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Testosterone, personality traits and tax evasion

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Tax evasion, testosterone and personality traits

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Abstract

This paper examines the potential effects of testosterone and personality traits on the decision to evade taxes. In a series of experiments, subjects completed a battery of behavioral tasks and made a one-shot tax evasion decision. We estimate a negative weakly significant treatment effect, which suggests that an exogenous increase in testosterone levels may inhibit the decision to evade taxes. Our results also suggest that Dominance and Self-Construal (Self-Control) are positive (negative) and significantly associated with tax evasion. We discuss mechanisms potentially linking testosterone and tax evasion. These findings support the inclusion of biological factors in the analysis of tax evasion behavior.

Keywords: Tax Compliance; Testosterone; Personality Traits; Experiment.

JEL Classification: H26; K42; C91; D91.

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1 Introduction

In this paper, we aim to shed light on important biological foundations of tax evasion by investigating the potential influence of hormones and personality trait on tax evasion behavior. Testing for the first time the causal role of testosterone in modulating the decision to evade taxes, we observe a significant negative correlation between (baseline) testosterone level and evasion. In a laboratory experiment, we find that the putative markers of androgen exposure are positive and significantly associated with tax evasion. Individuals with less prenatal testosterone exposure (higher Average 2D:4D) and greater pubertal testosterone exposure (wider face, fWHR) are more likely to evade more.[1] Although evasion is observed in both treated and not treated groups, we estimate a weak treatment effect, i.e., an exogenous increase in the individual's testosterone level has a negative effect on the participant's decision to evade taxes.

The negative effect of administered testosterone, although significant only at 10%, is robust when controlling for a set of potentially relevant explanatory variables such as individual characteristics (age, weight, height), prenatal and pubertal testosterone exposure, medication and drugs use, and personality traits. It is possible that an exogenous increase in testosterone may trigger concurrent and, to some extent, incompatible behaviors. Our experiment seems to be capturing the testosterone net effect an individual's tax evasion decision. One one hand, testosterone may increase prosocial (less selfish) behavior by means of tax compliance. On the other hand, it may trigger a more aggressive, risk taking attitude leading the participant to engage in tax evasion. In fact, we find supporting evidence that testosterone's effects on evasion are influenced by variation in trait dominance and trait self-control. Specifically, testosterone caused an increase in evasion behavior, but only among men scoring relatively high in trait dominance or low in trait self-control.

Our sample consisted of 117 healthy male young Canadians that received Androgel (a topical gel that increases testosterone concentrations in the bloodstream) or placebo (random assignment, double-blinded) to study the causal effect of testosterone on tax evasion. Subjects completed a battery of behavioral tasks. They were paid based on their performance on these tasks and were informed about the amount of tax owed. Participants then decided how much tax to pay and they were aware that tax payments were subject to auditing and penalties. Overall, the sample of treated and untreated was balanced considering observables, validating our identification strategy.

Personality traits, defined as patterns of thoughts, feelings, and behavior that predict how individuals respond to circumstances, have drawn attention from economists because of their potential as stable traits that influence behavior directly (Almlund et al. (2011); Gill and Prowse (2016)). We find that only three of the personality trait variables have a significant effect on the individual's decision to evade taxes in our experiment. The individual's trait Dominance (assertive,

[1] Digit ratio (2D:4D) denotes the relative length of the second (index) and fourth (ring) fingers. Facial width-to-height ratio (fWHR) is the ratio of the distance between the left and right zygomatic bones to the distance between the upper lip and brow.

forceful, and self-assured behavior) and Self-Construal (how people mentally represent the self as independent from others or interdependent with them) have a positive and significant effect on participant's decision to evade taxes. The estimated coefficient of our Self-Control measure is negative and significant. Quantitatively, the odds of evading taxes in the less dominant personality group is only 0.28 lower than in more dominant men. Individuals that see themselves as more independent are 0.47 more likely to engage in tax evasion, while those that view themselves as motivationally oriented toward others (interdependent self-construal) are 2.12 less likely to evade taxes. Lastly, evasion odds are 1.75 times lower for more self-controlled individuals.

Our results suggest evidence that participants that received 150 mg of Androgel (an exogenous increase in testosterone) experience a decrease of 0.973 unit in the log of the odds. The treatment group has odds 0.61 times lower to engage in tax evasion compared to the non-treatment (placebo) group. The odds ratio interpreted as the odds of evading taxes in non-treatment group is 1.64 times higher than in treatment group (i.e., the group that had their testosterone level exogenously increased). This negative sign is consistently estimated (although not significant) for different measures of tax evasion (share of taxes evaded, share of winnings evaded or amount of taxes evaded). This is not surprising given the that different measures of tax evasion, and the decision whether to evade taxes, are expected to be correlated. However, this might suggest that an exogenous increase in an individual's testosterone level affects the extensive margin of tax evasion, i.e., whether evasion occur or not occur, but not quite precisely by how much does evasion occur (intensive margin). A lower prevalence of tax evasion in the treated group is reinforced by permutation tests we perform for the treatment variable.

Tax compliance can be approached from many perspectives: it can be view as a problem of public finance, law enforcement, labor supply or ethics, or a combination of all these (Andreoni et al. (1998)). According to the traditional economic approach of tax compliance (e.g., Allingham and Sandmo (1972)), taxes are paid or evaded strategically.[2] However, many studies have noted that levels of tax compliance and evasion are far different than a risk vs. return model would predict (Skinner and Slemrod (1985); Slemrod (1992); Torgler (2007); Alm et al. (2010)). Researchers have noted that taxpayers exhibit a diverse range of beliefs and behaviors regarding the payment or evasion of taxes. Extensive empirical evidence has suggested that some taxpayers never evade, evasion increases with the tax rate, and evasion decisions are interdependent (Gordon (1989)).

In fact, individuals do not always behave as the selfish, rational, self-interested individuals portrayed in the standard neoclassical paradigm, but rather are often motivated by many other factors (Alm et al. (1992); Alm and Torgler (2011)). An individual's tax behavior can then be seen

[2]The taxpayer determines how much tax to pay (evade) as if making a gambling decision in which the higher expected returns resulting from evasion are balanced against the risk associated with the possibility of being caught and penalized. Following this view, the higher the audit probability and evasion fines, the lower the prevalence of tax evasion. The experiments of Baldry (1986) provide compelling evidence that the evasion decision is not just a simple gamble. This can be rationalized by introducing an additional (financial or psychic) cost into the evasion decision.

as the outcome of the interaction of objective, external factors (e.g., the tax system as an imposed system) and subjective, person-bound factors such as personality and taxpayers interdependence with others (Groenland and van Veldhoven (1983)). Moreover, individuals are rarely in isolation as all are members of social groups, societies and cultures. Consequently, tax behavior is not a function purely of individual choice: individuals might look to others in order to decide what is acceptable, reasonable, and expected within the social context in which the action is made (Cullis and Lewis (1997)).

Hence, a growing literature has considered other potential explanations for individuals' tax compliance behavior. Over the last two decades, new approaches involving laboratory experiments have also been developed to better understand the factors that might affect an individual's decision to pay or evade taxes (Pickhardt and Prinz (2014)). A variety of factors such as social norms (e.g., Cadsby et al. (2006); Konrad and Qari (2012); Hallsworth et al. (2017); Alm et al. (2017); Lefebvre et al. (2015)), tax morale (e.g., Gordon (1989); Erard and Feinstein (1994); Torgler (2002)), ethics (e.g., Alm and Torgler (2011)), institutional quality (e.g., Torgler and Schneider (2009); Alm et al. (2012)) and social interactions and cognitive traits (e.g., Myles and Naylor (1996); Kirchler (2007); Fortin et al. (2007); Coricelli et al. (2010); Dulleck et al. (2016)) have been presented as important potential explanations. Despite these efforts, however, little is known about the biological foundations of tax evasion.

Testosterone is one of the major sex hormones produced by the body and it is known to influence brain development and reproductive physiology. Testosterone also plays a critical role in mediating physiological and behavioral processes of relevance to human social behavior. It is of special interest in the study of socio-emotional and economic behavior because testosterone influences the brain in archetypical situations, such as fight, mating and the search and struggle for status (Carré et al. (2011a), Eisenegger et al. (2011)). As testosterone had been linked to a number of activities that involve elements of risk in both humans and other animals, researchers have examined whether testosterone may play a role in economic risk taking (see Apicella et al. (2015) for an extensive review). The documented sex difference in economic risk taking as well as the decline in economic risk taking with advancing age are both findings that accord with testosterone, which is higher in men (Dabbs (1990)) and declines with age (Kaufman and Vermeulen (2005)), as a potential mediator.

Researchers have argued that in addition to testosterone's role in modulating certain forms of aggressive behavior, it may also modulate other forms of social behavior related to one's willingness to achieve and/or maintain social status. Eisenegger et al. (2010, 2011, 2012)) have suggested that testosterone may increase prosocial behavior or lead to less selfish behavior if this increases one's social status. For instance, testosterone might directly affect people's social preferences and beliefs about others, rendering their motives more prosocial and their attitudes more cooperative. In the context of tax evasion, it is possible that some individuals believe most others will cooperate, i.e., pay their due taxes, and they themselves have a concern about their own status as an honest taxpayer, leading them to cooperate as well (i.e., pay taxes). Testosterone may have also affected individuals emotionally through, for instance, negative feelings related to being audited and caught evading, to motivate them to pay taxes owed, which might be associated with non-pecuniary or psychological costs of tax evasion (Gordon (1989); Coricelli et al. (2010); Dulleck et al. (2016)). Although we are not able to pin down the exactly mechanism behind the relationship between testosterone and tax evasion, we offer some discussion about the potential underlying nature of the estimated negative relationship between testosterone and tax evasion behavior. Exogenous increases in testosterone levels could be (negatively) associated with tax evasion through a mechanism in which testosterone increase the disutility of engaging in tax evasion.

