1 - E) - \varphi E - S \tag{8}$$

and

$$C_2 = \rho S + \omega_2 H(E) L_2. \tag{9}$$

where $L_1 - E$ is time spent in the market, E is time spent on education and $\omega_1(L_1 - E)$ denotes first period income (nonqualified labor income).[10] The quantities $L_1 - E$ and L_1 are thus interpreted as non-qualified labor and nonqualified nonleisure, respectively. $\omega_2 H(E) L_2$ denotes second period income (qualified labor income) and $\omega_2 H(E)$ is the return to second-period labor, where ω_2 is constant while the earnings function $H(E)$ displays positive but diminishing returns, $H' > 0 > H''$. The quantity L_2 is interpreted as qualified labor. Finally, denote by ρ the gross rate of return to saving. Combining (8) and (9) yields the lifetime budget constraint[11]:

$$C_1 + C_2/\rho = \omega_1 L_1 + \omega_2 H(E) L_2/\rho - (\varphi + \omega_1)E. \tag{10}$$

In the following, we assume that the household's maximization problem is well behaved so that there exists an interior unique solution that is differentiable in $\omega_1, \omega_2, \rho, \varphi$. The first-order conditions with respect to L_1, S, L_2, and E, respectively, are

$$\omega_1 = V_1'(L_1) \tag{11}$$

$$\rho = (1+\lambda)/u'(C_2), \tag{12}$$

$$(1+\lambda)\omega_2 H(E)/\rho = V_2'(L_2) \tag{13}$$

$$\omega_2 H'(E) L_2/\rho = \omega_1 + \varphi \tag{14}$$

Clearly, the higher the strength of temptation, the lower are second period consumption C_2, savings S and the optimal amount of education E.

We assume the second order conditions to be fulfilled. This requires some elasticity of the marginal disutility of labor that is sufficiently large at the second-best level of L_2:

$$\nu_2 \equiv L_2 V''_2/V'_2 > \frac{H'E/H}{-H''E/H'} \tag{15}$$

To see this, let $Y(L_2) \equiv \max_E[\omega_2 H L_2/\rho - (\omega_1 + \varphi)E]$ be the ability-rent income. The second-order condition with respect to L_2 then requires:

[10] Alternatively and equivalently, we could assume that the individual has N hours to split between L_1 and E. This would not affect our results.

[11] Note that the price of consumption is normalized to one.

$$0 > Y'' - V''_2 \underset{(12)}{=} -(1+\lambda)\frac{\omega_2}{\rho}\frac{H'2}{H''L_2} - V''_2 \underset{(13)}{=} -\frac{V'_2}{H}\frac{H'2}{H''L_2} - V''_2 \Longleftrightarrow \nu_2 = L_2 V''_2/V'_2 > \frac{H'E/H}{-H''E/H'}. \tag{16}$$

Richter (2011) provides an example of an earnings function that satisfies all the assumptions needed in the present paper:

$$H(E) \equiv hE^{\bar{\eta}} + H_0 \quad \text{with} \quad h > 0,\ 1 > \bar{\eta} > 0,\ H_0 \geq 0, \tag{17}$$

This specification implies an increasing elasticity of the earnings function, $\eta \equiv EH'/H$, if and only if $H_0 > 0$ (since $\eta = \bar{\eta}(1 - H_0/H(E))$). Furthermore, using (17), Equation 15 can be rewritten as

$$\nu_2 \equiv L_2 V''_2/V'_2 > \bar{\eta}/(1-\bar{\eta}). \tag{18}$$

2.3 | Welfare properties: The cost of self-control

In contrast to the models analyzed in Richter (2009, 2011), individuals face temptation in intertemporal decision making. More precisely, individuals are tempted to lower the associated cost of self control by increasing the fraction of time that they devote to work and to consume in the first period. However, regardless of individuals' decision, the temptation utility of the "most tempting option" remains unchanged. Consequently, individuals are always suffering from a loss of utility. Yet, a social planner might easily reduce this loss by transferring resources from the first period to the second one. According to that, a government might tax current labor in the first period and, simultaneously subsidize consumption (and/or saving or education) in the second one.

