Risk and Rationalization

– The role of affect and cognitive dissonance for sexual risk taking

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Abstract

This paper analyzes the mechanisms underlying excessive sexual risk taking in the presence of HIV. Drawing ideas from psychology on decision-making processes and risk evaluation, a theoretical model interacting affect-induced myopia and cognitive dissonance is developed and analyzed. The results of the theoretical analysis suggest that the effect of rationalization of personal risk depends on the risk of being HIV positive. Although rationalization causes excessive risk taking behavior for individuals with a relatively low lifetime risk, it may prevent fatalism among individuals whose lifetime risk of HIV is perceived as overwhelming.

Keywords: HIV/AIDS, Self-control, Time inconsistency, Dissonance theory, Regret

JEL-Classification: D81, D84, D91, I12

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1. Introduction

The purpose of this paper relates to the question of why people tend to engage in sexual behavior that is later regretted, and to how this tendency affects perceptions of personal risk and incentives to abstain from sexual risk taking in the future. More specifically, an inter-temporal model is developed in order to analyze the consequences of myopia and remorse on sexual behavior in the presence of HIV/AIDS. The model merges ideas from psychology regarding cognitive limitations of the human mind with economic theory of utility maximization, and is loosely based on previous work by Akerlof & Dickens (1982), O'Donoghue & Rabin (2000), Loewenstein & O'Donoghue (2007), Bénabou a& Tirole (2002; 2004). The results of the theoretical analysis suggest that defensive denial of personal risk contribute to excessive risk taking behavior for individuals with a relatively low lifetime risk, but may prevent fatalism among individuals whose lifetime risk of HIV is perceived as overwhelming. In addition, and consistent with research in psychology,[2] the theoretical analysis further suggests that focusing attention on anticipated regret may prove beneficial for increasing intentions to adopt safer sex practices.

The Human Immunodeficiency Virus (HIV) has harvested human deaths for nearly three decades.[3] Although educational campaigns have resulted in increased levels of HIV awareness and some signs of safer sexual practices, unprotected casual sex is still practiced in HIV susceptible groups.[4] Admittedly, the persistence of sexual risk taking may in part be explained by the increased availability and efficiency of antiretroviral (ARV) therapy or by risk loving preferences. However, for a large share of the HIV susceptible population, AIDS is still associated with premature death as well as social stigmatization.[5] Similarly, risk loving preferences cannot alone explain sexual risk taking behavior. Research in psychology show that engagement in risky sex is often associated with posterior regret, thus suggesting a presence of time-inconsistent preferences. [6]

Quasi-hyperbolic time preferences are today relatively standard procedure in economic models for intertemporal choice.[7] However, the mechanisms underlying the excess weight on present utility has not, until recently, received much attention.

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[2] See van der Pligt (1996) for an excellent review.
[3] UNAIDS (2009)
[4] Indeed, studies in sociology suggest that individuals with adequate HIV knowledge engage in recurrent sexual risk taking. See e.g. Campbell, (1997); Varga (1997b); Pettifor *et al.* (2000); MacPhail & Campbell (2001); Anderson & Beutel (2007)
[5] In 2008 alone, 2 million individuals died of AIDS related diseases. See Lakdawalla *et al.* (2006); Rao *et al.* (2006); Mechoulan (2007); UNAIDS (2009)
[6] See e.g. Richard, *et al.* (1996); Nordgren *et al.,* (2007)
[7] See e.g. Strotz (1955-1956); Thaler & Shefrin (1981); Loewenstein & Prelec (1992); Laibson (1997); O'Donoghue & Rabin (1999; 2001)

Loewenstein (1996) offers a potential explanation to time-inconsistent preferences by incorporating insights from neuroscience on how our decision-making capacity is affected during states of heightened physical arousal. According to Loewenstein, human decision making is governed by two basic systems in the brain; a cognitive (rational), and an emotional (impulsive). Both systems are of importance for making adequate and efficient decisions in a given situation. The cognitive system enables probability calculations related to the potential outcomes of a decision, while emotions give the individual a quick reference concerning how he/she "feels" about the alternatives. However, *visceral factors*, such as hunger or sexual desire, tend to crowd out the cognitive system and may therefore hamper the ability to make decisions consistent with long term rationality. In line with this theory, Loewenstein *et al.,* (2001), present empirical evidence indicating that both the mood experienced at the time of the decision and the time interval between decision and outcome has important implications for risk perception. More specifically, happy moods and a long time interval between tend to make people to react with a relatively low degree of fear to certain types of objectively dangerous situations.[8] In accordance with this theory, Alhakami & Slovic (1994) find an inverse relationship between perceived risk and perceived benefit of an activity, and that the strength of the correlation is related to the intensity of positive or negative affect associated with that activity; if an individual *likes* an activity, the risk associated with that activity is judged as relatively lower and benefits as relatively higher than activities disliked. Similarly, Ariely and Loewenstein (2006), show that experimentally induced sexual arousal creates an acceptance of norm-violating and risky behaviors that increase the likelihood of having sex.[9] The ideas developed by Loewenstein concerning affect-induced myopia have been incorporated in economic models by, for example, O'Donoghue & Rabin (2000), Loewenstein *et al.* (2003) and Lowenstein & O'Donoghue (2007).[10]

Now, the presence of visceral cues may explain why time-inconsistent behavior arises. However, we are still left with the question of what consequences these inconsistencies have for future preferences and behavior. According to Ainslie (1974; 1975; 2001), the failure to exert self-control may have long lasting effects on both behavior and preferences. Ainslie argues that an individual can be depicted as a patchwork of interests that differ with regard to the time-horizon of need-fulfillment. The relative bargaining power of each interest depends on the proximity of need-fulfillment, how costs and benefits are bundled, and on contextual cues. Visceral factors, such as sexual desire, activate and increase the bargaining power of the short term interest to satisfy this desire. If such behavior is in conflict with a long term interest a rational individual may

[8] See also Slovic (2001)
[9] See also e.g., Ditto *et al., (2006)*
[10] See also; Thaler & Shefrin (1981); Laibson (1998; 2001); Bénabou & Pycia (2002); Loewenstein, O'Donoghue, & Rabin (2003); Benabib & Bisin (2004); Bernheim & Rangel (2004); Battaglini *et al.* (2005); Broccas & Carillo 2008).

have incentives to act strategically in terms of the formation of *personal rules*. According to Ainslie, personal rules are "commitments made in the mind where the stake is nothing but the credibility of the individual to himself" (Ainslie, 2001, p.94). Most commonly, personal rules bundle rewards so that the present temptation is not only weighed against one reward in the future, but rather to a set of rewards.[11]

During the last decade, Ainslie's ideas have been explicitly incorporated in economic models for time-inconsistent behavior. The perhaps most comprehensive work has been done by Bénabou and Tirole (2002; 2004).[12] Bénabou and Tirole argue that individuals have incomplete information regarding their ability to resist short term temptations and therefore rely on past actions as indicators of character. In their 2002 paper, Bénabou and Tirole show that the presence of hyperbolic discounting may create incentives for an individual to engage in strategic behavior in terms of sending potentially self-deceiving signals to future selves concerning their ability to resist temptations. Bénabou and Tirole (2004) focus on the intrinsic motivation for rule based behavior. In addition to the incomplete information regarding ability, Bénabou and Tirole (2004) assume that individuals have imperfect recall concerning relapses and situational factors affecting the cost to abstain from indulgence in short term temptations. Failure to persevere signals a character of low ability to future selves and may thereby contribute to continuing impulsive behavior. However, incomplete information of situational factors related to the cost of abstaining enables an attribution of the failure to persevere to external circumstances, and thus allows future selves to rationalize past behavior.

The rationale for both signaling high ability to future selves and for rationalizing past behavior in Bénabou and Tirole (2002; 2004) in part stems from the assumption that individuals derive utility from having a positive self-image. In a series of psychological experiments, Festinger (1957) and Aronson (1968) showed that participants who voluntarily engaged in behavior inconsistent with their self-image afterwards rationalized their behavior in order to maintain a consistent self-concept. According to *cognitive dissonance theory* (Festinger, 1957; Aronson, 1968; 1992), inconsistent behavior has a tendency to create a negative physical arousal (cognitive dissonance), and therefore to create incentives to either change behavior, preferences or to change the evaluation of the behavior that caused the arousal.[13] Aronson (1992) suggests that most individuals strive for 3 things: 1) to preserve a consistent and predictable sense of self, 2) to preserve a competent sense of self, and 3) to preserve a morally good sense of self. Hence, an

[11] The violation of a personal rule reduces the credibility of that rule and thus sends a signal to the individual that he is unlikely to follow the rule in the future. Hence, giving in to a temptation is thus associated with a greater cost than if only the particular situation at hand is considered (Ainslie, 2001).
[12]See also e.g., Broccas and Carrillo (2008); Fudenberg & Levine (2006); Gul & Pesendorfer (2001)
[13] See also Aronson (1968; 1992),

individual that engages in behavior that either questions his/her intelligence or that induces feelings of guilt will experience incentives to perform dissonance reducing behavior.[14] Accordingly, dissonance theory predicts that people will in general use all available information *before* making a decision. However, *after* the decision has been made they will tend to seek reassurance that they did the right thing.[15]

States of physiological arousal have a potentially important role for rationalization tendencies since high levels of arousal severely diminish the ability to judge future consequences of current behavior.[16] Engagement in risky behavior threatens our self-image as competent individuals and may therefore give rise to anxiety.[17] Indeed, a number of studies in psychology suggest that individuals that engage in high risk behavior tend to underestimate their personal risk in comparison to similar others, and that some individuals displays maladaptive coping strategies such as a defensive denial of risk.[18] Hence, in order to fully understand persistent sexual risk taking it may be important to include self-image maintenance in the analysis.

In their seminal paper from 1982, Akerlof & Dickens use ideas from cognitive dissonance theory in order to analyze the economic consequences of risk taking behavior at the work place. In accordance with Aronson (1968; 1992), Akerlof and Dickens argue that accepting an exposure to risk questions the individual's intelligence, and thereby creates incentives to rationalize past behavior. In the setting of their theoretical model, rationalization is modeled as understating the risk taken. Applied on worker safety, Akerlof & Dicken's theoretical results suggest that insufficient supply of safety insurance in one period may induce underestimation of risk, and thus insufficient demand for insurance, in proceeding periods.

The model developed in this paper builds on the ideas as developed by Akerlof and Dickens (1982), O'Donoghue & Rabin (2000), Loewenstein & O'Donoghue (2007) and Bénabou & Tirole (2002; 2004). However, whereas Akerlof and Dickens model the exposure to health risk as exogenously given (i.e. insurance is only available in time period 2) the model presented in this paper assumes that the individual himself chooses the amount of risk to be exposed to (in terms of the decision to use condoms or not). Endogenous exposure to risk is implicitly incorporated in O'Donoghue & Rabin (2000), Loewenstein & O'Donoghue (2007) and Bénabou and Tirole (2002; 2004). However, the O'Donoghue & Rabin (2000), and Loewenstein & O'Donoghue (2007) papers end with the analysis of how affect may give rise to excessive sexual risk taking. In contrast, the model presented in this paper continues with an analysis of how myopic behavior

[14] Aronson (1992)
[15] Aronson (1989)
[16] See e.g. Tiedens and Linton (2001); Loewenstein & Lerner (2003)
[17] See e.g. Weinstein (1984); van der Pligt *et al.* (1993); van der Pligt (1996)
[18] See e.g. Offir, *et al.* (1993); van der Pligt *et al.* (1993); Abdool Karim *et al.* (1995); van der Pligt (1996); Varga (1997a; 2001); Blanton & Gerrard (1997) ; Gerrard, *et al.* (2000); Harré, (2000); Ariely & Loewenstein (2006)

affects incentives in future time periods. The Bénabou and Tirole (2002; 2004) papers provide an exquisite analysis of the development of behavior over time. The approach taken in this paper differs from Bénabou and Tirole in terms of an explicit incorporation of the role of cognitive dissonance and rationalizing behavior and in terms of the assumption of full information about preferences and past behavior. To my knowledge, no one has to date linked theories of myopic behavior with those of rationalizing behavior in relation to sexual risk taking behavior. The model presented in this paper tries to fill this gap.