There is also evidence that certain proxies of prenatal testosterone (2D:4D digit ratio) are associated with risk taking. Sapienza et al. (2009) suggest that circulating testosterone and prenatal testosterone exposure may be biological mechanisms that can account for differences in financial risk aversion and in risky career choices. Nadler et al. (2017) test how testosterone causally affects trading and prices and find that testosterone administration generated larger and longer-lasting bubbles by causing high bids and the slow incorporation of the asset's fundamental value. Nofsinger et al. (2018) find that higher testosterone participants choose higher risk asset allocations to earn a higher risk premium, while choosing diversified portfolios to reduce unsystematic risk. Researchers have also identified associations between the fWHR, a putative marker of pubertal testosterone exposure (Welker et al. (2016); Hodges-Simeon et al. (2016)) and behaviors relevant to tax evasion. For example, men with larger fWHRs were more likely to exploit the trust of others for personal gain (Stirrat and Perrett (2010)), prefer more self-favoring resource distributions (Haselhuhn et al. (2013)), use deception (Haselhuhn and Wong (2011)), misreport their finances (Jia et al. (2014)) and cheat in lotteries for cash prizes (Geniole et al. (2014); Haselhuhn and Wong (2011)). Some of these same behaviors were also predicted by dominance- and psychopathy-related personality traits (Geniole et al. (2014); Haselhuhn and Wong (2011)), which tended to share stronger associations with these behaviors than did the fWHR. Therefore, while we predict that the 2D:4D and fWHR measures share significant associations with tax evasion, personality traits related to dominance, self-control and self-construal may be stronger predictors of such behavior, with those individuals high in such personality traits more likely to evade taxes than those lower in these traits.

The remainder of this paper is organized as follows. Section 2 presents a simple theoretical model to explore a mechanism potentially linking testosterone and tax evasion. In Section 3, the methods and procedures of this study are described. Our empirical strategy and results are presented in Section 4. Robustness analysis and results of permutation tests are also presented in this section. Section 5 presents some discussion about the potential nature of our estimated negative relationship between testosterone and tax evasion behavior. Finally, overall conclusions, limitations of our study and possible policy implications are presented in Section 6.

2 A simple model of testosterone and tax evasion

In this section, we present a simple theoretical model to explore a mechanism potentially linking testosterone and tax evasion. As a starting point, we follow the common approach taken in the tax compliance literature and introduce testosterone into a standard setting in an attempt to provide an understanding of how testosterone can potentially affect the agent's decision to evade taxes.

Consider an individual endowed with income w. His tax liability is $x = \tau w$, where τ, $0 < \tau < 1$, is the exogenous tax rate, but he may choose to hide part of his tax liability. We assume that the decision of whether or not evade taxes is affected by an individual's testosterone level.[3] Let $q(T)$ be the probability an individual evade taxes, where T is his testosterone level. Hence, with probability $q(T)$, an individual that decides to evade taxes does it in the amount of $e = \lambda x$, where λ is the share of the tax liability evaded, and with probability $1 - q(T)$, he does not evade taxes, i.e., $e = 0$. We assume that agents can be audited with an exogenous probability p.

An individual's budget constraint depends on his decision to evade taxes and whether his is caught evading taxes, as follows

$$
\begin{array}{llll}
Evader\ Caught & c^{EC} = & w - x + e - \pi e & with \quad probabilities \quad q(T),\ and\ p \\
Evader\ Not\ Caught & c^{EN} = & w - x + e & with \quad probabilities \quad q(T),\ and\ (1-p) \\
Non - Evader & c^{NE} = & w - x & with \quad probability \quad 1 - q(T)
\end{array}
$$

where EC, EN, and NE stands for whether an individual is caught evading taxes, not caught evading taxes or does not evade taxes, respectively. Notice that for an individual that decides to evade taxes (with probability $q(T)$) the amount evaded e is the same regardless if he is caught evading taxes or not. However, his consumption will be different due to the penalty π in the case of being caught evading taxes. Also, if with probability $1 - q(T)$ the individual decides not to evade taxes, being audited or not does not affect his consumption as he is paying the correct amount of taxes.

The following expected utility problem describes the decision of a representative individual

$$E\left[U(c)\right] \;=\; q(T)Q\left(q(T), T\right)\left\{pU\left(c^{EC}\right) + (1-p)U\left(c^{EN}\right)\right\} + \left[1 - q(T)\right]U\left(c^{NE}\right) \qquad (1)$$

where, following the literature (e.g., Gordon (1989); Torgler and Schneider (2009); Coricelli et al. (2010); Dulleck et al. (2016)), we assume that the decision to evade taxes entails a cost. We restrict its effect on the extensive margin and interpret this cost broadly as psychological costs

[3] Our results suggest a negative (although not significant) effect of testosterone on the amount of taxes evaded (intensive margin). For clarity and simplicity, we have chosen not to include this feature in this model. We also abstract from personality traits.

associated to shame or guilty, being (or feeling) dishonest, physiologic discomfort, or feelings that the individual's actions deviates from what others are doing in society. The novelty here is the potential effects of biological aspects, namely testosterone, on the utility cost to evade taxes $Q\left(q(T),T\right)$. An individual testosterone level might affect this psychological cost directly $(T \rightarrow Q(\cdot,T))$ and indirectly, via the amount evaded $(T \rightarrow q(T) \rightarrow Q(q(T),\cdot))$. We assume that this cost is a decreasing and convex function of the individual evasion extensive margin, i.e., $\partial Q\left(q(T),T\right)/\partial q(T) = Q_q\left(q(T),T\right) < 0$ and $\partial^2 Q\left(q(T),T\right)/\partial\left(q(T)\right)^2 = Q_{qq}\left(q(T),T\right) \geq 0$, and $Q_{q,T}\left(q^*(T),T\right) = 0$.

We do not make any specific assumptions regarding $\partial Q\left(q(T),T\right)/\partial T = Q_T\left(q(T),T\right)$, but argue that the introduction of an individual's testosterone level on the psychological cost function of evasion is in line with reasons presented above. On one hand, it could be the case that an exogenous increase in testosterone levels induces an individual to a more pro-social behavior (Eisenegger et al. (2012)), i.e., to pay the required amount of taxes or, for instance, tax payments could also be interpreted as an imperfect substitute for donations (Andreoni et al. (1998); Drouvelis and Marx (February, 2018)). On the other hand, with higher levels of testosterone individuals might experience higher psychological costs associated with tax evasion activities (e.g., shame or guilty as in Gordon (1989); Torgler and Schneider (2009); Coricelli et al. (2010); Dulleck et al. (2016)), feeling more compelled to comply with taxation. In either cases, $Q_T\left(q(T),T\right)$ would be negative, with a direct negative effect on agent's expected utility (a disutility associated to the decision to evade taxes).[4]

Differentiating equation (1) with respect to $q(T)$ and solving for it (interior solution), we obtain the optimal probability of evasion as follows:

$$q^*(T) \quad = \quad \frac{1}{Q_q\left(q^*(T),T\right)}\left[\frac{U\left(c^{NE}\right)}{pU\left(c^{EC}\right)+(1-p)U\left(c^{EN}\right)} - Q\left(q^*(T),T\right)\right] \tag{2}$$

In order to understand the effect of an increase of testosterone on the individual's decision to evade taxes, we differentiate equation (2) with respect to the testosterone level T, and we get

$$q_T^* \quad = \quad \left\{\frac{-Q_q\left(q^*(T),T\right)Q_T\left(q^*(T),T\right)}{Q_{q,q}\left(q^*(T),T\right)\widetilde{U} + 2\left(Q_q\left(q^*(T),T\right)\right)^2}\right\} \tag{3}$$

where $q_T^* = \partial q^*(T)/\partial T$ and $\widetilde{U} = \left\{U\left(c^{NE}\right)/\left[pU\left(c^{EC}\right)+(1-p)U\left(c^{EN}\right)\right] - Q\left(q^*(T),T\right)\right\}$.

It is reasonable to assume, for instance, that the utility cost to evade taxes $Q\left(q(T),T\right)$ is linear in the probability an individual evade taxes, $q(T)$, and in his testosterone level T, which

[4]The function $Q\left(q(T),T\right)$ only gives the relative weight of two decisions: evade or not evade. Hence, in this model we only capture the relative increase or decrease of each portion of the individual's expected utility. This means that if $Q_T\left(q(T),T\right)$ is negative it could also mean an increase in the non-evasion portion of the expected utility. We interpret both cases as an increase in prosocial, less selfish behavior.

implies that $Q_{q,q}(q^*(T),T) = 0$ and $Q_{T,T}(q^*(T),T) = 0$. Since $Q_q(q(T),T) < 0$ (i.e., the higher the psychological cost of evasion, the less likely an individual is to evade taxes), the sign of $q_T^* = -\frac{Q_T(q^*(T),T)}{2Q_q(q^*(T),T)}$, equation (3), is determined by the sign of $Q_T(q(T),T)$. Hence, we conjecture that exogenous increases in testosterone levels (T) are negatively associated with the tax evasion decision ($q^*(T)$) through a mechanism in which testosterone enhances the disutility of engaging in tax evasion, measured by the utility cost to evade taxes $Q(q(T),T)$.[5]

3 Method

3.1 Participants, Experimental Design and Procedures

One hundred and twenty one young adult men were recruited from the general population in Sudbury, Ontario (Canada) through announcements posters placed throughout the community (e.g., malls, grocery stores, bus stations, etc.) and at random via phone contact from a database of prospective participants managed by Medicor Research Inc (MRI).[6] All prospective participants completed a detailed phone interview conducted by a research assistant (10 minutes or less) which was used to determine eligibility based on the inclusion and exclusion criteria as follows:

- *Eligibility inclusion criteria:* 1) be between the ages of 18 and 35; 2) be able to understand the procedures and be willing to sign informed consent; 3) be willing to provide saliva and blood samples for hormone analyses; and 4) be willing to have testosterone concentrations temporarily manipulated by the use of Androgel.