But how does a tax on first period income affect the cost of self control? As labor supply decisions are endogenous and individuals smooth consumption over their life-cycle, the effect on the cost of self control seems to be undetermined a priori: While the maximum temptation utility declines, as has been argued in the previous subsection, the effect on the temptation utility from the choice turns out to be ambiguous as individuals increase the amount of leisure time but also face lower consumption levels. Hence, the net effect on the cost of self control could either be positive or negative. In order to clarify this ambiguity, we now explicitly determine the cost of self control.

Comparing Equations 7 and 11 reveals that $L_1 = \hat{L}_1$ whereas $C_1 < \hat{C}_1$ as long as $S > 0$ or $E > 0$. Using (6) and (8), the cost of self control (SCC) is given by[12]

$$\begin{aligned} \text{SCC} &= \lambda((\hat{C}_1 - V_1(\hat{L}_1)) - (C_1 - V_1(L_1))) \\ &= \lambda((\omega_1 \hat{L}_1 - V_1(\hat{L}_1)) - (\omega_1 L_1 - V_1(L_1) - (\omega_1 + \varphi)E - S)) \\ &= \lambda((\omega_1 + \varphi)E + S). \end{aligned} \tag{19}$$

It is straight forward to show that these costs are unambiguously increasing in φ and ω_1.[13] Intuitively, lowering the costs of tuition (i.e., reducing φ) decreases the cost of self control as the marginal temptation-utility of the choice declines. Similarly, decreasing the return to nonqualified labor (i.e., decreasing ω_1, e.g., by increasing the tax on first period income), reduces the temptation utility of the "most tempting option" and the temptation utility from the choice. However, the net effect turns out to

[12]Note that the cost of self control equals zero in the second period as, absent any bequest motive, the individual consumes everything available (see Kumru & Tran, 2012).

[13]More precisely, making use of the Envelope theorem, we get $\frac{\partial SSC}{\partial \varphi} = \lambda E > 0$ and $\frac{\partial SSC}{\partial \omega_1} = \lambda E > 0$.

be unambiguously negative. The reason is the following: Increasing the tax on first period income always implies a larger drop in consumption for the "most tempting option" than for the actual choice (due to the consumption smoothing motive) whereas changes in leisure time exactly cancel each other out (as $L_1 = \hat{L}_1$).

Summarizing, the government may reduce the cost of self control and thus increase individuals' welfare by taxing current labor in the first period. However, such a tax also affects the commitment utility from the choice. To analyze how the presence of temptation affects the overall design of efficient tax policies is the aim of the next section.

3 | SECOND-BEST POLICY

In the following analysis, we characterize efficient tax policies with respect to education and labor in relation to the taxation of nonqualified labor when individuals face temptation in intertemporal decision making.

The government's problem is to raise some exogenous amount of revenue T by using four linear and distorting tax instruments that are assumed to be available. These instruments are modeled as the difference between prices before and after taxes and are levied on period i's labor income, on the return to saving, and on the cost of tuition. Specifically, denoting by $\omega_1, \omega_2, \rho, \varphi$ the endogenous prices after taxes and subsidies and by w_1, w_2, r, f the corresponding exogenous prices before taxes and subsidies, respectively, taxes are defined as follows: the tax on period i's labor income equals $w_i - \omega_i$, the tax on capital income $r - \rho$, and the tax on the cost of tuition $\varphi - f$. A negative value implies that the tax is effectively a subsidy. The government's budget is assumed to be balanced:

$$\begin{aligned}(w_1-\omega_1)(L_1-E)+(\varphi-f)E+[(w_2-\omega_2)H(E)L_2+(r-\rho)S]/r &\underset{(9)}{=} (w_1-\omega_1)L_1\\ +[(\varphi+\omega_1)-(f+w_1)]E+\left[\frac{w_2}{r}-\frac{\omega_2}{\rho}\right]HL_2+\left[\frac{1}{\rho}-\frac{1}{r}\right]C_2 &= T.\end{aligned} \tag{20}$$