The remaining part of the paper is outlined as follows: In order to build up a basic understanding of the model mechanisms, I first develop a basic model for strategic interaction between short-term and long-term interests concerning sexual choices under affect. I then introduce the opportunity to rationalize past behavior and analyze how the presence of cognitive dissonance affects sexual behavior, subjective risk evaluation and incentives to invest in self-control.

2. Theoretical approach

2.1 A basic model for sexual behavior

Consider an individual (for simplicity treated as a "he") that lives during 3 time periods. The rationale for using the non-standard framework of 3 time-periods is that this approach enables us to analyze both incentives to and effects of rationalizing behavior. Although the assumption of 3 time-periods is not strictly needed for the first part of the analysis, the assumption is maintained in order to give an overview of the full model. In order to keep the analysis as simple as possible I assume a separable lifetime utility function. This assumption enables an analysis focused on sexual behavior.

In each time period, the individual is assumed to face an exogenous supply of attractive sexual opportunities.[19] The individual's choice set is thus constituted by whether sexual experiences are to be safe or unsafe. Safe sex is defined as sex with a condom, where condoms are assumed to provide a 100 percent protection against sexually transmitted infections such as HIV, but also to insert a cost in terms of reducing pleasure of sexual consumption.[20] Finally, in order to enable the

[19] Naturally, to be correct sexual decisions should be modeled as a bargaining process between two parties. The model presented in this paper treats "sexual opportunities" as exogenous. In other words, the individual is assumed to meet an exogenous number of sexually attractive, and willing, individuals.

[20] Condoms naturally also have monetary costs. However, in order to keep the analysis as simple as possible, and since the analysis does not consider budget constraints other than the constraint related to health, monetary costs of condom use are neglected in the analysis below. Non-monetary costs related to condom use are, for example, physical reduction in sensation and social stigma. Social norms prescribe behaviors considered consistent with being a member of a particular social group. Consequently, if condoms are associated with promiscuity for women, lack of masculinity for men, and lack of trust or as a

analysis of cognitive dissonance in the augmented version of the model I assume that, if the individual contracts HIV in time period 1 or 2, he dies at the end of time period 2.[21] This assumption reflects the relatively long incubation time of AIDS. The simplifying assumption that an HIV infected individual dies at the end of time period 2 regardless of whether HIV is contracted in time period 1 or 2 is relatively strong and does have implications for the analysis since it implies that the marginal disutility of contracting HIV in the second period is lower than contracting HIV in the first period. However, the assumption enables analytical results and may be justified if older individuals in general are more vulnerable to infections such as influenza and pneumonia. Following O'Donoghue & Rabin (2000) and Loewenstein & O'Donoghue (2007), I assume that a rational individual does not discount the future.[22] The individual's preferences in period t are described by the lifetime utility function,

$$U(n_t, \varphi, \bar{x}_t) = u(\bar{x}_1) - C^n(n_1, \bar{x}_1) + u(\bar{x}_2) - C^n(n_2, \bar{x}_2) + \varphi^{(1-n_1)\bar{x}_1+(1-n_2)\bar{x}_2} \cdot \left(u(\bar{x}_3) - C^n(n_3, \bar{x}_3)\right) \quad (1)$$

where $\bar{x}_t$ represents the exogenous supply of sexual encounters in each time-period, and n_t is the endogenous share of sexual acts in which condoms are used in each time period. $\varphi = (1 - \Pr(HIV))$, represents the per-coital probability of staying HIV negative, where $\Pr(HIV)$ is the probability of acquiring HIV through one unprotected sexual act.[23] Since the supply of attractive sexual opportunities is assumed exogenous in the model, $u(\bar{x}_t)$, a constant, represents the maximal pleasure derived from sexual opportunities. The individual's decision alternatives are constituted by whether or not to use a condom during the sexual intercourse. As mentioned above, condoms are likely to reduce sexual pleasure in terms of interrupted foreplay, reduced sensitivity and perhaps a sense of awkwardness. In equation (1), $C^n(\cdot)$ represents the subjective cost of using condoms. Consider the following functional form for $C^n(\cdot)$,

$$C^n(n_t, \bar{x}_t) = \frac{{n_t}^2 \cdot \bar{x}_t}{2} \quad (2)$$

symptom of STI:s within a certain community, using condoms may imply cost in terms of social stigma and lowered self-esteem. Finally, the cost of condoms is also related to availability, as having a condom readily available in the heat of the moment in the pocket constitutes a lower cost than having to run to the store in order to buy one.

[21] Without treatment, HIV progresses into AIDS in approximately 10 years. Now, assuming that the individual does not use treatment is clearly a stark simplification. However, even if antiretroviral (ARV) treatment is used, HIV is associated with a shortened life span (e.g.Lakdawalla *et al.* (2006); Mechoulan (2007); UNAIDS (2009); Rao *et al.* (2006). In addition, in many poor countries, many individuals do not know their HIV status until they develop AIDS, and ARV's are nowhere nearly available for all.

[22] O'Donoghue & Rabin (2000) argue that discounting the future should relate to the uncertainty of the future occurring. Hence, if the future is certain discounting of the future should not take place. Although the future is always to some extent uncertain, including discounting in the model presented in this paper would not add to the analysis.

[23] $\Pr(HIV)$ in turn is the product of two probabilities; the probability that the sexual partner has HIV, and the probability of HIV transmission given that the partner has HIV.

This functional form suggests that condom related costs increase with the level of condom use, i.e., $C_n^n(\cdot) > 0, C_{nn}^n(\cdot) > 0$. Note that $C^n(\cdot)|_{n_t=0} = 0$. $u(\bar{x}_t) - C^n(n_t, \bar{x}_t)$, is thus the net pleasure of sex. Hence, as implied by equation (1) and (2), the individual's maximization problem is constituted by weighing the cost of using condoms, in terms of the reduction in sexual pleasure, to the benefit of protecting against health hazards such as HIV.

Before we analyze the effect of sexual arousal on risk-taking behavior, let us first define the solution for a rational individual without myopic tendencies. This solution is labeled *First Best* (FB) below, as it does not contain any preference reversal. Defining $(1 - n_1)\bar{x}_1 + (1 - n_2)\bar{x}_2 = x_{us}$ as the total amount of unprotected sex consumed and maximizing equation (1) with respect to n_1, n_2 and n_3 produces the following first order conditions

$$\frac{\partial U_1^{FB}}{\partial n_1} = -\frac{\partial C^n(n_1, \bar{x}_1)}{\partial n_1} - \bar{x}_1 \cdot \left(u(\bar{x}_3) - C^n(n_3, \bar{x}_3)\right) \cdot \ln(\varphi)\, \varphi^{x_{us}} = 0 \tag{3}$$

$$\frac{\partial U_1^{FB}}{\partial n_2} = -\frac{\partial C^n(n_2, \bar{x}_1)}{\partial n_2} - \bar{x}_2 \cdot \left(u(\bar{x}_3) - C^n(n_3, \bar{x}_3)\right) \cdot \ln(\varphi)\, \varphi^{x_{us}} = 0 \tag{4}$$

$$\frac{\partial U_1^{FB}}{\partial n_3} = -\varphi^{x_{us}} \cdot \frac{\partial C^n(n_3, \bar{x}_3)}{\partial n_3} \leq 0 \tag{5}$$

Equation (3)-(5), implicitly defines the optimal levels of condom use in each time period as functions of the risk of acquiring HIV. Let us define the optimal level of condom use in the first best scenario, ${n_t}^{*FB}(\bar{x}_1, \bar{x}_2, \bar{x}_3, \varphi)$. As can be seen in the equations (3)-(5), a rational individual without myopic tendencies maximizes lifetime utility by equating the marginal cost of using condoms, as depicted by the first terms on the left hand side of the equations, to the marginal benefit in terms of a reduction in the risk of dying prematurely. Note that a rational individual optimally sets ${n_3}^{*FB} = 0$, since there is no risk associated with unprotected sex in time period 3.

Now, as suggested by Loewenstein (1996) and Ainslie (2001), the long term interest to maximize lifetime utility may differ from the short term interest to maximize sexual pleasure. Accordingly, let us assume that the individual consist of a sequence of different selves (or interests) whose individual objective functions may differ in the evaluation of long term costs.

Let us start by assuming that the individual can be divided into two different selves in each time period; one long term interest, represented by a forward looking and rational self striving to maximize lifetime utility, and one short term interest, represented by a sexually aroused self. Let us denote the long term interest LR_t, and the short term interest in each time period SR_t, where LR reflects Long Run preferences, and SR reflects Short Run preferences.

In each time period, the individual is assumed to be exposed to exogenous shocks in terms of affective stimuli (such as the opportunity to engage in sexual activities). During states of affect, the short-term interest is assumed to have the executive power. The timing of the sex model is depicted in *Figure 1*, below.

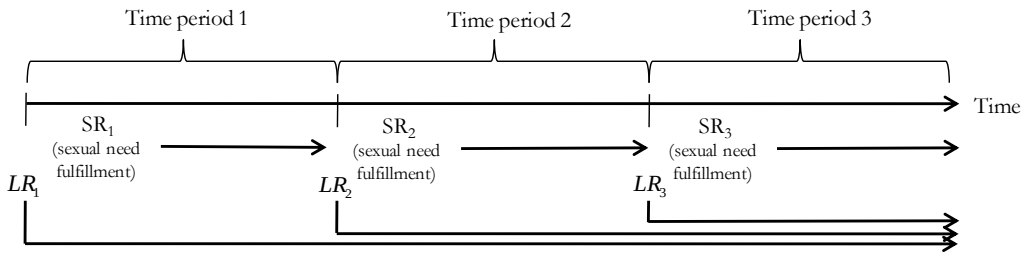

Figure 1: Timing of sexual decisions

At the onset of each time period, LR_t is assumed to use all available information to him at that point in time to maximize lifetime utility. However, LR_t is not in actual charge of future sexual decisions. The exposure to affective stimuli, in terms attractive sexual opportunities, gives rise to sexual arousal which is assumed to transfer the executive power to a more short sighted self (SR_t). [24] As the sexual arousal subsides, the individual is assumed to enter time-period 2 and the preferences of farsighted interests once again surmount. At the onset of time period 2 the long term interest (LR_2) is thus assumed to act in order to maximize the remaining lifetime utility. As in period 1, the individual in period 2 is assumed to get exposed to exogenous affective stimuli that transfer decision power to a shortsighted interest. If sexual risk taking in period 1 or 2 results in an HIV infection, the individual is assumed to die before reaching time period 3. If the individual does *not* catch HIV, long and short run selves in period three once again chooses optimal amounts of risky sex. After time period 3, the individual is assumed to die. Consequently, as unprotected casual sex in period 3 does not affect future utility, both long run and short run selves chooses unprotected sex consumption such that present utility is maximized (see equation (5)). In order to set the stage correctly, let us look closer at the behavior and objective functions of the affective selves.