- *Eligibility exclusion criteria:* 1) female; 2) currently receiving prescription medication for medical conditions affecting hormone concentrations (e.g., hypogonadism, prostate cancer, thyroid disease, Cushing's disease, Addison's disease); 3) current diagnosis of a psychiatric disorder (e.g., anxiety, depression, schizophrenia, bipolar); 4) current diagnosis of a heart condition; 5) alcohol and/or drug dependency; and 6) are members of teams/organizations (e.g., student-athletes) for whom testosterone is a banned substance.

Qualified participants were scheduled for testing sessions when they were provided with a detailed description of the experimental procedures. Testing for each participant occurred in a single session. Participants reported to the laboratory at one of two times, 10 AM or 1 PM. Upon arrival, participants completed informed consent. Next, participants completed a battery of online

[5] If we were to assume a convex utility cost $Q(q(T),T)$, we would obtain the same negative relationship between testosterone and the probability of evasion as long as this cost is nonneglectable but small enough relative to $U(c^{NE}) / [pU(c^{EC}) + (1-p)U(c^{EN})]$, such that $\widetilde{U} \geq 0$.

[6] The study was approved by the Nipissing University Research Ethics Board. Participant ethnicities were self-reported as follows: 77.5% Caucasian, 13.1% First Nations, 4.1% Asian, 1.7% Latin American, and 3.3% other. Medicor Research Inc (MRI) is an organization that focuses on connecting physicians in Northern Ontario with the top research being carried out by university professors and pharmaceutical companies. This company has carried out more the 100 studies since 2001. From these clinical studies, MRI has established a large database of potential research participants to draw from.

self-report questionnaires assessing basic demographic information and individual differences in personality.

- *Questionnaires:* the State-Trait Anxiety Inventory-2; the Self-Report Psychopathy Scale; Sociosexual Orientation Inventory; Trait Self-Control Scale; Self-Construal Scale, BIS/BAS Scale, Dominance/Prestige Questionnaire, Barratt Impulsivity Scale, Buss-Perry Aggression Questionnaire.

Participants were also photographed posing an emotionally-neutral facial expression and had their hands scanned via a standard picture scanner. With this information, we measured the facial width-to-height (fWHR) and the 2D:4D digit ratios, two putative measures of adolescent and prenatal androgen exposure, respectively (Manning et al. (1998); Welker et al. (2016)).

Research has recognized the need to differentiate between basal testosterone (stable level of endogenous testosterone) and acute testosterone changes (see Mazur and Booth (1998); Carré et al. (2011b) for reviews). After the completion of the online questionnaires but before drug administration, a first blood sample (10 ml) was obtained by a licensed phlebotomist and used for the assessment of participants' baseline testosterone level and serum hormone binding globulin. Participants then received 150 mg of Androgel or placebo topical gel (random assignment, double-blinded), applied to the upper arm and shoulder area by a male research assistant. [7]

Approximately 60 minutes after the gel application, a period during which participants rested, a second blood sample was drawn. Next, participants completed a battery of behavioral tasks, as described in the next section. Behavioral testing took approximately 2 hours to complete, after which participants were compensated for their time. The total time commitment for testing was 3 hours. Each participant received a compensation of $25/hour plus additional monetary rewards for performance on the decision making tasks. A third blood sample was obtained 75 min after gel application. The Tax Evasion task took place. Prior to being debriefed, participants provided a final blood sample (120 min after gel application) and were asked to guess the drug condition to which they were assigned. Figure 1 summarizes our procedure.

Nearly 95% of all testosterone travels through the bloodstream attached to large protein carriers. Notably, testosterone's effects on physiology and behavior typically occur after testosterone enters a cell and binds to intracellular receptors. Testosterone bound to the large protein carrier (SHBG) cannot get into the cell, and thus, is believed to be biologically inactive (i.e., cannot influence cell function and behavior). However, about 5% of testosterone in the blood is found in "free-form", i.e., not bound to a big protein carrier, which allows it to enter the cell to affect physiological processes. We measured both free and total testosterone (FreeT and Total-T, respectively). We first measured testosterone using a standard ELISA procedure. In this step, we

[7] The Androgel dose of 150 mg treated subjects received increases testosterone levels to the high-normal range. It is a relatively high dose (higher than the recommended dose (100 mg) used to treat men with low testosterone), but it has been showed this dose effectively modulates human decision-making in other studies, for instance, aggression (Carré et al. (2017)) and risk-taking (Wu (2018)).

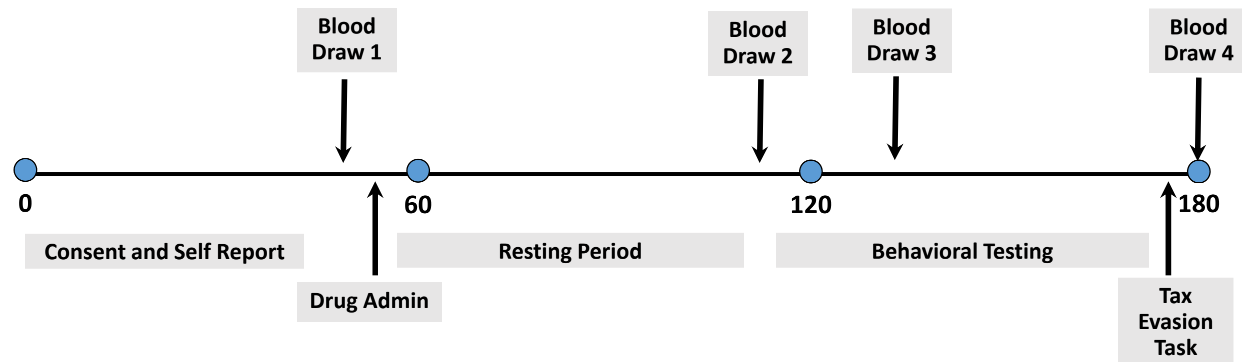

Figure 1: Experimental timeline for the entire protocol.

were measuring Total T (that is FreeT and T bound to SHBG). Then, to estimate the fraction of testosterone that was biologically active, we also measured SHBG and then apply a validated formula to estimate the free-fraction of testosterone, hence having two measures of testosterone: Total-T and FreeT. These values are highly correlated with one another.

3.2 Materials and Methods

Research participants completed a battery of behavioral tasks.

- *Behavioral tasks:* Point Subtraction Aggression Paradigm (PSAP), Formidability Assessment, Balloon Analogue Risk Task (BART), Emotion Recognition Task, Economic Decision Making Task, Attentional Adhesion Measure, Implicit Attention to Status Tasks and the Tax Evasion Task. In this section we focus on the Tax Evasion Task and a detailed description of other tasks is presented in the Appendix 7.1).

For the Tax Evasion Task, participants were first told how much money they earned on all tasks. In the consent form, prior to all tasks, they were informed that their earnings would be subject to taxation, probability of auditing, and the penalty for detected tax evasion according to Table I. Their hourly earnings (i.e, $25/hour) were not subject to taxation. Participants were also informed that the amount of taxes collected were put into a common pool and that there would be a draw at the end of the study in which one person would win the total amount of taxes (and penalties) accumulated during the study. A participant, once aware of how much taxes he owed, was instructed to put an amount in an envelop. The researcher was not present in the room when the participant decided whether and how much to pay in taxes.[8]

[8] The research assistant showed the participant the instructions for determining his earnings amount (winnings) and the corresponding amount of tax, and handed the participant an envelope. "Based on your performance on the task's today you have earned X dollars. Because you have won this amount of money, here are the tax scenarios

Recent experimental papers that study tax evasion (e.g, Dulleck et al. (2016)) consider a multi-round, multi-decision design. In Christian and Alm (2014) subjects participate in a "Tax Compliance Game". The game consists of six independent one-shot tax compliance decisions with different settings of audit probabilities, penalties, and returns from the tax amount paid. Our experimental design is a one-shot tax evasion decision and the reason is twofold: the invasive nature of the experiment and the potential need of additional dosages of the testosterone in a multi-round design and the already excessive length of the experiment. Participants could choose to pay any amount of taxes, i.e. they could partially or fully evade taxes. However, envelops ("tax payments") were subject to auditing. To determine whether or not to audit a participant, i.e., to open an envelop and verify whether the tax owed was paid, the research assistant rolled a dice. If the dice landed on 6, a participant was audited. This means a 1/6 probability of being audited. If audited and the amount paid was less than the tax due, a 100 percent penalty was assessed (Table I).

Table I: Earnings and Tax Schedule

Amount received	Tax required	Taxes paid if: Reported correct amount	Taxes paid if: Full evasion not audited	Taxes paid if (and audited): Full Evasion	Paid only $1	Paid only $2	Paid only $3	Paid only $4
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
8	1	0	0	2	0	0	0	0
12	2	0	0	4	2	0	0	0
16	3	0	0	6	4	2	0	0
20	4	0	0	8	6	4	2	0
24	5	0	0	10	8	6	4	2

Example. Consider a participant that earned a total of $20 in all behavioral tasks. According to the experiment tax code, he owed taxes in the amount of $4 (Table I). If he fully evaded taxes (i.e., put nothing in the envelop) and was not audited (5 out of 6 chance), he would get to keep the $20 without paying taxes. However, if he fully evaded the taxes, but was audited (1 out of 6 chance), he would have to pay the amount of taxes due ($4) and an additional penalty of the same amount (i.e., pay additional $4). In this case, the participant would take $12 home. He could also evade a fraction of the tax owed ($1, $2, or $3) and his take-home earnings would depend on being audited ($14, $16, or $18, respectively) or not ($19, $18, or $17, respectively).

offered to you (Table I). Please read through the instructions carefully and let me know when you're finished." Once the research assistant left the room, the participant decided how much taxes he wanted to pay and put the amount in the envelope. The research assistant reentered the room once they are finished and informed the participant the following: "I am now going to roll to dice to see if you are audited."