The planner maximizes the representative taxpayer's utility (4) in the quantities C_1, C_2, L_1, L_2, E and prices $\omega_1, \omega_2, \rho, \varphi$ subject to the behavioral constraints (7), (11)–(14), the individual budget constraint (10) and the government's budget constraint (20). Assume that the planner's maximization is well behaved and, following Richter (2011), that efficiency is characterized in terms of wedges. Let

$$\Delta_{L_1} \equiv \frac{w_1-\omega_1}{\omega_1} \tag{21}$$

denote the wedge on nonqualified labor,

$$\Delta_{C_2} \equiv \frac{r-\rho}{\rho} \tag{22}$$

the wedge on second period consumption,

$$\Delta_{L_2} \equiv \frac{w_2/r-\omega_2/\rho}{\omega_2/\rho} \tag{23}$$

the wedge on qualified labor and

$$\Delta_E \equiv \frac{w_2H'L_2/r-f-w_1}{\varphi+\omega_1} \underset{(14)}{=} \frac{w_2/r}{\omega_2/\rho}-\frac{f+w_1}{\varphi+\omega_1} \tag{24}$$

the wedge on education. Second period consumption (education; qualified labor) is effectively subsidized if Δ_{C_2} (Δ_E; Δ_{L_2}) is negative. Furthermore, according to (24), the wedge on education can be decomposed into two parts: the ratio of present returns before and after taxes and subsidies and the ratio of costs before and after taxes and subsidies. If these ratios are of same size, the wedge vanishes. It is important to note, however, that a negative value of Δ_E can be achieved by a combination of all four policy instruments. More precisely, effective subsidization is clearly reached by the statutory subsidization of the cost of tuition, but may also be achieved by (a) increasing the tax on nonqualified labor and thus reducing the opportunity cost of education, (b) by reducing the tax on qualified labor and thus increasing the return to education, and finally (c) by taxing savings and thus increasing the return to education (cf., Richter, 2011, p. 4).

In order to simplify notation, we make the following definitions: $\nu_1 \equiv L_1 V''_1/V'_1 > 0$ is the elasticity of marginal disutility of nonqualified labor resulting from the commitment utility, that is, the reciprocal of the wage elasticity and $\eta_\eta \equiv E\eta'/\eta$ the second-order elasticity of the earnings function.

Proposition 1. *If* ω_1, ω_2, ρ, *and* φ *are optimally chosen, then*

$$\frac{\Delta_E}{(1+\lambda)\Delta_{L_1} - \lambda\nu_1} = -\frac{\eta_\eta}{\nu_1} \tag{25}$$

Proof. See Appendix.

Equation 25 corroborates several important results of the existing literature.[14] Specifically, as has been demonstrated by Richter (2009), and by Bovenberg and Jacobs (2005) and Bovenberg and Jacobs (2011) in models with heterogenous taxpayers, Equation 25 implies that education should not be distorted ($\Delta_E = 0$) if the elasticity of the earnings function, η, is constant. Furthermore, if self control problems are absent, that is, $\lambda = 0$, Equation 25 corresponds to the second order elasticity rule derived by Richter (2011).

The contribution of the present analysis, however, is to extend the inverse elasticity rule when individuals face temptation. In order to interpret (25), we assume that (a) nonqualified labor income is taxed ($\Delta_{L_1} > 0$) and (b) that the elasticity of the earnings function is increasing ($\eta_\eta > 0$).

While the numerator in the bracketed expression on the left-hand side of (25) is unambiguously positive, the denominator consists of two parts: The wedge on nonqualified labor and a self control effect which captures how taxing nonqualified labor affects the cost of self control. With $\lambda = 0$, education should effectively be subsidized. With $\lambda > 0$, however, the configuration of the tax policy on education turns out to be ambiguous. The denominator can be positive or negative depending on the relative size of the elasticity of marginal disutility of nonqualified labor, ν_1:

$$\Delta_{L_1}(1+\lambda) - \lambda\nu_1 \gtrless 0 \quad \Longleftrightarrow \quad \nu_1 \lessgtr \frac{(1+\lambda)}{\lambda}\Delta_{L_1} \tag{26}$$

Hence, if ν_1 is sufficiently low (large), efficient education policy calls for subsidizing (taxing) education. Moreover, whether education should be subsidized more or less heavily as compared to the benchmark without temptation critically depends on the size of ν_1. Just note that

$$\Delta_{L_1}(1+\lambda) - \lambda\nu_1 \gtrless \Delta_{L_1} \quad \Longleftrightarrow \quad \Delta_{L_1} \gtrless \nu_1. \tag{27}$$