2.1.1 Sexual short term interests

The true cost of engaging in unprotected sex in time period 1 is given by the risk of acquiring HIV times the utility loss; $\left(1-\varphi^{(1-n_1)\cdot\bar{x}_1}\right)\cdot u(\bar{x}_3)$. However, as mentioned in the introduction,

[24] The intuition behind this assumption is that actual the decision of whether to use a condom or not is taken in the heat of the moment

strong physical arousal has a tendency to hamper rational decision making in terms of making the present more salient and reducing the ability to judge the future consequences of current behavior.[25] Hence, the sexually aroused selves should intuitively display myopic tendencies and base their decisions on a heuristic decision rule rather than on complex probability calculations. Consequently, it may be reasonable to assume that sexually aroused individuals base their risk evaluation on a linear probability function such as $\widetilde{\Pr}\,(HIV) \cdot (1 - n_1) \cdot \bar{x}_1$, [26] where, $\widetilde{\Pr}\,(HIV)$ represents the individual's perception of the risk of acquiring HIV. In addition, Loewenstein and Lerner (2003) argue that *expected* emotions differ from *immediate* emotions.[27] This implies that the *expected* experience of an outcome is likely to differ from the actual, or *immediate*, experience of that outcome. In other words, an individual under affect should not be able to correctly judge the loss associated with dying prematurely. Taken together, this implies that the shortsighted self would base his sexual decisions on the following cost function:

$$\beta \cdot \left(1 - \widetilde{\Pr}(HIV) \cdot (1 - n_1) \cdot \bar{x}_1\right) \cdot \widetilde{U}(\bar{x}_3) \tag{6}$$

where $\beta; 0 \leq \beta \leq 1$, is a discount factor. If we disregard the first constant term ($\beta \cdot \widetilde{U}(\bar{x}_3)$) and denote the product, $\beta \cdot \widetilde{\Pr}(HIV) \cdot \widetilde{U}(\bar{x}_3) = \omega$, equation (6') transforms into:

$$-\omega \cdot (1 - n_t) \cdot \bar{x}_t = -C^w(\omega, n_t, \bar{x}_t) \tag{6'}$$

The parameter ω thus represents a sense of "worry", or gut feeling, of taking a sexual risk. Now, the part of ω that represents the risk of HIV could (or perhaps should) naturally to some extent be based on the true risk of an HIV infection (for example a weighted mean of some upper and lower bound of $\Pr\,(HIV)$). However, including a mechanism displaying how ω depends on $\Pr(HIV)$ would prevent us from deriving analytically tractable results. I therefore assume that sexual arousal creates a non-transparent "veil of ignorance" that keeps the individual from estimating the true probability of acquiring HIV through engagement in unprotected casual sex.[28] Consider the objective function and first order condition for the sexually aroused self in time period 1:

$$U_1^{SR}(n_t, \bar{x}_t, \omega) = u(\bar{x}_t) - C^n(n_t, \bar{x}_t) - C^w(\omega, n_t, \bar{x}_t) \tag{7}$$

[25] Immediate emotions affect the decision maker's expectations about both the probability and the desirability of the future consequences. For example, good moods generally make people more optimistic about the probability of positive outcomes, and of their future experience of the outcomes of a certain behavior (e.g., Loewenstein *et al.,* 2001; Loewenstein and Lerner, 2003).
[26] See, e.g. Griffin *et al.* (1999)
[27] See also, e.g., Loewenstein *et al.,* (2003)
[28] This assumption may be justified by the energy consumption of the short term interest of getting laid; there is just too little energy left for that part of the brain engaged in calculating risk.

$$\frac{\partial U_1^{SR}}{\partial n_t} = -\left(\frac{\partial C^n(n_t, \bar{x}_t)}{\partial n_t} + \frac{\partial C^w(\omega, n_t, \bar{x}_t)}{\partial n_t}\right) = 0 \tag{8}$$

Equation (8) defines the optimal level of condom use as seen by the myopic self in period 1. Let us denote the short term optimal level of condom use ${n_t}^{m*} = {n_t}^{m*}(\omega)$. From equation (2), (6') and (7) it is easily seen that ${n_t}^{m*}$ is given by:

$${n_t}^{m*} = \omega \tag{9}$$

In order to evaluate the effect of myopic preferences, let us compare the optimal level of condom use as defined by equation (9) to the level of condom use implicitly defined by equations (3)-(5). Remember that, since sexual activities in time period 3 are "risk free", condom use in time period three is optimally set equal to zero. Hence, $C^n(0, \bar{x}_3) = 0$. Consider the following proposition:

Proposition 1

If sexual arousal disables consequence analysis and if $\omega \neq -u(\bar{x}_3) \cdot \ln(\varphi)\, \varphi^{x_{us}}$ *then* $n_1^{*m} \neq n_1^{*FB}$. *More specifically:*

a) *If the risk, or the potential utility loss, associated with unprotected sex is underestimated, condom use by sexually aroused agents will be lower than in the first best scenario, i.e.,* $If\ \omega < -u(\bar{x}_3) \cdot \ln(\varphi)\, \varphi^{x_{us}}$ *then* $n_1^{*m} < n_1^{*FB}$.
b) *If the risk, or the potential utility loss, associated with unprotected sex is overestimated, condom use by sexually aroused agents will be higher than in the first best scenario, i.e.,* $If\ \omega > -u(\bar{x}_3) \cdot \ln(\varphi)\, \varphi^{x_{us}}$ *then* $n_1^{*m} > n_1^{*FB}$.

Proof. See the appendix

The intuition behind *proposition 1* is relatively straight forward. If affect disables the ability to correctly evaluate future consequences of current behavior, sexually aroused individuals are forced to base decisions on a more or less vague sense of the danger involved in unprotected sex.[29] In addition, the presence of the discounting factor β always makes the individual to underestimate the future cost of current risk taking. Consequently, if the marginal risk of acquiring HIV, based on the linear probability function in equation (6') is smaller or equal to the true probability of an HIV infection, then sexually aroused individuals will always over consume risky sex. However, there may be instances when a risk perception based on the linear probability function actually underestimates the true risk of acquiring HIV. In addition, although the

[29] In the model presented in this paper, ω represents this sense of risk. ω is treated as an exogenous parameter and is thus assumed to be completely detached from the true probability distribution for φ. In reality, ω should, although distorted, naturally have some base in φ.

scenario is not very likely, some individuals may also overestimate the experienced cost of an HIV infection. If the overestimation of the marginal risk of acquiring HIV or the expected utility loss from an HIV infection is sufficiently large, there may actually exist instances where sexually aroused individuals consumes *less* unsafe sex than in the first best scenario. In both cases the inability to correctly judge the risk associated with unprotected casual sex, will give rise to a behavior that is inconsistent with the individual's long term interests.

The scenario described by *proposition 1* is somewhat unrealistic. Although some of us admittedly feel completely unable to control affective urges, most individuals do exert some control even during states of affect. Let us therefore analyze how access to self controlling measures affect behavior in the presence of affect induced myopia.

2.1.2 Self control

As mentioned in the introduction, Ainslie (2001) argues that farsighted interest may act strategically in terms of forming personal rules in order to prevent short term indulgence in destructive behavior. Accordingly, let us assume that forward looking selves can invest in measures that provide future selves with incentives to abstain from excessive risk taking. More specifically, let us assume that LR_1 and LR_2 have access to instruments that reduces the cost of using condoms for the sexually aroused self. Now, it should be noted that these investments cannot be seen as personal rules in a strict sense. Personal rules should be related to an intrinsic cost of violating the rule in terms of sending a signal of failure to the individual. In addition, a violation of the personal rule should reduce the credibility of the rule for future decisions.[30] These mechanisms are not included in the model presented in this paper. Instead, the self-control measures suggested here relates to a reduction in the cost of condom use, for example in terms of buying condoms beforehand or by investing time and effort to reduce the actual cost of *using* condoms.

I introduce instruments available to the long run interests as investments conducted by the long run selves in each time period respectively. Let $z_t; 0 \leq z_t \leq 1$ for $t = 1,2$ represent the instrument available to the long run self in each time period. The lower z_t is, the lower is the subjective cost of using a condom by sexually aroused selves assumed to be. The self control augmented subjective cost of using condoms is given by:

[30] The idea of a personal rule is to bundle costs and rewards such that short term interests are persuaded to act in accordance with long term goals. In other words, giving in today sends a signal to the individual that he will always give in is thus associated with a greater cost than if only the particular situation at hand is considered (see Ainslie, 2001).

$$C^n(n_t, z_t, \bar{x}_t) = z_t \cdot \frac{{n_t}^2 \cdot \bar{x}_t}{2} \tag{2'}$$

The functional form specified in equation (2') implies that, $C^n_{z_t}(n_t, z_t, \bar{x}_t) > 0$, and $C^n_{z_t z_t}(n_t, z_t, \bar{x}_t) = 0$. Further if $z_t = 0$, $C^n(n_t, 0, \bar{x}_t) = 0$. However, setting z_t low cannot be done without effort; making sure that condoms are available, practicing, or talking to a potential sexual partner about using condoms beforehand may take both time and energy. Let us therefore define the cost of investing in z_t in terms of an effort function:[31]

$$C^z(z_t, \bar{x}_t) = \frac{(1 - z_t)}{z_t} \cdot \bar{x}_t \tag{10}$$

The functional form of equation (10) suggests that the lower the individual wants to set z_t, the more it is going to cost him in terms of effort ($C^z_{z_t} < 0$, and $C^z_{z_t z_t} > 0$), Note that, if $z_t = 1$, then $C^z(1, \bar{x}_t) = 0$. The introduction of potential investments in self control implies that the life time utility function in equation (1) is now given by:

$$\begin{aligned} \mathrm{U}(z_t, n_t, \bar{x}_t, \varphi) = &-C^z(z_1, \bar{x}_1) + u(\bar{x}_1) - C^n(n_1, \bar{x}_1, z_1) - C^z(z_2, \bar{x}_2) \\ &+ u(\bar{x}_2) - C^n(n_2 \bar{x}_2, z_2) + \varphi^{x_{us}} \cdot u(\bar{x}_3) \end{aligned} \tag{1'}$$

Perfect foresight implies that LR_1 knows that SR_1 will treat z_1 as exogenously given when choosing ${n_1}^{m*}$. The first order condition for SR_1 thus defines ${n_1}^{m*} = {n_1}^{m*}(z_1, \omega, \bar{x}_1)$ as a function of the investment made by LR_1 in the previous time-period. The first order condition for a forward looking self with access to self-control is thus given by:

$$\begin{aligned} \frac{\partial U_t^{LR}}{\partial z_t} = &-\frac{\partial C^z(z_t, \bar{x}_t)}{\partial z_t} - \frac{\partial C^n(n_t^{*m}(z_t), \bar{x}_t, z_t)}{\partial z_t} \\ &- \left[\frac{\partial C^n(n_t^{*m}(z_t), \bar{x}_t, z_t)}{\partial n_t^{*m}} + \bar{x}_t \cdot u(\bar{x}_3) \cdot \ln(\varphi)\, \varphi^{x_{us}}\right] \cdot \frac{\partial n_t^{*m}}{\partial z_t} = 0 \end{aligned} \tag{11}$$

for *t=1,2*, since ${n_t}^{m*} = {n_t}^{m*}(z_t, \omega, \bar{x}_t)$ is now given by $n_1^{*m} = (\omega / z_1)$. Equation (11) defines the optimal level of self-control investments in each time period. Let us define this level of investment; ${z_t}^{*SC} = {z_t}^{*SC}(\bar{\boldsymbol{x}}, \omega, \varphi)$, where SC stands for *Self-Control* and $\bar{\boldsymbol{x}} = \bar{x}_1, \bar{x}_2, \bar{x}_3$. The first order condition in equation (11) suggests that a forward looking self maximizes utility by equating the marginal cost of investing in self-control to the marginal benefit. As can be seen in equation (11), the marginal cost of investments in self-control is constituted by both the direct investment

[31] As is clear from equation (10), for $z_t = 0$ the function is undefined. Hence to be strict $z_t; 0 < z_t \leq 1$. However, as z_t approaches zero, the cost of investments in self-control approaches infinity, thus implying that the individual will never find it optimal to set $z_t = 0$.

cost and by a cost related to the increase in condom use. The marginal benefit of investments in self-control relates to the reduction in condom cost at a given level of condom use, and by the increased probability of surviving to old age. Let us now analyze how the availability of investments in self control affects sexual choices in the sex model. Consider the following proposition:

Proposition 2

In the absence of myopic tendencies, a forward looking individual does not invest in self control, i.e., $z_t^{*FB} = 1$. *However, if the individual has myopic tendencies, and if* $\omega < -u(\bar{x}_3) \cdot \ln(\varphi)\, \varphi^{x_{us}}$, *we can no longer rule out an interior solution for investments in self control, i.e.,* $z_t^{*SC} \leq 1$.

Proof. See the appendix

The intuition behind *proposition* 2 is relatively straight forward. If long run interests do not have executive power over behavior in aroused states, they are forced to act strategically in order to constrain the decisions of future short-sighted interests. In other words, the knowledge that we, in the heat of the moment, tend to do things that we later regret creates incentives to bolster our ability to refrain from these foolish decisions. Hence, if practicing to put on a condom, or talking to potential sexual partners about condom use, relieves the tension of using condoms, this may constitute a way of reaching closer to our long term goals.

Until now, we have limited our analysis to a somewhat trivial model of investments in self-control in the presence of sexual myopia. This analysis was carried out to set the stage for the main topic of this paper; the presence of cognitive dissonance and its effect on sexual behavior. Let us therefore briefly discuss how the presence of cognitive dissonance changes the timing of the model, and the choice set of the long run selves in time period 1 and 2.