4 Empirical Strategy and Results

4.1 Variables definitions and descriptive statistics

In Table II we present our control variables and their definitions. Our endogenous binary variable takes the value of one if the participant evade any amount of taxes, i.e., full or partial evasion, and zero otherwise. We divide our control variables into three groups: androgen exposure, personality traits and demographic and medication. In the set of androgen exposure variables, besides the participant's baseline or pre-treatment testosterone, we have two indicators of the individual's androgen exposure: the average 2D:4D and fWHR, which are putative markers of prenatal and pubertal testosterone exposure, respectively.

We consider seven variables related to the individual's personality traits. The individual's anxiety and aggressiveness are self-reported measures of trait anxiety and trait aggressiveness. Although there is no evidence linking these two personality traits to tax evasion, Gordon (1989) has suggested, for instance, that a false income declaration may induce anxiety, guilt or a reduction in self-image and Frank et al. (2009) report that aggressiveness (tax avoidance) and risk taking aggressiveness are positively related. Hence, it might be expected that people with higher levels of anxiety and aggressiveness engage in tax evasion behavior more than their counterparts.

People with dominant personality styles tend to behave in assertive, forceful, and self-assured ways (Slatcher et al. (2011)) to achieve or maintain high social status. Trait dominance has been described as reflecting "a person's characteristic feelings of control and influence over his life circumstances versus feelings of being controlled and influenced by others or events" (Mehrabian (1996)). Such feelings of control and certainty have been found to increase financial risk-taking behavior (Lerner and Keltner (2000, 2001); Demaree et al. (2009)). Given that trait dominance measures stable, individual differences in the appraisal of control and certainty, we investigate whether trait dominance would be a useful measure in the prediction of tax evasion behavior.

An individual's ability to exert self-control under affectively charged situations might also affect his decision to evade taxes. It is possible that instigating triggers and impelling forces, such as provocation and prize competition might promote a risk-taking tax evasion behavior or an impulse to evade taxes similar to an aggressive impulse.[9] With our Self-Control measure we intend to capture the potential relationship between an individual's self-control and his tax evasion behavior, for instance, accounting for the fact that such impulses may not manifest behaviorally among individuals high in trait self-control because these individuals are better equipped to override such impulses.

One important individual difference that might predispose how people respond to tax evasion concerns self-construal, a culturally-relevant difference in how individuals define the self in relation

[9] Research has indicated that tasks designed to bolster self-control decreased individuals' subsequent aggression, whereas those designed to disrupt or temporarily reduce self-control increased aggression (Denson et al. (2012); Denson (2015)).

Table II: Variables definitions

Androgen exposure	
Baseline Testosterone	Individual variability in testosterone (ng/mL).[1]
Average 2D:4D	Putative marker of prenatal testosterone exposure[2] Higher scores = less testosterone exposure.
fWHR	Putative marker of pubertal testosterone exposure.[3] High values = wider face, greater pubertal testosterone exposure.
Personality traits	
Anxiety	Self-report measure of trait anxiety. Higher score = greater trait anxiety.
Dominance	Composite measure.[4] Higher score = greater dominance.
Self-Control	Composite measure, Carré et al. (2017).[5] Higher score = greater self-control.
Self-Construal	A self-report measure of self-construal, Welker et al. (2017).[6] Higher scores = greater independent self-construal.
Trait Aggressiveness	A self-report measure of trait aggressiveness.
Psychopathy Factor 1	Self-report measure of Factor 1 psychopathy, Paulhus et al. (2017).[7] Higher scores = greater Factor 1 psychopathy
Psychopathy Factor 2	Self-report measure of Factor 2 psychopathy,, Paulhus et al. (2017)[7] Higher scores = greater Factor 2 psychopathy
Demographic and medication	
Medication Use	Dummy variable. 1: participant is on medication
Recreational Drug Use	Dummy variable. 1: participant uses recreational drugs
Smoker	Dummy variable. 1: participant smokes cigarettes

[1] *Baseline Testosterone*: measured prior to drug/placebo administration; FreeT1. [2] *Average 2D:4D*: measured by dividing the length of the second digit by the length of the fourth digit. [3] *fWHR*: measured by dividing the facial width (bizygomatic width) by the upper facial height (midbrow to upper lip). [4] *Dominance*: the average of standardized scores on two self-report dominance scales (IPIP, and dominance subscale of the Dominance-Prestige scale). [5] *Self-Control*: the average of standardized scores on two self-report self-control scales (Brief Self-Control scale,and Barratt Impulsivity Scale, reversed). [6] *Self-Construal*: computed by subtracting scores on the independent subscale from the collectivist subscale. [7] *Psychopathy Factor 1, 2*: measured using the Self-Report Psychopathy Scale

to others. Individuals with more independent self-construal view the self as being unique and independent of others, leading to behaviors that maximize gains for the self, rather than for others. On the other hand, those with interdependent self-construal view themselves as connected to and motivationally-oriented toward others, defining the self by external, situational factors, e.g., groups, relationships, communities (Cross et al. (2011)). This personality trait can potentially be linked, for instance, to empirical findings that suggest that evasion decisions are interdependent - some relationship between non-pecuniary costs and society's attitude towards evasion (Gordon (1989); Alm and Torgler (2006); Christian and Alm (2014))

We also control for psychopathy factors 1 and 2 (Paulhus et al. (2017); Carré et al. (2015)). Researchers have investigated socio-cognitive deficits in populations characterized by a lack of empathy - namely, individuals with psychopathy and/or individuals scoring relatively high on self-report measures of psychopathic traits. Typically, psychopathy/psychopathic traits have been characterized as varying along two distinct dimensions (Hare and Neumann (2008)). Factor 1 is characterized by interpersonal/affective features of psychopathy and involves lack of guilt and empathy, shallow affect, and pathological lying, whereas Factor 2 involves characteristics such as impulsivity, anti-social behavior, and sensation-seeking. We also consider whether the participant was taking any medicine, using recreational drugs, and a cigarette smoker or non-smoker. We built three dummy variables with values equal to one in the case of positive responses and zero otherwise. We also control for the individual's age (measured in years) and BMI (measured using the following calculation: weight (lb) / height (in) / height (in)] x 703).

Because some of these participants were missing values on select variables (one participant on height, one on Self-Control as measured using the Brief Self-control Scale, 2 on the psychopathy measures, one on medication usage, and height on 2D:4D), the occurrence of which was determined to be completely random (Little's MCAR test: $\chi 2 = 216.66$, $df = 253$, $p = 0.95$), we imputed the values using expectation-maximization.[10] By imputing the missing scores, we are able to maintain a final sample, for each analysis, of 117 male Canadians, aged between 18 and 35 years (Average: 25.05 years, stdev = 4.914).[11]

Table III presents descriptive statistics for the total, treated and placebo samples. Figure 2 shows the proportion of taxes evaded by the subjects in our sample, a suggestive evidence that most of the variation in our study is in fact on the extensive margin (i.e., the decision of whether evade taxes (see Appendix 7.2 for additional information).

The individuals in the treated group have slightly higher baseline testosterone than those in the placebo group. The average 2D:4D and fWHR measures of androgen exposure are very similar across both sets of individuals. Regarding the personality traits measures one can observe differences regarding Dominance and Self-Control indicators. However we cannot reject that they are different than our population mean (close to zero). Demographic characteristics are relatively similar as well. Overall, the sample of treated and untreated is balanced considering observables and this emphasizes that our experiment was correctly randomized which in turn validates our identification strategy.

[10] Imputing missing values is a more optimal statistical approach than is pairwise deletion, which changes the actual subset of participants used in each analysis, and listwise deletion, which deletes the other non-missing and usable data for the participants who are missing certain values (thus reducing overall statistical power, reviewed in Graham, 2009).

[11] We believe our sample size is quite reasonable ($n = 117$) and our study had enough statistical power (0.80) to detect a medium-sized effect ($D = 0.50$). For a statistical power of 0.8, a significance level of 10%, 5% and 1%, and using our 117 observations, we compute the minimum detectable effect of 0.20, 0.23 and 0.28 respectively. Comparing those numbers with our estimated effect of 0.37 (without any controls), we conclude that our experiment does not present power problems.

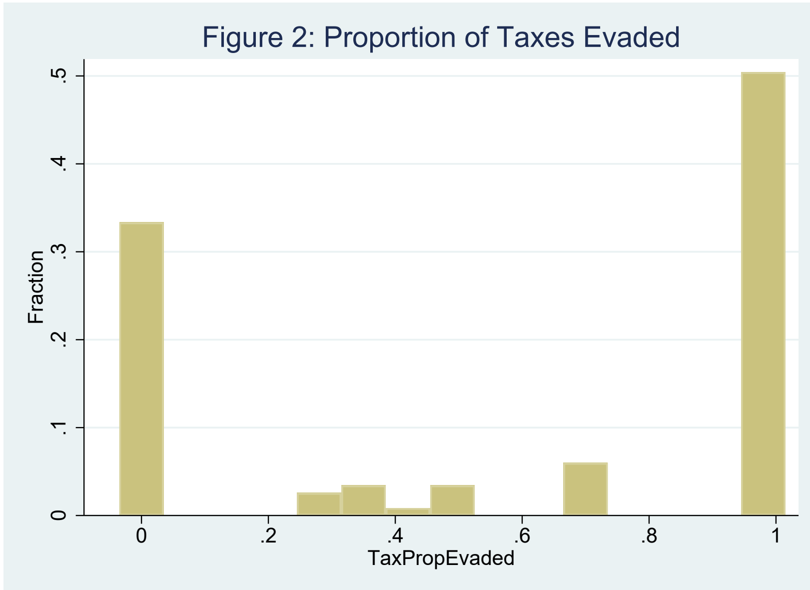

Figure 2: Proportion of Taxes Evaded

The results presented in Table IV suggest that the treatment, Drug (0 = Placebo, 1 = Testosterone), is negatively associated with tax evasion. Results also suggest a positive and significant correlation between tax evasion, measured as the decision to evade tax, and fWHR, Dominance, Self-Construal and Medication use. For instance, fWHR is positively correlated with tax evasion, suggesting that wider face individuals, i.e., greater pubertal testosterone exposure, evade more. The correlation is negative and significant for the Self-Control measure and tax evasion. We explore and discuss these relationships further in the next section.