The intuition behind these findings is the following. Taxing nonqualified labor income generates two effects on individuals' lifetime utility: First, the commitment utility from the choice declines as the amount of disposable resources decreases, thereby reducing earnings and consumption in the first

[14](Richter, 2013, fig. 2) uses data from the OECD to calculate tax wedges on nonqualified labor and education. According to his findings, about one third of all OECD countries tax tertiary education in effective terms. The corresponding numbers for Δ_E range from −0.8 to 0.5. Furthermore, the wedge on nonqualified labor Δ_{L_1} is positive in all countries and takes on values in the range of 0.05–0.45.

period. Moreover, a lower return to nonqualified labor discourages working, which, in turn, reduces earnings and consumption even further. Second, as has been shown in the previous section, the cost of self control declines as well. Hence, the net effect depends on the relative strength of these two changes. Our findings show that the net effect turns out to be positive, that is, individuals' lifetime utility increases, if the elasticity of marginal disutility of nonqualified labor (the reciprocal of the wage elasticity) is sufficiently large. In this case, income taxation implies only a modest increase in leisure (relative to the decrease in consumption), which generates a substantial reduction in the maximum temptation utility, and, consequently, in the cost of self control. On the contrary, if the elasticity of marginal disutility of nonqualified labor is sufficiently small, income taxation brings about a substantial increase in leisure. This, in turn, generates only a small reduction in the cost of self control and thus a reduction in individuals' lifetime utility. Therefore, the government has a strong incentive to subsidize education in order to lower the cost of self control.

Consequently, v_1 has a double role in determining optimal education policies: (a) it is part of the inverse elasticity rule of optimal taxation and (b) it is a key factor in shaping the level of the self control cost which, in turn, determines the dynamic redistribution of resources between the present and the future.

In sum, the planner trades off the objective of maximizing the social ability rent against the objectives of minimizing the efficiency loss resulting from distorted choices of the utility-generating quantities C_1, C_2, L_1, and L_2 (as in Richter, 2009) *and* the efficiency gains resulting from reductions in the cost of self control. If the speed at which working disutility increases is sufficiently low, $\Delta_{L_1} > \nu_1$, then, the reduction in the self control cost by taxing nonqualified labor is modest and the planer should additionally subsidize second period consumption, which, in turn, implies that education should effectively be subsidized.[15]

We now turn to the analysis of efficient labor taxation. In order to illustrate the effect of temptation on optimal policies, we assume $H(E) = E^{\bar{\eta}}$. In the Appendix, we show that wage taxes are second best if they satisfy

$$\frac{(1-\bar{\eta})\nu_2 - \bar{\eta}}{\nu_1} = \frac{\Delta_{L_2}}{\Delta_{L_1}(1+\lambda) - \lambda\nu_1} \tag{28}$$

Note that the numerator on the left hand side of Equation 28 is positive by assumption (recall Equation 18). The above equation contains several familiar results as a special case. Specifically, for both $\lambda = \bar{\eta} = 0$, Equation 28 equates to the inverse elasticity rule which requires setting wage taxes inversely proportional to the corresponding wage elasticities of labor supply. Furthermore, if only $\lambda = 0$, Equation 28 corresponds to the extended inverse elasticity rule which accounts for endogenous education [see Richter, 2009, eq. 13]. The presence of temptation, however, implies that nonqualified labor should be taxed more heavily relative to qualified labor if the wage elasticity of nonqualified labor is sufficiently large, that is, if the elasticity of marginal disutility of nonqualified labor, v_1, is small enough.[16] In this case, taxing nonqualified labor lowers the cost of self-control and thus the resulting welfare loss. Moreover, if $\Delta_{L_1} > 0$ and if the strength of temptation, λ, is sufficiently strong, efficient labor taxation calls for subsidizing qualified labor, that is, $\Delta_{L_2} < 0$. The nature of this latter results is

[15]As mentioned in the introduction, an alternative modelling approach of temptation is the one developed by Laibson (1997) where individuals have time inconsistent preferences. Lee (2012) uses this "hyperbolic discounting" model to study optimal education policies and finds that subsidizing education eases individual's self-control problems. His model, however, abstracts from savings and labor supply decisions which turn out to be important in the present framework.