2.2 A Model for sexual rationalization

As mentioned in the introduction, cognitive science suggests that individual well-being is dependent on having a coherent and positive self-concept. Hence, if myopic tendencies induces excessive risk taking, then future interests to minimize suffering may well give rise to rationalization tendencies. Let us therefore extend the previous analysis and assume that the individual has an additional short-term self whose main interest is to reduce anxiety and maintain a positive self-image. The new timing of the model is depicted in *Figure 2*, below:

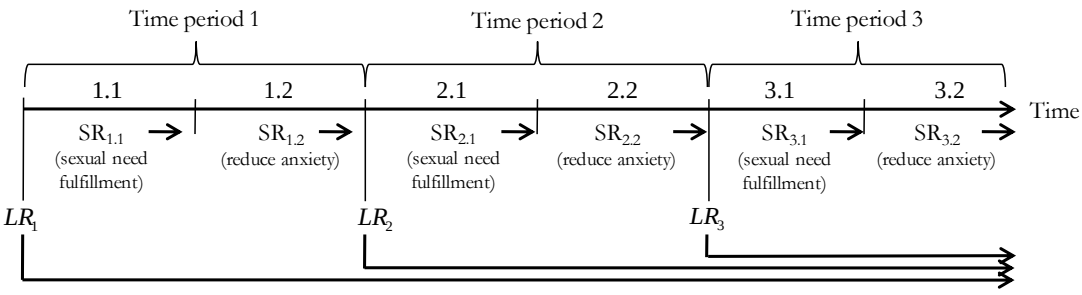

Figure 2: Timing of decisions related to sexual behavior and rationalization

As before, LR_1 is assumed to use all available information in order to maximize lifetime utility, but not to be in charge of the actual decision making during states of sexual affect. However, the introduction of cognitive dissonance implies that, if the individual engages in excessive risk taking in time period t.1, he will now experience negative physical arousal in terms of anxiety in time period t.2. Hence, if decisions in previous periods have resulted in excessive risk taking, a new short run self with the interest to minimize HIV related anxiety will surmount as the individual enters time period 1.2. This short sighted self ($SR_{1.2}$) myopically strives to maintain a positive self-image in terms of rationalizing past behavior. Rationalization is modeled as a subjective evaluation of personal risk of acquiring HIV during an unprotected sex act. As in the above, the true per-coital probability of remaining HIV negative is given by, φ. Let us define the subjective per-coital probability or remaining HIV negative, as chosen by $SR_{1.2}$, $\tilde{\varphi}$.

After tackling the aftermath of the sexual activity, the individual is assumed to enter time period 2 were the long term interest (LR_2) maximizes the remaining lifetime utility. However, if $SR_{1.2}$ has rationalized past behavior, in terms of choosing $\tilde{\varphi} \neq \varphi$, LR_2's decisions will not be based on the true risk of acquiring HIV from an unprotected sexual act but rather on $\tilde{\varphi}$. As in period 1, the individual in period 2 is assumed to get exposed to exogenous affective stimuli that create myopic behavior in period 2.1, and potentially rationalizing behavior in time period 2.2.

Since the individual is assumed to die after time period 3, rationalization in period 2 has no effect on sexual behavior in time period 3. Consequently, since rationalization in period 2 has no future costs this aspect is ignored in the analysis below. Before we turn to the analysis of the effect of rationalization opportunities on sexual behavior and investments in self control, let us briefly discuss the cognitive dissonance function. This is done in the next section.

2.2.1 Rationalizing short term interests

Voluntary involvement in unsafe sexual activities implies that the individual exposes himself to the risk of dying prematurely.[32] Hence, in accordance with the ideas of Aronson (1968), this type of behavior questions may question the individual's self-image as an intelligent and responsible individual (and induce fear of premature death). In our model this implies that, if $\varphi < 1$, and if ${n_t}^{m*} < 1$, the individual experiences a sense of anxiety and an urge to restore the consistency of his self-concept in terms of seeking information affirming that the decision taken was the right one. This may for example imply that the individual downplay his sexual partner's relative riskiness. Hence, in the analysis below, the restoration of a positive self-image is assumed to be carried out in terms of rationalizing past behavior.

Naturally, the restoration of a positive and coherent self-image does not come without costs. Rationalization implies that the individual needs to use effort to convince himself that his preferred perception of his behavior is the correct one. However, for simplicity this aspect of rationalization costs will be disregarded here. More importantly, rationalization of personal risk distorts the information set of future selves. Since the individual's perception of the riskiness of past behavior is likely to be based on the risk of acquiring HIV, rationalization implies changing his perception of the per-coital survival probability.

Before we define the cognitive dissonance function, let us define the main characteristics that should be included in this function to make it consistent with cognitive dissonance theory. Define $\tilde{\varphi}^*$ as the optimal level of subjective personal survival probability from the perspective of $SR_{1.2}$. The cognitive dissonance function should then have the following characteristics:

1) If there is no risk involved in a certain behavior, there will be no need to rationalize behavior, i.e.,

$$if\ \varphi = 1\ \ then\ \ \tilde{\varphi}^* = 1\ \forall\, n_1 \tag{12}$$

2) If an individual has not engaged in any risk taking in previous time periods there should not be any need to rationalize behavior, i.e.

$$if\ n_1 = 1\ \ then\ \ \tilde{\varphi}^* = \varphi\ \ \forall\, \varphi \tag{13}$$

A cognitive dissonance function which meets these requirements is given by:

$$CD\big(\tilde{\varphi}, n_1, c_f\ \big) = \frac{1}{2} \cdot c_f \cdot (1 - n_1) \cdot \bar{x}_1 \cdot (1 - \tilde{\varphi})^2 \tag{14}$$

[32] The anxiety could naturally also be related to the social stigma associated with being HIV positive. However, the analysis of social stigma is beyond the scope of this paper

where $c_f \geq 1$ is a scale parameter measuring the negative arousal caused by having an inconsistent self-concept (or the fear of premature death). In other words, as long as the individual does not engage in sexual risk taking ($n_1 = 1$ or $\varphi = 1$), cognitive dissonance will never arise.[33] However, if past behavior involves sexual risk, the individual will experience a threat towards his self-image and enter into a state of negative physical arousal. As in the case of sexual arousal, affect due to cognitive dissonance is assumed to hamper the individual's ability to judge the future consequences of current behavior. Remember that the true consequences of choosing a *personal* risk of HIV ($\tilde{\varphi}$) that diverge from the true level of HIV risk (φ) is that future selves may underestimate the risk of an HIV infection. In other words, the cost of rationalization is the increased risk of premature death, as given by:

$$u(\bar{x}_3) \cdot \varphi^{(1-n_1)\bar{x}_1} \cdot \left[\varphi^{(1-n_2(\varphi))\bar{x}_2} - \varphi^{(1-n_2(\tilde{\varphi}))\bar{x}_2}\right] \tag{15}$$

As in the case of sexual arousal, the heightened arousal associated with anxiety is likely to affect the cognitive capacity to evaluate the future consequences of a given decision. Psychological research suggest that while positive moods are associated with heuristic information processing, negative moods are associated with a more systematic information processing. However, extremely negative states of affect, such as fear, also seem to be associated with a heuristic information processing or avoidance.[34] Since an HIV infection is still associated with premature death in most instances, it may be reasonable to assume that a potential HIV infection causes the individual to experience fear. Consequently, an individual that suspects that his previous behavior has exposed him to HIV is unlikely to engage in complex probability calculations, but rather to rely on heuristics. In addition, since affect reduces the ability to judge future consequences of current behavior, an individual experiencing fear should not consider the behavioral consequences of rationalization (i.e. the effect of rationalization on future condom use). Instead, the individual is once again assumed to rely on a heuristic approach to evaluate the future cost of current behavior in terms of the function:

$$C_r(\bar{x}_3, \tilde{\varphi}, \varphi) = \frac{1}{2} \cdot u(\bar{x}_3) \cdot (\tilde{\varphi} - \varphi)^2 \tag{16}$$

Drawing intuition from equation (14), it may be appropriate to include condom use in period 1 in the heuristic approach specified in equation (16). However, including previous condom use

[33] To be correct, cognitive dissonance should be a function of the deviation between actual behavior and the individual's self-image as an intelligent and competent person. It is naturally possible that the individual has a self-image that is consistent with some degree of risk taking behavior. This specification implies that $(1 - n_1)$ is replaced with $(\bar{n}_1 - n_1)$ in equation (14), where $\bar{n}_1^i$ is the level of condom use that is consistent with the individuals self-image as an intelligent person. However, using this specification we cannot guarantee that $0 \leq \tilde{\varphi} \leq 1$ for $n_1 > \bar{n}_1$. For simplicity I therefore treat the personal norm as not engaging in sexual risk taking at all.

[34] See, e.g. Griffin *et al.* (1999)

linearly in equation (16) makes subjective personal risk independent of past behavior (see footnote 36). Since this seems highly unrealistic, I assume that the cost of rationalization is independent of past condom use. The short run self in time period 1.2 thus strives to minimize cognitive dissonance by minimizing the function:

$$F\left(n_1, c_f, \bar{x}_3, \tilde{\varphi}, \varphi \right) = CD\left(\tilde{\varphi}, n_1, c_f \right) + C_r(\bar{x}_3, \tilde{\varphi}, \varphi) \tag{17}$$

Let us briefly analyze the function specified in equation (17). The first part of $F\left(n_1, c_f, \bar{x}_3, \tilde{\varphi}, \varphi \right)$ is associated with anxiety related to previous risk taking behavior while the second part is associated with the perceived cost of self-deception. Note that the short term interest to minimize anxiety takes condom use in previous time periods as given. Minimizing equation (17) with respect to $\tilde{\varphi}$ defines the optimal value of personal risk, $\tilde{\varphi}^{*m} = \tilde{\varphi}^{m*}\left(n_1^{*m}, c_f\ , u(\bar{x}_3), \varphi\right)$ as given by:[35]

$$\tilde{\varphi}^{*m} = \frac{u(\bar{x}_3)\varphi + c_f(1 - n_1^{*m})\bar{x}_1}{u(\bar{x}_3) + c_f(1 - n_1^{*m})\bar{x}_1} \tag{18}$$

Equation (18) implies that, if ${n_1}^{*m} < 1$, and $\varphi < 1$ then cognitive dissonance will create incentives to rationalize by setting $\tilde{\varphi}^{*m} > \varphi$. Hence, if the actions of the short term interest in time period 1.1 results in excessive risk taking, cognitive dissonance will induce an underestimation of personal risk in time period 1.2. This in turn affects distorts the information set of the long run interest in time period 2. If, on the other hand, ${n_1}^{*m} = 1$ or $\varphi = 1$, the individual does not experience any anxiety and therefore evaluates personal risk rationally. We are now ready to analyze the effects of sexual arousal and rationalizing tendencies on condom use and investments in self control. Consider the cognitive dissonance augmented utility function, as defined for the long run interest in time period 1.

$$\begin{aligned} \mathrm{U}\left(z_1, z_2, n_1, n_2, \bar{x}_1, \bar{x}_2, \bar{x}_3, \omega, \varphi, \tilde{\varphi}, c_f\ \right) \\ = -C^z(z_1, \bar{x}_1) + u(\bar{x}_1) - C^n(z_1, n_1, \bar{x}_1) - CD\left(\tilde{\varphi}, n_1, c_f\ \right) \\ - C^z(z_2, \bar{x}_2) + u(\bar{x}_2) - C^n(z_2, n_2, \bar{x}_2) + \varphi^{x_{us}} \cdot u(\bar{x}_3) \end{aligned} \tag{19}$$

[35] Including condom use in equation (16) implies that the individual minimizes the expression:

$$\frac{1}{2} \cdot c_f \cdot (1 - n_1) \cdot \bar{x}_1 \cdot (1 - \tilde{\varphi})^2 + \frac{1}{2} \cdot (1 - n_1) \cdot u(\bar{x}_3) \cdot (\tilde{\varphi} - \varphi)^2$$

Thus implying an optimal level of $\tilde{\varphi}$ equal to:

$$\tilde{\varphi}^{*m} = \frac{u(\bar{x}_3)\varphi + c_f\bar{x}_1}{u(\bar{x}_3) + c_f\bar{x}_1}$$

The alternative is to include a quadratic term in equation (14) and a linear term in equation (16). However, this does not change the results in the analysis below. In order to facilitate exposition I therefore disregard the effect of condom use in time period 1 on the short run cost of rationalization.