Three variable measure the individual's testosterone level after the treatment, i.e., after an increase of 150 mg of the androgen for treated subjects. The variables FreeT2, FreeT3 and FreeT4 represent the testosterone levels in the free form 60 min, 75 min and 120 min after gel application (treatment), respectively. The results presented in Table V confirms that, controlling for the individual's baseline testosterone level, testosterone levels increase almost 50% after the treatment and remain elevated throughout the duration of the study.

4.2 Testosterone, personality traits and tax evasion

In this section we consider the potential causal effect of testosterone and personality traits on the participant's tax evasion behavior. We start by considering the partial (marginal) effects of each variable in our controls groups (androgen exposure, personality traits and demographic and medication) on the agent's decision to evade taxes (Table VI).[12] When each of the androgen exposure variables were entered as simultaneous predictors of tax evasion in a binary logistic

[12] The results presented in Table VI are robust when we consider a combined binary logistic regression model that includes all of the significant predictors from the androgen (fWHR), personality (Dominance, Self-Control, Self-Construal), and demographic/medical (medication use) sets of variables.

Table III: Descriptive statistics

	total		treated		placebo	
	mean	*st.dev*	mean	*st.dev*	mean	*st.dev*
Evasion (0 = No, 1 = Yes)	0.504	0.502	0.458	0.502	0.552	0.502
Androgen exposure						
Baseline Testosterone	5.28	*(2.39)*	5.40	*(2.35)*	5.15	*(2.44)*
Average 2D:4D	0.96	*(0.03)*	0.95	*(0.03)*	0.96	*(0.03)*
fWHR	1.73	*(0.15)*	1.73	*(0.13)*	1.72	*(0.16)*
Personality traits						
Anxiety	1.90	*(0.43)*	1.86	*(0.43)*	1.94	*(0.43)*
Dominance	0.00	*(0.88)*	0.10	*(0.92)*	-0.11	*(0.92)*
Self-Control	0.00	*(0.92)*	0.12	*(1.06)*	-0.13	*(1.06)*
Self-Construal	0.41	*(0.99)*	0.36	*(0.95)*	0.45	*(0.95)*
Trait Aggressiveness	2.88	*(0.91)*	2.85	*(0.94)*	2.92	*(0.94)*
Psychopathy Factor 1	2.23	*(0.60)*	2.22	*(0.60)*	2.24	*(0.60)*
Psychopathy Factor 2	2.16	*(0.65)*	2.13	*(0.72)*	2.20	*(0.72)*
Demographic and medication						
Age	25.36	*(4.99)*	25.98	*(5.09)*	24.72	*(4.84)*
BMI	26.30	*(5.72)*	26.39	*(4.90)*	26.21	*(6.50)*
Medication Use	0.09	0.293	0.08	0.28	0.10	0.31
Recreational Drug Use	0.29	0.46	0.36	0.48	0.24	0.43
Smoker	0.44	0.50	0.41	0.50	0.47	0.50
# observations	117		59		58	

regression, the fWHR was the only significant predictor, with men with larger fWHRs more likely to evade taxes than those with smaller fWHRs.

Table VI also presents our results for the bivariate associations between each of the personality and tax evasion variables. When variables such as Anxiety, Dominance, Self-Control, Self-Construal, Trait Aggressiveness, Psychopathy Factors were considered simultaneously, we find that Dominance, Self-Control, and Self-Construal were significant predictors of tax evasion. These results suggest that those higher (vs lower) in Dominance and independent Self-Construal, and lower (vs higher) in Self-Control were more likely to evade taxes. Finally, we repeat the exercise but considering only demographic and medical variables. We find that individuals currently taking medication were more likely to evade taxes than were those who were not currently taking medication. An individual's age, BMI or smoking habits are factors not related to his tax evasion decision.

Men administered testosterone were less likely to evade taxes than were men that received

Table IV: Bivariate correlations

	Evasion (0 = No, 1 = Yes)	Controlling tax owed
Androgen exposure		
Average 2D:4D	0.127	0.150
fWHR	0.228*	0.200*
Baseline Testosterone[1]	-0.1471	-0.1481
Drug (0 = P, 1 = T)	-0.094	-0.106
Personality traits		
Anxiety	-0.071	-0.025
Dominance	0.316**	0.322**
Self-Control	-0.249**	-0.275**
Self-Construal	0.203*	0.207*
Trait Aggressiveness	0.080	0.117
Psychopathy Factor 1	0.097	0.119
Psychopathy Factor 2	0.117	0.141
Demographic and medication		
Age	-0.063	-0.064
BMI	0.123	0.123
Medication Use	0.202*	0.195*
Recreational Drug Use	0.088	0.072
Smoker	-0.059	-0.037

*: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.01$. [1]When two outliers on baseline testosterone ($StDev > 4$) were removed from these analyses, the association became slightly stronger and marginally significant. Evasion (controlling for taxes owed): $r = -0.175$, $p = 0.06$ ($r = 0.171$, $p = 0.07$).

placebo. It is also noteworthy that men's baseline concentrations of testosterone, measured before drug administration, shared a negative (albeit non-significant) association with tax evasion (Table IV). And, individuals who were exposed prenatally to greater levels of testosterone, as indexed by digit ratios (2D:4D), were significantly less likely to evade taxes. We also found that fWHR and Dominance were significant predictors of tax evasion, such that those with larger fWHRs and higher Dominance were more likely to evade taxes than were those with smaller fWHRs and low Dominance. Some other predictors were significant or marginal, with this distinction depending on whether the taxes owed was controlled statistically in the model. In particular, those who used medication, had low Self-Control, and were higher in independent Self-Construal were more likely to evade taxes.

Table V: Effect of treatment on testosterone levels

	FreeT2 coef/sd	FreeT3 coef/sd	FreeT4 coef/sd
Drug (0=P, 1=T)	2.499***	2.946***	2.869***
	(0.355)	(0.422)	(0.439)
Baseline Testosterone	1.231***	1.099***	0.852***
	(0.121)	(0.096)	(0.082)
Constant	-1.135*	-0.305	1.145***
	(0.622)	(0.512)	(0.430)
Adj. R^2	0.728	0.630	0.537
# observations	117	117	117

*: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.01$.

In sum, from our binary logistic analysis, it appears that testosterone exposure during prenatal development (2D:4D) and adulthood (baseline testosterone) may function to reduce tax evasion, whereas testosterone exposure during puberty (fWHR) may promote this behavior. The results presented in Table VI also suggest that personality traits (Dominance, Self-Control, Self-Construal) and demographic/medical (medication use) variables are relevant to explain an individual decision to evade taxes.

Next, we present our full empirical results on the potential causal relationship between testosterone and evasion. We investigate whether an increase in (induced) testosterone levels affects an individual's i decision to evade taxes based on the following regression

$$
\begin{aligned}
Evasion_i &= \alpha + \beta_0(Drug)_i + \beta_1(Baseline\ T)_i + \beta_2(Average\ 2D4D)_i \\
&+ \beta_3(fWHR)_i + \beta_4(Personality\ Traits)_i \\
&+ \beta_5(Demographic - Medication)_i \\
&+ \beta_6(Taxes\ Owned) + \epsilon_i
\end{aligned} \tag{4}
$$

Our endogenous variable $Evasion$ is a binary variable. It is equal to one if a participant evades whether the full or a fraction of the amount taxes owed, and it is zero otherwise. The variable $Drug$ captures our treatment assuming the value zero if the participant received a placebo or one if he received 150 mg of Androgel (testosterone). In Table VII we report the results for seven alternative models when we control for variables and characteristics, other than treatment, that might affect a participant's decision to evade taxes. $Baseline\, T$ is the individual's baseline level of testosterone and testosterone exposure during prenatal development and puberty are capture by $Average2D4D$ and $fWHR$, respectively. We consider several variables in the groups $PersonalityTraits$ (Anxiety, Dominance, Self-Control, Self-Construal, Trait Aggressiveness, Psychopathy Factors 1 and 2) and $Demographic\ Medication$ (Smoker, Medication and recreational drug use). We also control for the amount of taxes owed by the participant (*Taxes Owned*). We assume that our regressors are orthogonal to the error terms.

Table VI: Binary logistic regression results

	Evasion (0 = No, 1 = Yes)			
	mean	*stdev*	mean	*stdev*
			Controlling for tax owed	
Androgen exposure model				
Drug (0 = P, 1 = T)	-0.42	*(0.39)*	-0.44	*(0.40)*
Average 2D:4D	8.66	*(6.27)*	10.07	*(6.41)*
fWHR	3.61**	*(1.52)*	3.21**	*(1.53)*
Baseline Testosterone	-0.10	*(0.08)*	-0.10	*(0.08)*
Taxes owed			0.38*	*(0.22)*
Constant	-13.75**	*(6.81)*	-15.61**	*(6.99)*
Personality traits model				
Drug (0 = P, 1 = T)	-0.52	*(0.43)*	-0.59	*(0.44)*
Anxiety	-0.20	*(0.67)*	-0.03	*(0.69)*
Dominance	1.18***	*(0.36)*	1.17***	*(0.37)*
Self-Control	-0.86***	*(0.31)*	-0.84***	*(0.31)*
Self-Construal	0.47**	*(0.25)*	0.50**	*(0.25)*
Trait Aggressiveness	-0.68*	*(0.40)*	-0.58	*(0.41)*
Psychopathy Factor 1	-0.79	*(0.54)*	-0.82	*(0.55)*
Psychopathy Factor 2	0.37	*(0.52)*	0.36	*(0.53)*
Taxes Owed			0.47*	*(0.24)*
Constant	3.43***	*(1.46)*	1.42	*(1.78)*
Demographic and medication model				
Drug (0 = P, 1 = T)	-0.47	*(0.40)*	-0.48	*(0.40)*
Age	-0.04	*(0.04)*	-0.04	*(0.04)*
BMI	0.06	*(0.04)*	0.05	*(0.04)*
Medication Use	1.86**	*(0.85)*	1.74**	*(0.85)*
Recreational Drug Use	0.84*	*(0.46)*	0.74	*(0.47)*
Smoker	-0.26	*(0.44)*	-0.15	*(0.45)*
Taxes Owed			0.34	*(0.22)*
Constant	-0.55	*(1.32)*	-1.55	*(1.49)*

*: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.01$.