[16]More precisely, $\Delta_{L_1} \gtreqless (1+\lambda)\Delta_{L_1} - \lambda\nu_1 \iff \nu_1 \gtreqless \Delta_{L_1}$.

generally in line with Krusell et al. (2010) who show that taxation of capital can be welfare improving and that the presence of temptation calls for subsidizing second period consumption.

4 | CONCLUSIONS

This paper extends the inverse elasticity rule of optimal taxation when individuals face temptation in intertemporal decision making. Efficient education policy requires subsidizing education only if self control problems are sufficiently severe and the elasticity of the earnings function is increasing in education. Analogously, efficient labor taxation calls for subsidizing qualified labor to increase second period consumption, if the strength of temptation is sufficiently large.

A key element in our setting is the sensitivity of individuals to taxes which, in turn, renders the cost of self control endogenous to tax policy. Hence, even if the strength of temptation is large, the total cost of self control might be low for a strong individual response to taxation. Consequently, elasticities matter for two reasons: (a) the inverse elasticity rule of optimal taxation and (b) the intensity of the effect of taxation in determining the cost of self control.

Our findings highlight the potential importance of temptation and nonstandard preferences for the design of optimal policies. While Richter (2009, 2011) has shown that education should effectively be subsidized if the elasticity of the earnings function is increasing in education, we demonstrate that this result only holds if temptation problems are sufficiently severe. By contrast, if temptation problems are not sufficiently severe, efficient education policy calls for taxing education. Moreover, our results point to a possible complementarity relation between nonqualified and qualified labor taxation. Countries having a large average elasticity of marginal disutility of labor (a low wage elasticity) may only generate small reductions in labor supply when taxing nonqualified labor, which, in turn, makes taxation of qualified (relative to nonqualified) labor more likely. This may help to understand why developed countries, in which labor supply is less elastic than in developing ones,[17] show relatively high levels of taxation on qualified labor (i.e., high income groups) and thus more progressive income tax systems compared to developing countries.[18]

Our results are derived within the context of a model that is general in some respects, but of course it depends on other, less general assumptions. For example, we have ruled out credibility problems of government policies. In the context of education policies, time consistent policies have been studied, for example, by Boadway, Marceau, and Marchand (1996) and Andersson and Konrad (2003). Moreover, our analysis is based on the Ramsey approach to optimal taxation, whereas the so-called Mirrlees approach is used by Bovenberg and Jacobs (2005) and Bovenberg and Jacobs (2011). Finally, the analysis could be extended to allow for heterogenous taxpayers, see for example (Richter, 2009, sec. 3). We leave a more thorough analysis of these important issues for future research.

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[17]Heckman and Pagés (2004) note that informal workers often evade taxation which, in turn, helps explaining why the relevant labor supply to the formal sector in developing countries turns out to be more elastic than in developed ones. See Fuest and Riedel (2009) and Besley and Persson (2013) for recent surveys of the literature on taxation and development.

[18]Piketty and Quian (2009), Gemmell and Morrissey (2005), and Schmitt (2005) among others find that many tax systems in developing countries are substantially less progressive than those in developed ones.

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APPENDIX

Proof of Proposition 1. The planner's problem can be simplified by replacing ω_1 by V_1' and $\hat{L}_1$ by L_1 (as $\omega_1 = V_1'(L_1) = V_1'(\hat{L}_1)$). The restated planner's problem is

$$\begin{aligned}\max[&V_1'(L_1)L_1 - V_1(L_1) + \omega_2 H(E)L_2/\rho - (\varphi + V_1'(L_1))E - C_2/\rho \\ &+ u(C_2) - V_2(L_2) + \lambda[V_1'(L_1)L_1 - V_1(L_1) + \omega_2 H(E)L_2/\rho \\ &- (\varphi + V_1'(L_1))E - C_2/\rho] - \lambda[V_1'(L_1)L_1 - V_1(L_1)]]\end{aligned} \tag{29}$$