Under perfect foresight, the long run and forward looking self in time period 1 (LR_1) rationally observes future costs and benefits of engaging in unprotected sex. As in section 2.1, perfect foresight implies that LR_1 knows that $SR_{1.1}$ will treat z_1, as set by LR_1, as exogenously given when choosing ${n_1}^{m*}$. The first order condition for $SR_{1.1}$ thus defines ${n_1}^{m*} = {n_1}^{m*}(z_1, \omega, \bar{x}_1)$ (see equation (11)). Since the decision variables for LR_1 is constituted by z_1,, let us in the following for simplicity denote ${n_1}^{m*} = {n_1}^{m*}(z_1)$. The rationale for including the $CD(\tilde{\varphi}, n_1, c_f, \bar{x}_1)$ function in the objective function for the long run self in time period 1 is that the long run self knows that if the behavioral choices of the short sighted self in time period 1.1 implies an excessive engagement in sexual risk taking, this will cause the individual to experience anxiety in time period 1.2. Further, with perfect foresight, LR_1 also knows that $SR_{1.2}$ will set $\tilde{\varphi}^{m*}$ by minimizing the cognitive dissonance function and treating ${n_1}^{m*}$ as exogenously given. Hence, if LR_1 has perfect foresight and is rational, he will treat $\tilde{\varphi}^{m*} = \tilde{\varphi}^{m*}\left(n_1^{*m}(z_1), c_f, u(\bar{x}_3), \varphi\right)$ as a function of the level of condom use set by $SR_{1.1}$and thus as a function of the investment in z_1 .

$$\tilde{\varphi}^{m*}\left(n_1^{*m}(z_1), c_f, u(\bar{x}_3), \varphi\right) = \left(\frac{u(\bar{x}_3)\varphi + c_f\left(1 - n_1^{*m}(z_1, \omega, \bar{x}_1)\right)\bar{x}_1)}{u(\bar{x}_3) + c_f\left(1 - n_1^{*m}(z_1, \omega, \bar{x}_1)\right)\bar{x}_1}\right) \tag{18'}$$

Finally, LR_1 rationally anticipates that LR_2 treats the subjective personal HIV risk, as chosen by the short run self in time period 1.2 ($\tilde{\varphi}^{m*}$), as the true level of survival probability and thus base his investment decisions on this parameter rather than on φ.[36] This implies that the objective function and first order derivative for LR_2 are given by:

$$\begin{aligned} \mathrm{U}(z_2, {n_2}^{m*}(z_2), \bar{x}_2, \tilde{\varphi}^{m*}) = &-C^z(z_2, \bar{x}_2) + u(\bar{x}_2) - C^n(z_2, {n_2}^{m*}(z_2), \bar{x}_2) \\ &+ (\tilde{\varphi}^{m*})^{x_{us}(n_1^{m*}, n_2^{m*}(z_2))} \cdot u(\bar{x}_3) \end{aligned} \tag{20}$$

$$\begin{aligned} &\frac{\partial U(z_2, {n_2}^{m*}(z_2, \omega), \bar{x}_2, \tilde{\varphi}^{m*})}{\partial z_2} \\ &= -\frac{\partial C^z(z_2, \bar{x}_2)}{\partial z_2} - \frac{\partial C^n(z_2, {n_2}^{m*}(z_2), \bar{x}_2)}{\partial z_2} - \frac{\partial C^n(z_2, {n_2}^{m*}(z_2), \bar{x}_2)}{\partial n_2} \cdot \frac{\partial {n_2}^{m*}(z_2)}{\partial z_2} \\ &- \bar{x}_2 \cdot \ln(\tilde{\varphi}^{m*}) \cdot (\tilde{\varphi}^{m*})^{x_{us}(n_1^{m*}, n_2^{m*}(z_2))} \cdot u(\bar{x}_3) \cdot \frac{\partial {n_2}^{m*}(z_2)}{\partial z_2} = 0 \end{aligned} \tag{21}$$

Note that, since $\tilde{\varphi}^{m*} = \tilde{\varphi}^{m*}\left(n_1^*(z_1, \omega), \bar{x}_1, c_f, u(\bar{x}_3), \varphi\right)$ is a function of z_1, z_2 and $n_2^{m*} = n_2^{m*}(z_2(z_1), \bar{x}_2, \omega)$ will also be functions of z_1. Hence, with perfect foresight, LR_1 sets z_1 in

[36] In the model presented in this paper, rationalization is assumed to always be successful, in terms of completely changing the information set for future selves.

order to maximize equation (19), treating the choices of future selves as functions of z_1. The objective function for LR_1 under full information is thus given by:

$$\begin{aligned} \mathrm{U}(z_t, \bar{x}_1, \bar{x}_2, \bar{x}_3, \omega, \varphi, c_f\ ) \\ &= -C^z(z_1, \bar{x}_1) + u(\bar{x}_1) - C^n({n_1}^{m*}(z_1), \bar{x}_1, z_1\ ) \\ &- CD\big(\tilde{\varphi}^{*m}\big({n_1}^{m*}(z_1), \varphi, u(\bar{x}_3), c_f\ \big), c_f, \bar{x}_1\big) - C^z(z_2(z_1), \bar{x}_2\ ) + u(\bar{x}_2) \\ &- C^n\left(\bar{n}_2, {n_2}^{m*}\big(z_2(z_1)\big)\right) + \varphi^{x_{us}(n_1^{m*}(z_1,\omega), n_2^{m*}(z_2,\omega))} \cdot u(\bar{x}_3) \end{aligned} \tag{19'}$$

As is clear from equation (19'), I assume that the individual only experiences anxiety due to past risk taking in time period 1.2. In reality, as long as $\tilde{\varphi}^{*m} < 1$ and ${n_1}^{m*} < 1$, people are likely to experience anxiety from time to time even in later time periods. However, although including anxiety in time period 2 as a function of $\tilde{\varphi}^{*m}$ would be an interesting extension of the model, this would not allow us to derive analytically tractable results. Let us therefore assume that the cognitive dissonance cost is only experienced in time period 1.2. Further, in order get a clearer intuition and simplify the analysis below, let us make the following assumption:

Assumption 1

The direct effect of condom use on cognitive dissonance outweighs the indirect effect, i.e. $\left|\frac{\partial CD}{\partial {n_1}^{m*}}\right| > \left|\frac{\partial CD}{\partial \tilde{\varphi}^{m*}} \cdot \partial\varphi m{*}\partial n1m{*}\right.$.

In order to see the rationale for *assumption* 1, note that the total effect of condom use on the anxiety associated with cognitive dissonance is given by:

$$\frac{\partial CD}{\partial {n_1}^{m*}} + \frac{\partial CD}{\partial \tilde{\varphi}^{m*}} \cdot \frac{\partial \tilde{\varphi}^{m*}}{\partial {n_1}^{m*}} \tag{22}$$

The first term in equation (22) describes the reduction in anxiety associated with a lower level of risk taking behavior and is negative by equation (14). The first part of the second term in equation (22) is positive from equation (14) and describes how an increase in the subjective survival probability reduces the anxiety associated with unprotected sex. Finally, $\partial\tilde{\varphi}^{m*}/\partial {n_1}^{m*}$ is associated with the reduced need to rationalize at higher levels of condom use and is negative by equation (18'). Taken together, equation (22) implies that an increase in condom use has two effects in opposite directions on anxiety. The direct effect of increased condom use reduces anxiety, but since an increase in condom use also reduces the optimal level of $\tilde{\varphi}^{m*}$, an increase in condom use indirectly *increases* anxiety. *Assumption 1* simply states that condom use induces a

net reduction in the anxiety related to sexual risk taking. In order to facilitate the presentation below, let us also define:

$$C^z(z_1, \bar{x}_1) = C^{z1} \qquad C^z(z_2(z_1), \bar{x}_2\ ) = C^{z2}$$

$$C^n(z_1, {n_1}^{m*}(z_1, \omega), \bar{x}_1\ ) = C^{n1} \qquad C^n(z_2(z_1), {n_2}^{m*}(z_2(z_1), \omega), \bar{x}_2\ ) = C^{n2}$$

$$CD\big(\tilde{\varphi}\big({n_1}^{m*}(z_1, \omega), \varphi, \bar{x}_3, c_f\ \big), c_f, \bar{x}_1\big) = CD$$

Maximizing equation (19') with respect to z_1 produces the first order condition:

$$\begin{aligned}\frac{\partial U_1^{LR}}{\partial z_1} = &-\left[\frac{\partial C^{z1}}{\partial z_1} + \frac{\partial C^{n1}}{\partial z_1} + \left(\frac{\partial C^{n1}}{\partial {n_1}^{m*}} + \bar{x}_1 \cdot u(\bar{x}_3) \cdot \ln(\varphi)\, \varphi^{x_{us}(z_1, z_2(z_1))}\right) \cdot \frac{\partial {n_1}^{m*}}{\partial z_1}\right] \\ &- \left[\frac{\partial CD}{\partial {n_1}^{m*}} + \frac{\partial CD}{\partial \tilde{\varphi}^{m*}} \cdot \frac{\partial \tilde{\varphi}^{m*}}{\partial {n_1}^{m*}}\right] \cdot \frac{\partial {n_1}^{m*}}{\partial z_1} - \left[\frac{\partial C^{z2}}{\partial z_2} + \frac{\partial C^{n2}}{\partial z_2}\right. \\ &\left. + \left(\frac{\partial C^{n2}}{\partial {n_2}^{m*}} + \bar{x}_2 \cdot u(\bar{x}_3) \cdot \ln(\varphi)\, \varphi^{x_{us}(z_1, z_2(z_1))}\right) \cdot \frac{\partial {n_2}^{m*}}{\partial z_2}\right] \frac{\partial z_2(z_1)}{\partial z_1} = 0\end{aligned} \tag{23}$$

$\partial z_2(z_1)/\partial z_1$ can be partitioned into:

$$\frac{\partial z_2(z_1)}{\partial z_1} = \left(\frac{\partial z_2(z_1)}{\partial {n_1}^{m*}} + \frac{\partial z_2(z_1)}{\partial \tilde{\varphi}^{m*}} \cdot \frac{\partial \tilde{\varphi}^{m*}}{\partial {n_1}^{m*}}\right) \cdot \frac{\partial {n_1}^{m*}}{\partial z_1} \tag{24}$$

where $\partial z_2(z_1)/\partial {n_1}^{m*}$ relates to the direct effect of condom use in time period 1 on incentives to invest in self-control in time period 2, and $(\partial z_2(z_1)/\partial \tilde{\varphi}^{m*}) \cdot (\partial \tilde{\varphi}^{m*}/\partial {n_1}^{m*})$ relates to the indirect via rationalization. Let us briefly analyze the first order condition in equation (23). The expression within the first square bracket pertains to the within-period marginal benefits and costs of investments in z_1 and thus corresponds to the first order condition in equation (11). However, when the individual has the ability to rationalize past behavior, investments in self-control have additional costs and benefits. The term within the second square bracket in equation (23) describes the marginal effect of investments in self-control on anxiety caused by cognitive dissonance and thus on incentives to engage in denial of risk. The term within the last square bracket corresponds to the first order condition for the forward looking self in time period 2 evaluated at φ. Finally, as can be seen in equation (24), investments in self-control in time period 1 affects investment incentives in time period 2 both in terms of the effect on condom use in time period 1 and thus on the probability of being HIV negative, and in terms of changing the information set due to rationalization.

Now, the main question asked in this paper is how affect induced myopia and rationalization tendencies affect sexual risk taking. In order to answer these questions, we need to analyze how rationalization affects the incentives to invest in self-control in time period 2. Let us therefore take a closer look at the two last parts of equation (23).

From equation (2') and (18') and given *assumption 1*, the term within the second square bracket of equation (23) is negative. Hence, investments in self-control in time period 1 have the additional direct marginal benefit of reducing cognitive dissonance. However, since investments in self-control also affects incentives to rationalize personal risk it also indirectly affects the incentives facing the forward looking self in time period 2. Let us denote the expression within the last square bracket in equation (23) $FOC_2(\varphi)$. If $\tilde{\varphi}^{*m} = \varphi$, then $FOC_2(\varphi) = 0$. However, with $\tilde{\varphi}^{*m} \neq \varphi$ it may be the case that $FOC_2(\varphi) \neq 0$, since the forward looking self maximizes perceived utility by setting $FOC_2(\tilde{\varphi}^{m*}) = 0$. Hence, in order to determine how rationalization tendencies affect incentives to engage in unsafe sex and invest in self-control we need to analyze the sign of $FOC_2(\varphi) \cdot (\partial z_2/\partial z_1)$.