The first column of Table VII presents the results of our benchmark model: the relationship between being treated, i.e., received Androgel, and the decision to evade taxes (partially or fully). We find a negative, although not significant, causal effect. When we control for medication and recreational drug use and smoking habits (column 5), the treatment effect remains negative and it becomes significant at 10%. The inclusion of personality traits increase the magnitude (absolute value) of the treatment effect coefficient, which goes from 0.438 (column 5) to 0.973 (column 6). These findings might be suggestive evidence that testosterone's association with tax evasion behavior depends on key personality traits. In other words, dominance, self-control and self-construal might moderate the association between testosterone and tax evasion.[13] The treatment effect is negative and again significant at 10%, suggesting (albeit weakly) that an exogenous increase in the individual's testosterone level reduces the participant's decision to evade taxes.

The coefficient of the variable *Drug* is significant at ten percent and it is equal to -0.973, meaning that participants that received 150 mg of Androgel (an exogenous increase in testosterone) results in a decrease of 0.973 unit in the log of the odds. This indicates that, for a one standard deviation change, the treatment group has odds 0.61 times lower to engage in tax evasion compared to the non-treatment (placebo) group. Alternatively, we could calculate the odds ratio of failure rate (i.e., evade taxes), which gives an odds ratio of $1/0.61 = 1.64$. The odds ratio can be then interpreted as the odds of evading taxes in non-treatment group is 1.64 times higher than that in treatment group (i.e., the group that had their testosterone level exogenously increased).

While individuals are likely to evade less once they are induced to increase their testosterone level, the putative markers of androgen exposure predict tax evasion in different ways. Individuals with less prenatal testosterone exposure (higher Average 2D:4D) and greater pubertal testosterone exposure (wider face, fWHR) are more likely to evade more. We find that one standard deviation increase in the 2D:4D measure leads to odds 1.63 times higher. This suggests that individuals that were less exposed to prenatal testosterone have odds 1.63 higher to evade taxes than their (more) exposed counterparts. Regarding our putative measure of adolescent testosterone exposure, we observe an increase of 3.8 of the log of the odds ratio on the decision to evade following a one unit increase in the individual's fWHR measure. The results suggest higher fWHR individuals - higher values, greater pubertal testosterone exposure - has odds 1.77 times higher compared to lower fWHR individuals to evade taxes.

As expected based on our results reported on Table VI, only three of the personality trait variables have a significant effect on the individual's decision to evade taxes in our experiment. The individual's trait Dominance (assertive, forceful, and self-assured behavior) has a positive and significant effect on his decision to evade taxes. Moreover, based on the estimated coefficient of the variable Dominance, a one standard deviation increase in this measure implies odds 3.51 higher. This amounts to say that the odds of evading taxes in the less dominant personality group is 0.28 lower than in more dominant men.

[13] Carré et al. (2017) find that exogenous testosterone on its own did not modulate aggressive behavior. However, testosterone's effects on aggression were strongly influenced by variation in (trait) dominance, self-control. Welker et al. (2017) present preliminary evidence that testosterone's association with aggression depends on self-construal.

Table VII: Testosterone and Evasion Decision

Evasion (0 = No, 1 = Yes)	(1) coef/sd	(2) coef/sd	(3) coef/sd	(4) coef/sd	(5) coef/sd	(6) coef/sd	(7) coef/sd
Drug (0=P, 1=T)	-0.378	-0.354	-0.320	-0.377	-0.438*	-0.977*	-0.973*
	(0.373)	(0.376)	(0.383)	(0.409)	(0.446)	(0.522)	(0.541)
Baseline Testosterone		-0.126	-0.116	-0.124**	-0.195	-0.174*	-0.171*
		(0.091)	(0.095)	(0.102)	(0.094)	(0.106)	(0.101)
Age			-0.042	-0.024	-0.044	-0.036	-0.050
			(0.040)	(0.043)	(0.049)	(0.062)	(0.066)
BMI			0.037	-0.016	-0.013	-0.019	-0.017
			(0.040)	(0.050)	(0.056)	(0.064)	(0.069)
Average 2D:4D				9.218*	12.018	13.490*	16.287*
				(6.502)	(6.854)	(8.863)	(9.848)
fWHR				3.724	3.215*	4.262*	3.824*
				(1.963)	(1.967)	(2.221)	(2.179)
Medication Use					2.202***	2.767***	2.799***
					(0.939)	(0.870)	(0.900)
Recreational drug use					0.909**	1.214*	1.051*
					(0.485)	(0.583)	(0.589)
Smoker					-0.278	-0.772	-0.661
					(0.464)	(0.587)	(0.565)
Anxiety						0.115	0.207
						(0.867)	(0.865)
Dominance						1.483***	1.430***
						(0.429)	(0.429)
Self-Control						-0.847**	-0.809**
						(0.335)	(0.330)
Self-Construal						0.504*	0.568*
						(0.291)	(0.308)
Trait Aggressiveness						-0.730	-0.645
						(0.451)	(0.479)
Psychopathy Factor 1						-0.513	-0.548
						(0.623)	(0.637)
Psychopathy Factor 2						0.283	0.293
						(0.614)	(0.646)
Taxes Owed							0.452
							(0.318)
Constant	0.208	0.857	0.872*	-13.351*	-14.628	-15.455*	-18.909*
	(0.265)	(0.544)	(1.535)	(7.255)	(7.529)	(9.544)	(10.328)
Adj R^2	0.006	0.021	0.033	0.074	0.135	0.314	0.329
# observations	117	117	117	117	117	117	117

*: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.01$. *Evasion*: binary variable equals to one if a participant evades whether the full or a fraction of the amount taxes owed, and it is zero otherwise. *Drug* captures our treatment assuming the value zero if the participant received a placebo or one if he received 150 mg of Androgel (testosterone). *Baseline T*: baseline level of testosterone. Testosterone exposure during prenatal development and puberty are capture by *Average2D4D* and *fWHR*. *PersonalityTraits* (Anxiety, Dominance, Self-Control, Self-Construal, Trait Aggressiveness, Psychopathy Factors 1 and 2) and *Demographic Medication* (Smoker, Medication and recreational drug use).

The estimated coefficient of our Self-Control measure is negative (-0.809) and significant at five percent. This result suggest that an individual's ability to exert self-control under affectively charged situations might also mitigate the effect of testosterone on tax evasion. Quantitatively, the higher the individual's ability to self-control, the lower the odds that he will evade taxes - an increase in one unit will reduce the log of odds ratio to evade in 0.809. Evasion odds are 1.75 (0.57) times lower (higher) for more (less) self-controlled individuals, following a one standard deviation increase in the Self-Control measure.

Our results also suggest that Self-Construal - how people mentally represent the self as independent from others or interdependent with them - is an important moderator of the relationship between testosterone and tax evasion. Individuals scoring high in the Self-Construal measure view the self as being unique and independent of others, leading to behaviors that maximize gains for the self, which in the context of our lab experiment is reflected in larger probability to evade taxes. Increasing this measure by one unit (approximately one standard deviation), increases the log of odds ratio by 0.56, which implies that individuals that see themselves as more independent are 0.47 more likely to engage in tax evasion. Alternatively, those with interdependent self-construal and view themselves as connected to and motivationally-oriented toward others are 2.12 less likely to evade taxes.

Our results regarding the (statistically weak) negative effect of exogenous testosterone on evasion can potentially be reconciled with the literature on risk taking. According to, for instance, Apicella et al. (2015) and Carré et al. (2017), the testosterone effects on aggressiveness (which, in our study, can be seen as manifested in the tax evasion decision) is strongly influenced by trait dominance and self-control. More specifically, exogenous increases in an individual's testosterone levels might enhance one's aggressive behavior, but only among men scoring relatively high in dominance or low in self-control. To explore these effects on our experiment, we build a variable that interacts our dummy for treated individuals with these two specific personality traits, i.e., dominance and self-control. We consider three models: (i) we include both personality traits directly and the correspondent interaction terms separately, (ii) we consider a set of regressions including only the interaction term for each personality trait, and (iii) we repeat the same strategy considering both personality traits and the correspondent interaction terms. Our results presented in Table VIII reinforce that dominance and self-control may modulate evasion decision. In other words, when we take into account the interaction of an increase in testosterone level and personality traits, we find that the larger the dominance score trait the larger the increase in the log of odds ratio of the evasion decision (1.14) for a given exogenous increase in testosterone levels. We also find a diminishing impact on the decision to evade laboratory taxes (-0.55) for individuals with less self-control (see Appendix).

Table VIII: Testosterone and Evasion Decision

Evasion (0 = No, 1 = Yes)	(1) coef/sd	(2) coef/sd	(3) coef/sd	(4) coef/sd	(5) coef/sd	(6) coef/sd
Drug (0=P, 1=T)	-0.976*	-0.561	-0.962*	-0.906*	-0.962*	-0.519
	(0.541)	(0.528)	(0.546)	(0.533)	(0.545)	(0.518)
Drug*Dominance	-0.023	1.148**			-0.003	1.136**
	(0.791)	(0.462)			(0.801)	(0.447)
Drug*Self-Control			0.156	-0.555*	0.156	-0.435
			(0.631)	(0.320)	(0.638)	(0.315)
All controls	Y	N	Y	N	Y	N
All except dominance	N	Y	N	N	N	Y
All except self-control	N	N	N	Y	N	Y
Adj R^2	0.006	0.021	0.033	0.074	0.135	0.329
# observations	117	117	117	117	117	117

*: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.01$.