in $\varphi, L_1, \omega_2, E, C_2, \rho, L_2$, subject to

$$(1+\lambda)\omega_2 H(E)/\rho = V_2'(L_2), \quad (\alpha) \tag{30}$$

$$\omega_2 H'(E)L_2/\rho = \varphi + V_1'(L_1), \quad (\mu) \tag{31}$$

$$\frac{1+\lambda}{u'(C_2)} = \rho, \quad (\kappa) \tag{32}$$

$$[w_1 - V_1'(L_1)]L_1 + [(\varphi + V_1'(L_1)) - (f + w_1)]E + \left[\frac{w_2}{r} - \frac{\omega_2}{\rho}\right]H(E)L_2 + \left[\frac{1}{\rho} - \frac{1}{r}\right]C_2 = T. \quad (\gamma) \tag{33}$$

The simplified first-order conditions with respect to φ, L_1, ω_2 and E are as follows[19]:

$$\frac{\partial}{\partial\varphi}: \quad \mu = (\gamma - (1+\lambda))E; \tag{34}$$

$$\frac{\partial}{\partial L_1}: \quad \gamma(w_1 - V_1') \underset{(34)}{=} (\gamma - 1)L_1 V''_1; \tag{35}$$

$$\frac{\partial}{\partial \omega_2}: \quad 1+\lambda \underset{(34)}{=} \gamma - \alpha\frac{1+\lambda}{L_2(1-\eta)}; \tag{36}$$

$$\begin{aligned}\frac{\partial}{\partial E}: \quad \gamma[f + w_1 - w_2 H' L_2/r] &\underset{(34),(36)}{=} [\gamma - (1+\lambda)]\left[\varphi + V_1' - \eta\omega_2 H' L_2/\rho + \omega_2 H'' E L_2/\rho\right] \\ &= [\gamma - (1+\lambda)]\left[1 - \eta + \frac{H''E}{H'}\right](\varphi + V_1') = [\gamma - (1+\lambda)]\frac{E\eta'}{\eta}(\varphi + \omega_1);\end{aligned} \tag{37}$$

Dividing (35) by V_1' and (37) by $\varphi + \omega_1$ and solving the resulting equation system yields (25).

Proof of Equations (28) . The first-order conditions of the simplified planner's problem with respect to ω_2 and C_2 are:

[19]Note that the proof does not rely on the derivatives with respect to L_2, C_2, and ρ.

$$\frac{\partial}{\partial \omega_2}: \quad \alpha = \frac{(1-\eta)L_2}{1+\lambda}(\gamma - (1+\lambda)) \tag{38}$$

$$\frac{\partial}{\partial C_2}: \quad \alpha \frac{1+\lambda}{L_2(1-\eta)} \underset{(36)}{=} \gamma/(1+\Delta_{C_2}) + \kappa \frac{u''(C_2)}{u'(C_2)^2}(1+\lambda)\rho - u'(C_2)\rho; \tag{39}$$

The latter equation can be simplified by inserting Equations 22, 32, and 38:

$$\frac{\partial}{\partial C_2}: \quad 0 = \gamma(1/\rho - 1/r) - \kappa\rho u''(C_2)/u'(C_2) \tag{40}$$

Moreover, the simplified first order condition with respect to L_2 is given by

$$\frac{\partial}{\partial L_2}: \quad 0 \underset{(34)}{=} \gamma\Delta_{L_2} + \eta(\gamma - (1+\lambda)) - \alpha \frac{V_2'\prime(L_2)\rho}{\omega_2 H(E)} \tag{41}$$

Substitute (38) into (41) and make use of (13) to get

$$0 = \gamma\Delta_{L_2} + (\gamma - (1+\lambda))(\eta - (1-\eta)\nu_2). \tag{42}$$

Similarly, substituting (36) into (35) and dividing the resulting equation by V_1' yields

$$\gamma\Delta_{L_1} = \nu_1 \alpha \frac{1+\lambda}{L_2(1-\eta)} + \nu_1\lambda. \tag{43}$$

Finally, insert (38) into (43) and rearrange terms to reach

$$\gamma\Delta_{L_1} = \lambda\nu_1 + \nu_1(\gamma - (1+\lambda)). \tag{44}$$

Solving the resulting equation system (42), (44), and making use of $H(E) = E^{\bar{\eta}}$ yields (28).