It can be shown that the marginal effect of rationalization on sexual risk taking hinge on whether rationalization causes the forward looking self in time period 2 to under- or overestimate the marginal cost of unprotected sex. The effect can be summarized by the term:[37]

$$\ln(\varphi) \cdot \varphi^{x_{us}} - \ln(\tilde{\varphi}^{*}) \cdot (\tilde{\varphi}^{m*})^{x_{us}} \tag{25}$$

where $\ln(\varphi) \cdot \varphi^{x_{us}}$ relates to the true marginal effect of an unprotected sexual act on survival probability, and $ln(\tilde{\varphi}^{*}) \cdot (\tilde{\varphi}^{m*})^{x_{us}}$ is the marginal effect as perceived by a rationalizing individual. It can further be shown that the sign of equation (25) depends on the perceived risk of being HIV positive upon entrance in time period 2. As is shown in the appendix, this effect is captured by the expression:

$$\left(1 + x_{us} \cdot ln(\tilde{\varphi}^{*m})\right) \tag{26}$$

If equation (26) is positive, a marginal increase in $\tilde{\varphi}^{*m}$ implies that the marginal risk of an unprotected sexual act is underestimated. However, if x_{us} is sufficiently high, or if $\tilde{\varphi}^{*m}$ is sufficiently low, $\left(1 + x_{us} \cdot ln(\tilde{\varphi}^{*m})\right)$ may be negative. In this case, a marginal increase in $\tilde{\varphi}^{*m}$ actually causes an *overestimation* of the perceived marginal risk of unprotected sex, due to a perceived *increase* in the probability of being HIV negative. Whether or investments in self-control in time period 1 increases or reduces incentives to invest in self-control in time period 2 in this

[37] With a linear probability function of the kind $\varphi = (1 - x_{us} \cdot PR(HIV))$ an increase in investments in self-control in time period 1 would unambiguously increase incentives to invest in self-control in time period 2. Calculations are available from the author upon request.

scenario depends on the relative effect of increased condom use on true and subjective survival probability. To see this, let us return to equation (24). The first term on the RHS in equation (24) relates to the direct effect of increased condom use in time period 1 on incentives to invest in self-control in time period 2. Since condom use increases the probability of being HIV negative in time period 2, and thus the marginal benefit of using condoms in this period, this term is unambiguously negative (see the appendix for a derivation of this result). The second term on the RHS in equation (24) relates to the indirect effect of condom use in time period 1 on incentives to invest in self-control in time period 2. As is shown in the appendix, the sign of this term hinges on the sign of equation (26). If equation (26) is negative, rationalization increases the perceived probability of being HIV negative in time period 2 and therefore makes the total effect of condom use on incentives to invest in self-control in time period 2 ambiguous. Consider the following proposition:

Proposition 3

3.1) If $1 + x_{us} \cdot ln(\tilde{\varphi}^{*m}) > 0$*, rationalization induces an* <u>underestimation</u> *of the marginal cost of unprotected sex and an* <u>underinvestment</u> *in self-control in time period 2. This creates incentives for precautionary savings in terms of overinvestment in self-control in time period 1*

3.2) If $1 + x_{us} \cdot ln(\tilde{\varphi}^{*m}) < 0$*, rationalization induces an* <u>overestimation</u> *of the marginal cost of unprotected sex. However, incentives for investments in self-control in time period 1 depend on the relative magnitude of the direct and indirect effect of condom use on incentives to invest in self-control in time period 2:*

a. If $\left|\frac{\partial z_2(z_1)}{\partial n_1{}^{m*}}\right| > \left|\frac{\partial z_2(z_1)}{\partial \tilde{\varphi}^{m*}} \cdot \frac{\partial \tilde{\varphi}^{m*}}{\partial n_1{}^{m*}}\right|$*, then the reduction in HIV risk due to increased condom use in time period 1 outweighs the* <u>*perceived*</u> *increase in perceived HIV risk due to reduced rationalization. In this case rationalization* <u>reduces</u> *incentives for investments in self-control in time period 1*

b. If $\left|\frac{\partial z_2(z_1)}{\partial n_1{}^{m*}}\right| < \left|\frac{\partial z_2(z_1)}{\partial \tilde{\varphi}^{m*}} \cdot \frac{\partial \tilde{\varphi}^{m*}}{\partial n_1{}^{m*}}\right|$ *then the reduction in HIV risk due to increased condom use in time period 1 is outweighed by the* <u>*perceived*</u> *reduction in HIV risk due to reduced rationalization. In this case rationalization creates incentives for precautionary savings in terms of* <u>higher</u> *investments in self-control in time period 1.*

Proof. See the Appendix

Investments in self-control in time period 1 have the direct benefit of reducing sexual risk taking and anxiety associated with cognitive dissonance in this period. In addition, due to the reduction in anxiety, investments in self-control in time period 1 reduce incentives to rationalize personal risk. Consequently, the more self-control used in time-period 1, the more correctly will the forward looking self in time-period 2 judge the risk of engaging in unprotected sex. However,

judging HIV risk more correctly does not necessarily imply more investments in self-control in time period 2. As mentioned above, the marginal benefit of an investment in self-control in time period 2 depends both on the perceived probability of acquiring HIV from an unprotected sexual act, and on the perceived probability of already being infected with HIV (i.e., the greater the probability of already having the virus, the smaller is the perceived benefit of abstaining from unprotected sex).[38]

Rationalization of personal risk contributes to an underestimation of the per-coital risk of an HIV infection for an HIV negative individual. However, it also affects the perceived risk of being HIV positive. Put differently, an underestimation of personal HIV risk *overestimates* the probability of being HIV negative and thus the *overestimates* the perceived marginal benefit of abstaining from unprotected sex. The result in *Proposition 3.2* implies that, if the effect of an increase in the subjective appraisal of being HIV negative is greater than the reduction in the perceived per-coital risk of an HIV infection, rationalization may lead to an overall *increase* in the perceived marginal cost of unprotected sex in time period 2.[39] Hence, from the perspective of the forward looking self in time period 1, rationalization may cause over-restrictive behavior in future time periods. However, even if investments in self-control in time period 1 reduces incentives to invest in self-control in time period 2 by reducing rationalization, the increase in condom use that follows from investments in self-control always increase the marginal benefit of condom use in time period 2 due to the reduced probability of being HIV positive.

The results in *Proposition 3.2* suggest that, if the effect of increased condom use outweighs the effect of reduced rationalization on the perceived probability of being HIV positive, investments in self-control in time period 1 always increases incentives to invest in self-control in time period 2. This implies that, if rationalization induces an overestimation of the marginal cost of unsafe sex, the forward looking self in time period 1 has incentives to prevent exaggerated self-control in time period 2 by under-investing in self-control. If, on the other hand the effect of rationalization outweighs the direct effect of condom use, increased investment in self-control in time period 1 reduces exaggerated self-control in time period 2. Hence, in this case, the forward looking self in time period 1 once again has incentives to engage in precautionary investments in self-control.

The result in *Proposition 3.2* may at first glance appear contra-intuitive. However, if HIV is perceived as more or less unavoidable, then from the perspective of the forward looking self in time period 1, investment in self-control in time-period 2 is a waste of resources. Hence, if rationalization induces an overestimation of the marginal cost of unsafe sex, it will cause future

[38] Indeed, disregarding the self-deception effect, the higher sexual risk taking in period 1 is, the lower will the perceived marginal cost of unsafe sex in time period 2 be.

[39] This result hinges on the assumption that the individual does not know his or her HIV status.

selves to engage in over-restrictive behavior. Consequently, since investing in self-control in time period 1 reduces the risk of rationalization, the forward looking self in time period 1 will have incentives to promote condom use.

So far we have assumed that individuals have perfect information about their rationalization tendencies. However, it may be reasonable to assume that individuals are more or less naïve about the existence and effects of cognitive dissonance. Let us therefore briefly analyze the consequences of naïveté on investments in self control. This is done in the next section.

3.2.1 Naïveté

Naïve individuals are usually defined as individuals that do not realize that future behavior will be affected by myopic tendencies (including sexually induced myopia). However, since the main question asked in this paper is how rationalization affects sexual risk taking I find it more interesting to focus the analysis on the cognitive dissonance aspect of naïveté. In addition, if the individual is completely naïve about sexually induced myopia, and the cost of investments in z_1 are sufficiently high, he will completely refrain from investments in z_1. Hence, condom use in equilibrium will be the same as when self control measures are not available ($n_1{}^* = n_1{}^{m*}$). Consequently, let us assume that naïveté only concerns rationalization tendencies and define $\theta; 0 \leq \theta \leq 1$ as a measure of the degree of naïveté. This implies the following definition of naïve and sophisticated individuals.

Definition 2

A completely sophisticated individual is an individual who is fully aware of myopic tendencies and rationalization behavior, i.e., $\theta = 1$

A completely naïve individual is an individual who is aware of sexual myopia but who is ignorant about rationalization tendencies, i.e., $\theta = 0$

An individual who is partially naïve about his rationalization tendencies is thus defined by $\theta; 0 < \theta < 1$

A completely naïve individual is unaware of that unsafe sexual practices induces fear and rationalization in the future. This implies that naïve individuals ignore the effect of investments in self-control on rationalization and anxiety and thus treats $\tilde{\varphi}^{*m}$ as exogenous and equal to φ. In addition, naïveté implies that the individual will disregard that the long run self in time period 2 will base his investment decisions on $\tilde{\varphi}^{*m} \neq \varphi$, and thus presume that equation (24) only includes the first term; $\partial z_2(z_1)/\partial z_1 = (\partial z_2(z_1)/\partial n_1{}^{m*}) \cdot (\partial n_1{}^{m*}/\partial z_1)$. In other words, a completely naïve LR_1 fails to include the indirect effect of rationalization, as depicted by the second term in

equation (24); $(\partial z_2(z_1)/\partial\tilde{\varphi}^{m*})\cdot(\partial\tilde{\varphi}^{m*}/\partial {n_1}^{m*})\cdot(\partial {n_1}^{m*}/\partial z_1)$. With the inclusion of naïveté, the first order condition for the forward looking self in time period 1 is thus given by:

$$\begin{aligned}\frac{\partial U_1^{LR}}{\partial z_1} = &-\left[\frac{\partial C^{z1}}{\partial z_1}+\frac{\partial C^{n1}}{\partial z_1}+\left(\frac{\partial C^{n1}}{\partial {n_1}^{m*}}+\bar{x}_1\cdot u(\bar{x}_3)\cdot\ln(\varphi)\,\varphi^{x_{us}(z_1,z_2(z_1))}\right)\cdot\frac{\partial {n_1}^{m*}}{\partial z_1}\right]\\ &-\theta\cdot\left[\frac{\partial CD}{\partial {n_1}^{m*}}+\frac{\partial CD}{\partial\tilde{\varphi}^{m*}}\cdot\frac{\partial\tilde{\varphi}^{m*}}{\partial {n_1}^{m*}}\right]\cdot\frac{\partial {n_1}^{m*}}{\partial z_1}\\ &-\left[\frac{\partial C^{z2}}{\partial z_2}+\frac{\partial C^{n2}}{\partial z_2}+\left(\frac{\partial C^{n2}}{\partial {n_2}^{m*}}+\bar{x}_2\cdot u(\bar{x}_3)\cdot\ln(\varphi)\,\varphi^{x_{us}(z_1,z_2(z_1))}\right)\cdot\frac{\partial {n_2}^{m*}}{\partial z_2}\right]\\ &\cdot\left(\frac{\partial z_2(z_1)}{\partial {n_1}^{m*}}+\theta\cdot\frac{\partial z_2(z_1)}{\partial\tilde{\varphi}^{m*}}\cdot\frac{\partial\tilde{\varphi}^{m*}}{\partial {n_1}^{m*}}\right)\cdot\frac{\partial {n_1}^{m*}}{\partial z_1}\end{aligned} \tag{28'}$$

As can be seen in equation (28'), the special case of $\theta = 1$ implies that the individual has perfect foresight and thus that the results from above hold. However, if $\theta < 1$, the individual underestimates his tendency to rationalize past behavior. $\theta < 1$, furthermore implies that the long forward looking self in period 1 does not consider the full cost of rationalization in terms of underestimation of HIV risk in time period 2. Consider the following proposition:

Proposition 4

Naïveté of self-deception tendencies contributes to an <u>increase</u> *in sexual risk taking in time period 1, i.e.,* $\partial z_1/\partial\theta > 0$.