Finally, regarding the demographic and medication characteristics, we observe a positive and significant relationship between medication use and the decision to evade taxes in our sample (Table VI). Recreational drug users also face a larger probability to evade, but one eight smaller than medicine users. Variables such as age, BMI, smoker, and other personality traits, as well as the amount of taxes owed, are not significant to explain the decision to evade taxes in our experiment.

4.3 Robustness Analysis

Although the treatment effect is significant only at ten percent, which potentially reduces our ability to assert that an exogenous increase in testosterone significantly and statistically reduces tax evasion, the negative sign of this variable is consistently estimated for different measures of tax evasion, namely the share of taxes evaded, the share of earnings evaded and the amount of taxes evaded.

In the Appendix 7.3 we present the complete set of estimations for all these measures when controlling for measures of androgen exposure, personality traits, demographic and medication use. The main results are summarized in Table IX, which seem to suggest that an exogenous increase in an individual's testosterone level affects the tax evasion extensive margin, i.e., whether to evade or not, but not quite precisely the amount an individual evades (the intensive margin). Although different measures of tax evasion are correlated, our results suggest that the decision whether to evade or not (extensive margin of evasion) could be more affected by biological factors, which is reinforced in our findings.

For different measures of tax evasion, the results are also robust with respect to androgen exposure and personality traits, i.e., (i) putative markers of prenatal and pubertal testosterone

Table IX: Testosterone and Other Measures of Tax Evasion

	Evasion Decision (0 = No, 1 = Yes) coef/sd	Share of Taxes Evaded coef/sd	Shared of Earnings Evaded coef/sd	Amount of Taxes Evaded coef/sd
Drug (0=P, 1=T)	-0.973*	-0.066	-0.010	-0.110
	(0.541)	(0.079)	(0.015)	(0.259)
Baseline Testosterone	-0.171*	-0.015	-0.003	-0.047
	(0.101)	(0.016)	(0.003)	(0.046)
Average 2D:4D	16.287*	2.793*	0.561**	10.857**
	(9.848)	(1.469)	(0.281)	(5.023)
fWHR	3.824*	0.540	0.109*	2.145*
	(2.179)	(0.331)	(0.063)	(1.100)
Dominance	1.430***	0.157***	0.029***	0.491***
	(0.429)	(0.056)	(0.010)	(0.181)
Self-Control	-0.809**	-0.156***	-0.030***	-0.490***
	(0.330)	(0.056)	(0.011)	(0.190)
Self-Construal	0.568*	0.068	0.015*	0.322**
	(0.308)	(0.048)	(0.009)	(0.152)
Taxes Owed	0.452	0.079*	0.022***	0.757***
	(0.318)	(0.041)	(0.007)	(0.138)
Adjusted R^2	0.329	0.290	0.320	0.414
# observations	117	117	117	117

*: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.01$. All other controls included.

exposure (2D:4D, fWHR) are positive and significantly associated with tax evasion and (ii) Dominance and Self-Construal (and Self-Control) are positive (negative) and significantly associated with tax evasion.

Table X presents additional robustness analysis for our main endogenous (binary) variable *Evasion* (see Appendix 7.4 and 7.5 for complete results). The participant's belief about the treatment, i.e., whether he believes he received placebo or testosterone (Zizzo (2010); Eisenegger et al. (2011)), is not statistically significant to explain his tax evasion decision. However, when controlling for this belief of treatment assignment, the negative sign of the variable *Drug* and its statistically significance is again verified. Following Chassang et al. (2015), we also investigate possible interactions between treatment (induced androgen) with two subsets of variables: (i) other measures of testosterone exposure (fWHR and 2D:4D indicators) and (ii) personality trait variables. For any interaction considered, the treatment effect negative sign is estimated. However, these results must be considered more carefully given our small sample size.

Finally, we perform permutation tests.[14] These tests invoke the concept of exchangeability,

[14]Permutation tests have a long history in statistics since Fisher (1935) and are widely used in statistics and medicine. Imbens and Rosenbaum (2005) applied permutation inference to well-known "weak instrument" data

Table X: Testosterone and Evasion Decision

Evasion (0 = No, 1 = Yes)	(1) coef/sd	(2) coef/sd	(3) coef/sd	(4) coef/sd	(5) coef/sd	(6) coef/sd	(7) coef/sd
Drug (0=P, 1=T)	-0.438*	-0.977*	-0.973*	-0.952*	-18.350	-13.460*	-1.237
	(0.446)	(0.522)	(0.541)	(0.540)	(17.535)	(7.608)	(3.687)
Baseline Testosterone	-0.195	-0.174*	-0.171*	-0.189*	-0.199*	-0.180*	-0.191
	(0.094)	(0.106)	(0.101)	(0.107)	(0.105)	(0.105)	(0.132)
Demographic	Y	Y	Y	Y	Y	Y	Y
Androgen Exposure	Y	Y	Y	Y	Y	Y	Y
Medication Use	Y	Y	Y	Y	Y	Y	Y
Personality Traits	N	Y	Y	Y	Y	Y	Y
Tax Owed	N	N	Y	Y	Y	Y	Y
Treatment Beliefs	N	N	N	Y	N	N	N
Interactions							
Drug and 2D:4D	N	N	N	N	Y	N	N
Drug and fWHR	N	N	N	N	N	Y	N
Drug and Personality Traits	N	N	N	N	N	N	Y
Adjusted R^2	0.006	0.021	0.033	0.330	0.336	0.349	0.372
# observations	117	117	117	117	117	117	117

*: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.01$.

which suggests that under the null hypothesis H_0 of no effect, potential treated and untreated responses are exchangeable without affecting their joint distribution. If the null hypothesis is true, changing the exposure would have no effect on the outcome, i.e., the shuffled data sets should look like the real data (and by randomly shuffling the exposures we can make up as many data sets as we like). This strategy provides valid tests (Type I error) given that we have insufficient information about the distribution of the data.

We propose a simple permutation test to assess the null hypothesis that treatment has no effect on the outcome of interest. That is, shuffling the drug condition variable breaks any association between testosterone and tax evasion behavior, our null hypothesis. If the null hypothesis, that an exogenous increase in testosterone level makes no difference to tax evasion, is true, then the t statistic should be mostly unaffected by a different assignment of participants to treatment-placebo scenarios. For each of these different assignments, the participant's (full or partial) tax evasion is used to calculate the t statistic, so a distribution of possible t statistics is generated.

We compute a p-value by comparing the statistic for the original data with the permutation distribution. Figure 3 shows the permutation distribution for the treatment (*Drug*) coefficient

in economics to find that only permutation methods provided reliable inference. For more on permutation (or randomization) tests in general, see Ernst (2004) and Lehmann and Romano (2005), among others.

β_0, equation 4. Our permutation tests for the full model suggests that about 9.6% (roughly) of the estimated β_0 were greater in magnitude than our estimated effect (-0.973), which implies a p-value of 0.096 for our estimate. Note that this is very similar to our estimated model and still significant at 10% (see Table VI, column (7)).[15]

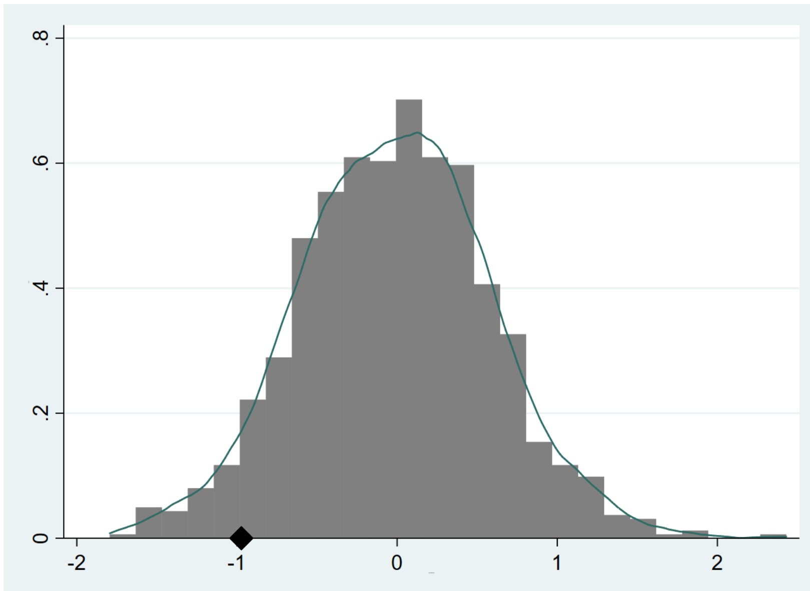

Figure 3: Permutation distribution for the difference in the conditional means between treated and non-treated participants. The observed difference of -0.973 is shown: about 9.6% (roughly) of the estimated β_0, equation (4), were greater in magnitude than our estimated effect.

5 On the mechanism behind the relationship between testosterone and tax evasion

We estimated and identified a negative causal effect of testosterone on tax evasion. However, we are not able to pin down the exact mechanism, the underlying channel through which testosterone might affect an agent's decision to evade taxes. In this section, we present some discussion about the potential nature of our estimated negative relationship between testosterone and tax evasion behavior.

First, our results could be viewed along the possible interpretations offered by Eisenegger et al. (2012) with respect to testosterone and social behavior. Eisenegger et al. (2010) and van Honk et al. (2012) have suggested that it is possible that testosterone directly affects people's social preferences, that is, it directly renders their motives more prosocial or lead to a less selfish behavior in certain situations.