Proof. See the appendix

Naïveté of self-deception tendencies prevents the individual from incorporating the full cost of engaging in unsafe sex and therefore results in excessive risk taking in time period 1. However, the incentives for increasing consumption of unprotected sex depend on the lifetime probability of acquiring HIV. As suggested by *Proposition 3*, self-deception causes an underestimation of the marginal HIV risk for individuals with a relatively low lifetime risk of acquiring HIV, and thus to lower than optimal investments in self-control in time period 2. This implies that sophisticated "low risk" individuals have incentives to engage in precautionary condom use in order to prevent excessive risk taking in the future. Naïveté of cognitive dissonance implies that this precautionary behavior does not take place, and thus to an increase in sexual risk taking in both time periods.

In contrast, for individuals with a relatively high lifetime risk of an HIV infection, self-deception implies an overestimation of the perceived marginal risk of an HIV infection in time period 2, and thus to overly restrictive behavior in this time period. Sophisticated "high risk" individuals thus have incentives to restrict consumption of unsafe sex in time period 1 in order to prevent *lower than optimal* consumption of unprotected sex in later time periods. Hence, as for

"low risk" individuals, naïveté of cognitive dissonance implies that "high risk" individuals will engage in excessive sexual risk taking in time period 1. However, for "high risk" individuals, the overconsumption of risky sex as young may actually contribute to a *reduction* in sexual risk taking in later time periods. The mechanism behind this result is that the increase in the subjective survival probability that arises due to an increase in sexual risk taking spurs investments in self-control in later time periods among individuals characterized by a high risk of acquiring HIV. In other words, rationalization may prevent fatalism. However, excessive risk taking in period 1 will only contribute to a reduction in risk taking behavior in period 2 if the effect of rationalization on the perceived probability of being HIV negative outweighs the reduction in true survival probability due to lower condom use (i.e., if equation (24) is negative).

4. Conclusion

In many cases, decisions that seem defendable during states of strong affect are later found to collide with longer term interests and thus regretted. Regret, in turn, is commonly associated with negative emotions such as anxiety. The model, presented in this paper, focuses on our tendency to rationalize past behavior as a way to reduce anxiety and restore a consistent and positive self-image. Admittedly, the consequences of affect induced myopia and cognitive dissonance may in many situations not lead to decisive life changes. However, in the case of sexual risk taking, decisions taken under affect may be irreversible. Hence, even if an individual changes behavior after realizing the risk taken, he or she cannot eliminate the risk of being HIV positive. In addition, since HIV does not cause instant death, and since many individuals hesitate to test for HIV, anxiety may occur both due to cognitive dissonance and fear of social stigma and premature death. Since past behavior cannot be made undone and since HIV is incurable, rationalizing may be one of few instruments left to reduce anxiety.

The results presented in this paper suggest that sexual risk taking may, in addition to increasing the risk of an HIV infection directly, increase the inclination to engage in unsafe sex practices in the future and that the mechanism behind this behavior is two-fold: First, sexual risk taking during young age increases the likelihood of being infected with HIV and thus reduces the perceived marginal benefit of abstaining from unsafe sex during later periods in life. Second, if affect induced risk taking is associated with defensive denial in terms of rationalizing, the underestimation of personal per-coital risk of HIV may lead to an underestimation of the marginal cost of unprotected sex later in life and therefore to excessive risk taking behavior. However, as suggested by *Proposition 3.2*, the defense mechanism to rationalize may not be destructive in all circumstances. Since denial of risk also reduces the perceived probability of

being infected with HIV it may create incentives to use protection for individuals who would otherwise resort to fatalism and reckless behavior. Hence, self-deception may not be a maladaptive coping strategy in all circumstances. This result is consistent with the relatively substantial body of psychological research presented in van der Pligt *et al.* (1993) and van der Pligt (1996).

Consistent with research in psychology, *Proposition 4* suggests that anticipating regret (i.e. being aware of cognitive dissonance and rationalizing tendencies) increases incentives to engage in precautionary behavior, and that a spread between expected and actual emotions may contribute to maladaptive behavior (e.g. Richard *et al.*, 1996; Loewenstein & Lerner, 2003). However, since the incentives schemes underlying the behavioral reactions to reductions in self-deception differ with regards to the true risk of being infected with HIV, empirical research is necessary in order to create policy recommendations. For individuals with a relatively low lifetime risk of HIV, a reduction in rationalization unambiguously increases incentives to abstain from unsafe sex in later time periods. However, for individuals with a substantial lifetime risk of HIV, rationalization reduces incentives to engage in unsafe sex via the effect on the perceived probability of being HIV negative. If the true risk of HIV is sufficiently high and if some risk is unavoidable, investments in self-control may be perceived as relatively fruitless. This implies that the mechanism underlying safe sex practices during young age is related to the incentive to prevent future selves from engaging in over-restrictive behavior.

The true per-coital transmission rate of HIV is substantially less than 1 percent for the majority of the HIV susceptible population (e.g., Gray *et al.,* 2001; Quinn, *et al.*, 2000). However, as shown by Shaklee and Fishhoff (1990), many individuals overestimate the per-coital risk of an HIV infection. The above analysis implies that if the per-coital risk of HIV is perceived as relatively high, the knowledge that we will not be able to abstain completely from unsafe sex may induce fatalism. Hence, for individuals living in environments where HIV constitutes a significant threat it may actually prove beneficial to inform about the relatively *low* transmission probability of HIV in order to prevent excessive risk taking.

It should be noted that these results are based on the assumption that individuals do not test for HIV. If people do take HIV tests from time to time, the analysis changes. Disregarding altruistic motives, HIV positive individuals have relatively little to lose from indulging in unprotected casual sex. However, for individuals testing negative, the marginal cost of unsafe sex will increase.

Although there have been substantial advances within the economic field of research concerning risk perception, economic research usually focuses on lotteries with monetary

rewards.[40] For the subjects in these experiments, it may be easy to predict the experienced benefit of a positive outcome, or the experienced cost of a negative outcome. However, when it comes to issues of life and death, predicting experienced emotions may be more difficult. Hence, it is of immense importance to empirically investigate how decisions under risk are affected when the risk relates to issues such as HIV/AIDS. In addition, and as mentioned above, the incentives for and consequences of different coping strategies such as defensive denial needs empirical investigation, not only in the realm of sexual risk taking behavior but also related to risk taking behavior in general. Finally, the model presented in this paper assumes that rational individuals base their decisions on relatively complicated probability calculations. Empirical research is needed to investigate if this assumption really holds.

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[40] E.g. Kahneman & Tversky, 1979

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Appendix

A1. Variables, parameters and definitions

Table A1.1

Variables	
n_t	Condom use in time period t
z_t	Self-control in time period t
$\tilde{\varphi}$	Subjective per-coital risk of HIV
Parameters	
φ	Objective per-coital risk of HIV
$\bar{x}_3$	Exogenous supply of attractive sexual opportunities in time period t
ω	Worry
c_f	Cognitive dissonance cost (fear)
Superindex	
m	Myopic optimum
FB	First Best optimum
SC	Self-control optimum

A2. Proofs

Proof of proposition 1

Compare the first order conditions for a far sighted and a short sighted individual. Equation (3) and (4) suggests that an individual without myopic tendencies maximizes utility by setting:

$$\frac{\partial C^n(n_t\,,\bar{x}_t\,)}{\partial n_t} = -\bar{x}_t \cdot u(\bar{x}_3) \cdot ln(\varphi)\,\varphi^{x_{us}} \tag{A.1}$$

Myopic agents, on the other hand, maximize short term utility by setting:

$$\frac{\partial C^n(n_t, \bar{x}_t)}{\partial n_t} = \omega \cdot \bar{x}_t \tag{A.2}$$

Substituting $\omega \cdot \bar{x}_t$ from equation (A.2) into equation (A.1) gives us an estimate of the risk evaluation error that the sexually aroused self makes in t.1:

$$\bar{x}_t \cdot (\omega + u(\bar{x}_3) \cdot \ln(\varphi)\, \varphi^{x_{us}}) \tag{A.3}$$

Hence, if $\omega < -u(\bar{x}_3) \cdot \ln(\varphi)\, \varphi^{x_{us}}$, the value of using condoms is underestimated by the myopic agent in comparison to a rational individual without myopic tendencies and thus $n_1^{*m} < n_1^{*FB}$. If if $\omega > -u(\bar{x}_3) \cdot \ln(\varphi)\, \varphi^{x_{us}}$, $n_1^{*m} > n_1^{*FB}$, q. e .d.

Proof of proposition 2

Let us start by noting that, in the absence of myopic selves, the first order conditions for z_t are given by:

$$\frac{\partial U}{\partial z_t} = -\frac{\partial C^z(z_t, \bar{x}_t)}{\partial z_t} - \frac{\partial C^n(n_t, \bar{x}_t, z_t)}{\partial z_t} = 0 \tag{A.4}$$

Equation (A.4) implies that the optimal level of z_t for an individual without myopic problems is given by:

$$z_t{}^{FB} = \frac{\sqrt{2}}{n_t} \tag{A.5}$$

However, since $z_t \in [0,1]$, and since $n_t \in [0,1]$, the first order condition in equation (A.4) can never be fulfilled. In other words, we have a corner solution where the forward looking individual sets $z_t{}^{*FB} = 1 < \frac{\sqrt{2}}{n_t}$, and where

$$\frac{\partial U}{\partial z_t} = -\frac{\partial C^z(z_t, \bar{x}_t)}{\partial z_t} - \frac{\partial C^n(n_t, \bar{x}_t, z_t)}{\partial z_t} > 0 \tag{A.4'}$$

Now consider the first order condition in equation (18), and define:

$$\begin{aligned} A &= -\left(\frac{\partial C^n(n_t^{*m}(z_t), \bar{x}_t, z_t)}{\partial n_t^{*m}} + \bar{x}_t \cdot u(\bar{x}_3) \cdot \ln(\varphi)\, \varphi^{x_{us}}\right) \cdot \frac{\partial n_t^{*m}}{\partial z_t} \\ &= -(n_t^{*m} \cdot \bar{x}_t \cdot z_t + \bar{x}_t \cdot u(\bar{x}_3) \cdot \ln(\varphi)\, \varphi^{x_{us}}) \cdot \frac{\partial n_t^{*m}}{\partial z_t} \end{aligned} \tag{A.6}$$

Note that, with the access to investments in self control, n_t^{*m} is now given by:

$$n_1^{*m} = \frac{\omega}{z_1^*} \tag{A.7}$$

Substituting the expression in equation (A.7) into equation (A.6) gives us:

$$A = -(\omega + u(\bar{x}_3) \cdot \ln(\varphi)\, \varphi^{x_{us}}) \cdot \bar{x}_t \cdot \frac{\partial n_t^{*m}}{\partial z_t} \tag{A.8}$$

Since $\partial n_t^{*m}/\partial z_t < 0$, it follows that if $\omega < u(\bar{x}_3) \cdot \ln(\varphi)\, \varphi^{x_{us}}$, $A < 0$. Hence, if $\omega < u(\bar{x}_3) \cdot \ln(\varphi)\, \varphi^{x_{us}}$, we can no longer rule out an interior solution for z_t. Let us further compare the first order condition for a sexually aroused self in time-period t.1 with and without the presence of self-control:

$$n_t^{*m} = \omega \tag{A.9}$$

$$n_t^{*SC} = \frac{\omega}{z_t^{*SC}} \tag{A.10}$$

Hence, if we have an interior solution, condom use will be higher when the LR_1 has access to self controlling measures than when these measures are not available, q. e. d.

Proof of proposition 3

In order to see proposition 3, let us first analyze how the sign of $FOC_2(\varphi)$ is affected by $\tilde{\varphi}^{*m} > \varphi$. In order to do this, let us define:

$$\tilde{A} = -\bar{x}_2 \cdot ln(\tilde{\varphi}^*) \cdot (\tilde{\varphi}^{m*})^{x_{us}} \cdot u(\bar{x}_3) \cdot \frac{\partial n_2}{\partial z_2} \tag{A.11}$$

$$A = -\bar{x}_2 \cdot ln(\varphi) \cdot \varphi^{x_{us}} \cdot u(\bar{x}_3) \cdot \frac{\partial n_2}{\partial z_2} \tag{A.12}$$

where $\tilde{A}$ pertains to the perceived marginal benefit of investments in self-control in terms of reduced HIV risk in the case of self-deception, and A is associated with the true marginal benefit in the absence of self-deception. Let us now add and subtract $\tilde{A}$ and A from $FOC_2(\varphi)$in equation (28). By the first order condition for LR_2 in equation (21) we can easily see that $[FOC_2(\varphi) - A +$ *A=0*. Consequently, the sign of *FOC2φ* hinges on the sign of *A−A*, and thus ultimately on $[\ln(\varphi) \cdot \varphi^{x_{us}} - \ln(\tilde{\varphi}^*) \cdot (\tilde{\varphi}^{m*})^{x_{us}}]$:

$$FOC_2(\varphi) = -\bar{x}_2 \cdot u(\bar{x}_3) \cdot \frac{\partial {n_2}^{m*}}{\partial z_2} \cdot [\ln(\varphi) \cdot \varphi^{x_{us}} - \ln(\tilde{\varphi}^*) \cdot (\tilde{\varphi}^{m*})^{x_{us}}] \tag{A.13}$$

The term within square brackets in equation (A.13) corresponds to the difference in perceived marginal cost of unsafe sex with and without rationalization. If $[\ln(\varphi) \cdot \varphi^{x_{us}} - \ln(\tilde{\varphi}^*) \cdot (\tilde{\varphi}^{m*})^{x_{us}}] < 0$, rationalization implies that the individual in t.2 underestimates the marginal cost of unsafe sex. This implies that the forward looking self in t.2 will under-invest in self-control from the perspective of the forward looking self in t.1, i.e., $FOC_2(\varphi) < 0$. In contrast, if $[\ln(\varphi) \cdot \varphi^{x_{us}} - \ln(\tilde{\varphi}^*) \cdot (\tilde{\varphi}^{m*})^{x_{us}}] > 0$, rationalization implies that the forward looking self in t. 2

overestimates the marginal cost of unprotected sex, and thus that that the forward looking self in time period 2 overinvests in self-control from the perspective of the long run self in t.1, i.e., $FOC_2(\varphi) < 0$.

As mentioned above, if $\tilde{\varphi}^{m*} = \varphi$, then $[\ln(\varphi) \cdot \varphi^{x_{us}} - \ln(\tilde{\varphi}^*) \cdot (\tilde{\varphi}^{m*})^{x_{us}}] = 0$ and consequently $FOC_2(\varphi) = 0$. Rationalizing behavior by assumption implies that $\tilde{\varphi}^{m*} > \varphi$. However, as can be seen in figure A1 below, due to the non-linearity of the survival probability function, a higher perceived survival probability does not necessarily imply a reduction in the marginal cost of unprotected sex.

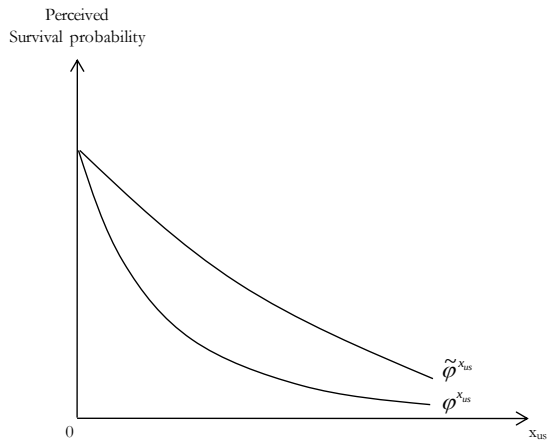

Figure A1: Survival probability as a function of unprotected sex

If we differentiate $[\ln(\varphi) \cdot \varphi^{x_{us}} - \ln(\tilde{\varphi}^{m*}) \cdot (\tilde{\varphi}^{m*})^{x_{us}}]$ with respect to $\tilde{\varphi}^{m*}$ at a given level of unprotected sex, we can derive an expression for the breaking point of the change in perceived marginal cost:

$$\frac{\partial}{\partial \tilde{\varphi}^{m*}} [\ln(\varphi) \cdot \varphi^{x_{us}} - ln(\tilde{\varphi}^*) \cdot (\tilde{\varphi}^{m*})^{x_{us}}]\Big|_{x_{us}} = -(\tilde{\varphi}^{m*})^{x_{us}-1} \cdot \left(1 + x_{us} \cdot ln\,(\tilde{\varphi}^*)\right) \tag{A.14}$$

Hence, if $\left(1 + x_{us} \cdot ln\,(\tilde{\varphi}^{m*})\right) > 0$, rationalization results in a lower perceived marginal cost of unprotected sex as compared to the case without rationalization and vice versa. The result in equation (A.14) suggests that effect of rationalization depends on the perceived probability of being HIV positive. If this risk is sufficiently large (so that $1 + x_{us} \cdot ln(\tilde{\varphi}^*) < 0$), then rationalization may increase the marginal benefit of abstaining from unsafe sex due to the perceived increase in the likelihood of being HIV negative.

Likewise, taking a closer look at $\partial z_2/\partial z_1$ in equation (29), we see that the sign of this expression hinges on the sign and relative magnitude of $\partial z_2/\partial \tilde{\varphi}^{m*}$. To see this, differentiate the first order condition for LR_2 in equation (21) with respect to z_2 and n_1^{*m} and denote these derivatives $\Omega_{z_2 n_1^{*m}}$ and $\Omega_{z_2 z_2}$ respectively. $\partial z_2/\partial n_1^{*m}$ is then given by:

$$\frac{\partial z_2}{\partial n_1^{*m}} = -\frac{\Omega_{z_2 n_1^{*m}}}{\Omega_{z_2 z_2}} \tag{A.15}$$

If we have an interior solution, from the second order condition for a maximum it follows that $\Omega_{z_2 z_2} < 0$. The derivative of equation (21) with respect to n_1^{*m} is given by:

$$\Omega_{z_2 n_1^{*m}} = \bar{x}_1 \cdot \bar{x}_2 \cdot u(\bar{x}_3) \cdot ln(\tilde{\varphi}^{m*})^2 \cdot (\tilde{\varphi}^{m*})^{x_{us}} \frac{\partial n_2^{m*}}{\partial z_2} < 0 \tag{A.16}$$

Hence, the first term in equation (29) is unambiguously negative. The intuition behind this result is that, since increased condom use in period 1 reduces the likelihood of being infected by HIV, it raises the marginal benefit of investing in self control in time period 2. The second term within the square brackets relates to the partial derivative: $\frac{\partial z_2(z_1)}{\partial \tilde{\varphi}^{m*}} \cdot \frac{\partial \tilde{\varphi}^{m*}}{\partial n_1{}^{m*}}$. From equation (18) it can be shown that $\partial \tilde{\varphi}^{*m}/\partial n_1 < 0$. $\partial z_2/\partial \tilde{\varphi}^{m*}$ is given by:

$$\frac{\partial z_2}{\partial \tilde{\varphi}^{m*}} = -\frac{\Omega_{z_2 \tilde{\varphi}^{m*}}}{\Omega_{z_2 z_2}} \tag{A.17}$$

where $\Omega_{z_2 \tilde{\varphi}^{m*}}$ is obtained by differentiating equation (21) with respect to $\tilde{\varphi}^{m*}$:

$$\Omega_{z_2 \tilde{\varphi}^{m*}} = -(\tilde{\varphi}^{m*})^{x_{us}-1} \cdot \bar{x}_2 \cdot u(\bar{x}_3) \cdot \frac{\partial n_2^{m*}}{\partial z_2} \cdot \left(1 + x_{us} \cdot ln\,(\tilde{\varphi}^*)\right) \tag{A.18}$$

As can be seen in equation (A.18), the sign of $\Omega_{z_2 \tilde{\varphi}^{m*}}$ and thus of $\partial z_2/\partial \tilde{\varphi}^{m*}$ hinge on whether $\left(1 + x_{us} \cdot ln\,(\tilde{\varphi}^*)\right)$ is greater or less than zero. Combining the result in equation (A.14) and (A.19) we thus have the following result:

1. If $\left(1 + x_{us} \cdot ln\,(\tilde{\varphi}^{m*})\right) > 0$,then $\partial z_2/\partial \tilde{\varphi}^{m*} > 0$ and $[\ln(\varphi) \cdot \varphi^{x_{us}} - \ln(\tilde{\varphi}^*) \cdot (\tilde{\varphi}^{m*})^{x_{us}}] < 0$. Consequently, $FOC_2(\varphi) < 0$ and $\partial z_2/\partial z_1 > 0$.
2. If $\left(1 + x_{us} \cdot ln\,(\tilde{\varphi}^*)\right) < 0$, then $\partial z_2/\partial \tilde{\varphi}^{m*} < 0$ and $[\ln(\varphi) \cdot \varphi^{x_{us}} - \ln(\tilde{\varphi}^*) \cdot (\tilde{\varphi}^{m*})^{x_{us}}] > 0$. Consequently, $FOC_2(\varphi) > 0$. However, since $\partial z_2/\partial n_1^{*m} < 0$ the sign of $\partial z_2/\partial z_1$ depends on the relative magnitude of $\partial z_2/\partial n_1^{*m}$ and $(\partial z_2/\partial \tilde{\varphi}^{m*}) \cdot (\partial \tilde{\varphi}^{m*}/\partial n_1^{*m})$.
    a. If $\left|\frac{\partial z_2(z_1)}{\partial n_1{}^{m*}}\right| > \left|\frac{\partial z_2(z_1)}{\partial \tilde{\varphi}^{m*}} \cdot \frac{\partial \tilde{\varphi}^{m*}}{\partial n_1{}^{m*}}\right|$, then $\partial z_2/\partial z_1 > 0$
    b. If $\left|\frac{\partial z_2(z_1)}{\partial n_1{}^{m*}}\right| < \left|\frac{\partial z_2(z_1)}{\partial \tilde{\varphi}^{m*}} \cdot \frac{\partial \tilde{\varphi}^{m*}}{\partial n_1{}^{m*}}\right|$, then $\partial z_2/\partial z_1 < 0$, q.e.d.

Proof of proposition 4

In order to compare the behavior of a sophisticated individual to that of a naïve individual, let us differentiate equation (30') with respect to θ and $z_1$and define these derivatives $\Omega_{z_1\theta}$ and $\Omega_{z_1 z_1}$, respectively. The effect of naïveté on investments in self-control in time period 1 is thus given by:

$$\frac{\partial z_1}{\partial \theta} = -\frac{\Omega_{z_1\theta}}{\Omega_{z_1 z_1}} \tag{A.19}$$

where $\Omega_{z_1\theta}$ is given by:

$$\Omega_{z_1\theta} = -\left[\frac{\partial CD}{\partial {n_1}^{m*}} + \frac{\partial CD}{\partial \tilde{\varphi}^{m*}} \cdot \frac{\partial \tilde{\varphi}^{m*}}{\partial {n_1}^{m*}}\right] \cdot \frac{\partial {n_1}^{m*}}{\partial z_1} + FOC_2 \cdot \frac{\partial z_2(z_1)}{\partial \tilde{\varphi}^{m*}} \cdot \frac{\partial \tilde{\varphi}^{m*}}{\partial {n_1}^{m*}} \cdot \frac{\partial {n_1}^{m*}}{\partial z_1} \tag{A.20}$$

Now, given *assumption 1*, $\left[\frac{\partial CD}{\partial {n_1}^{m*}} + \frac{\partial CD}{\partial \tilde{\varphi}^{m*}} \cdot \frac{\partial \tilde{\varphi}^{m*}}{\partial {n_1}^{m*}}\right] < 0$, and from *proposition 3* we know that $FOC_2 \cdot \frac{\partial z_2(z_1)}{\partial \tilde{\varphi}^{m*}} < 0$. Hence, $\Omega_{z_1\theta} < 0$, and we thus have that $\partial z_1/\partial\theta < 0$, q. e. d.