A second possibility is that testosterone can potentially influence the subject's beliefs about the other individuals' cooperation levels. For example, a subject who received testosterone may

[15] We find consistent permutation tests results for the alternative models (columns (1-6), Table VI) when we control (or not) for variables and characteristics, other than treatment.

believe that others are more cooperative while their own motives remain unchanged. In addition, and not mutually exclusive, testosterone may increase an individual concerns for one's status, conferring higher status to himself as a cooperative group member than otherwise. In the context of our tax evasion experiment, it is possible to that participants believe others will cooperate, i.e., pay their due taxes, and themselves have a concern about their own status as honest taxpayers. In either cases, testosterone may have causally affected participants' motives and beliefs in a way that lead them to refrain from evading taxes. These mechanisms are, to some extent, supported by our results for the relationship between personality traits (Dominance, Self-Control and Self-Construal) and tax evasion.

Finally, testosterone might increase the non-pecuniary (psychological) costs of tax evasion (Gordon (1989)). Recent studies have investigated directly the role of emotions on tax compliance (Coricelli et al. (2010, 2014); Casal and Mittone (2016)). Coricelli et al. (2010) find higher skin conductance responses (SCRs) when participants evaded, and higher arousal and negative effects associated with being audited. They observe that negative feelings are related to a higher fine, and learning that photographs of participants would be disseminated increases this effect (a treatment in which the pictures of evaders were publicly displayed few seconds at the end of the period favored compliance). The decision to evade and the proportion of evaded income were related to the anticipation and the experience of emotional responses. This supports their explanation that tax compliance is driven by shame, which is increased with greater public punishment. The results of Dulleck et al. (2016)'s laboratory experiments provide empirical evidence of a positive correlation between a physiological measure of stress (heart rate variability) and tax compliance. That is, higher stress increases tax compliance. They offer an interpretation of their measures of stress: individuals are triggered by moral emotions, which motivate compliance decisions. To the extent that testosterone may have causally affected participants' motives and beliefs, it is possible that it may also have affected individuals emotionally to motivate them to pay taxes owed.

6 Conclusion

An individual's tax behavior can be seen as the outcome of the interaction of objective (external) and subjective (person-bound) factors. The experimental literature on tax evasion has shown the importance of both economic and psychological variables to explain taxpayers' decisions to pay or evade taxes. However, the importance of testosterone and more generally of hormones in tax evasion has been almost unexplored. There is still a lack of understanding about the biological aspects (hormone levels) of tax compliance. This field of research may benefit from a deeper understanding of the biological foundations of individuals' decisions to pay taxes.

From a laboratory experiment with 117 young men, we present suggestive evidence that testosterone levels may inhibit tax evasion behavior. The results presented show a negative effect of administered testosterone (significant at 10%). Results are consistent when controlling for a set of potentially relevant explanatory variables such as individual characteristics, prenatal and pubertal testosterone exposure, medication and drugs use, personality traits, treatment beliefs, and drug interactions, as well as for different measures of tax evasion. We also find that the putative markers of prenatal and pubertal testosterone exposure (2D:4D, fWHR) are positive and significantly associated with tax evasion. Dominance and Self-Construal (and Self-Control) are positive (negative) and significantly associated with tax evasion.

Results obtained from laboratory experiments are often criticized, for instance, by arguing that the lab environment does not properly represent and reflect the natural, real life environments. In our particular setting, questions might emerge regarding the representative role of our candidates, the contextual framework and the tax schedule proposed. First, we acknowledge that the external validity of our experiment may be jeopardized by the fact that participants are probably more informed than real-life tax evaders (Alm et al. (2015); Banerjee et al. (2016)). Moreover, in reality, auditing probabilities are very low (much lower than in our experiment).

Second, inclusion and exclusion criteria are used to select a sample of participants might be biased by the fact that the potential candidates come from a pool of individuals that have already demonstrated interest in participating in such experiments. However, although arguably limited, participants are presented with a common choice faced in their daily life, i.e., whether to pay taxes facing a possibility of being audit. This is a major advantage of our experiment *vis-à-vis* the use of survey data to study tax evasion behavior when it is often the researcher who makes inferences about respondents' tax evasion behavior.

Finally, in designing our experiment, we have purposely chosen to contextualize the tax evasion decision. In most experimental studies of tax evasion, as Cadsby et al. (2006) point out, participants are instructed that they may report any amount of income from zero up to the amount they actually earned or received. Such studies may encourage some subjects to think of the experimental setting as an invitation to play a gambling game, and to behave accordingly, under reporting their incomes whenever the expected returns are high enough to justify the risk of being penalized if audited.[16] Our results are observed in a setup where individuals know the amount of tax due and also know that they can be caught evading. This is in line with what is expected of taxpayers by tax authorities, namely full compliance.

Although we have refrained from using terms such as "fraud", we can reasonably assume that subjects understood that they were required to pay the entirety of their taxes to avoid punishment. Subjects (taxpayers) were presented not with a morally-neutral gamble, but with instructions that unambiguously demand compliance. The notion of "penalty" and "fine" should have made it clear that under-reporting meant cheating. While some participants, interpreting the instructions literally, may feel that they indeed have an obligation to pay laboratory taxes,

[16] In an experiment conducted by Wibral et al. (2012), the subjects payoff depended on the self-reported outcome of a die-roll. They find that testosterone administration decreases lying in men, but in a situation in which subjects knew they could not be caught lying.

some may not. It is possible that an exogenous increase in testosterone may trigger a concurrent aggressive (risk taking; tax evasion) and prosocial (less selfish; tax compliance) behavior and our experiment is capturing the testosterone net effect. Through additional exercises, we find that the testosterone effects on evasion were strongly modulated by heterogeneity in trait dominance and trait self-control, a possible way to reconcile a positive relationship between testosterone and risk taking behavior. Nevertheless, and despite its limitations, we believe our results shed important light on the biological foundations of tax evasion.

Certainly, more research is needed to advance our understanding of the importance and influence of hormones and personality traits on tax compliance, as well as to determine if our findings will hold independent of a specific domain. At this stage, we believe it is still premature to discuss more elaborate policy implications of our findings and we would not go as far as proposing a testosterone tax. However, we could envision, for instance, efforts to document taxpayers testosterone exposure, personality traits and their attitude towards taxes (and tax evasion) in a less intrusive setting. We pursue this in future research.

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7 Appendix

7.1 Behavioral Tasks

Behavioral tasks completed by research participants:

- Point Subtraction Aggression Paradigm (PSAP): The PSAP is a well validated computer-based behavioral measure of reactive aggression in which participants are told they are playing the game with another male participant and the goal of the task is to earn as many points as possible, which are later exchangeable for money. For the PSAP, participants have three response options: button 1 earns them points after a hundred consecutive presses; button 2 steals points after ten consecutive presses; and button 3 protects points after ten consecutive presses. Throughout the task, points are randomly stolen from participants and this is attributed to their partner who gets to keep all the points that he steals. Participants can steal points back, but are told that they have been assigned to the experimental condition whereby they do not get to keep stolen points. Participants are told that at the end of the game, they will be paid based on how many points they accumulated during the task and that their game partner would be paid based on how many points he accumulated during the task. Each point earned will be worth $0.20. In the current study, we used a single 10 minute block of the task as previous work indicated that changes in testosterone during competition are most strongly correlated with aggression on the PSAP within the first block.

- Formidability Assessment: Just prior to performing the PSAP, participants are presented with an array of 11 images depicting their own face which has been morphed to appear relatively more/less masculine (note: one of the faces is their true, unmanipulated face). Participants will be tasked with selecting which face is their true self. Immediately after the PSAP, participants perform a similar Formidability Assessment task. However, in this case, they are presented with an array of 11 images of their PSAP opponent which has been morphed to appear relatively more/less masculine. In this case, participants are tasked with selecting the face that is their true PSAP opponent.

- Balloon Analogue Risk Task (BART): Participants complete the Balloon Analogue Risk Task (BART). In this version of the task, participants accumulate money points by pumping up 20 virtual balloons. Each balloon pump earn participants $.05. Each balloon have a maximum threshold of pumps it could reach before it explodes, ranging between 1 to 30 pumps. If a balloon explodes, all points are lost from that specific balloon. Participants also have an option to save the points from a balloon, provided that the balloon has not yet exploded, and move on to pumping the next balloon in the sequence. Altogether, when performing this task, participants must make a decision to engage in risky behavior with each button press, as the balloon has a chance to explode with each press.

- Emotion Recognition Task: Participants complete the Emotion Recognition task which involves judging facial expressions that have been morphed to be more-less salient (e.g., 20% expression vs. 100% expression). Participants are asked to guess the emotional expression of the face (anger, fear, disgust, sad) from a brief (2 sec) video clips.

- Economic Decision Making Task: In this task, participants make decisions regarding small economic gambles, for example a choice between $5 guaranteed or a 50/50 gamble that pays $0 or $10. This task measures individuals sensitivity to economic risk. The more frequently participants accept gambles, the more risk seeking they are. Participants are paid bonuses based on randomly chosen trials within the task and dependent on their actual choices. The range of bonus payment is $0 - $5. Based on participants' speed, this task takes approximately 10-15 minutes to complete. This study examine the extent to which testosterone administration promotes enhanced economic risk seeking.

- Attentional Adhesion Measure: The task it is a modified version of the dot probe task adapted from work done by other researchers. The task comprises 16 practice trials and 4 experimental blocks, with 12 trials within each block. During each trial the participant is going to be exposed to either a face of an attractive woman or a baby face. In the subsequent slide the subject is then exposed to a probe (either a circle or a square) on the same side (filler trial) or the opposite side (shift trials) of where the stimulus of the first slide was presented. Task objective is to identify the shape of the probe as fast as possible. The time required to identify the probe shape during shift trials is taken as a measure of Attentional adhesion.

- Implicit Attention to Status: Participants work on a measure of implicit status concerns, which will be presented as a measure of visual perceptual speed. Participants are given 5 min to complete a word search similar to the jumble puzzles that appear in many Sunday newspapers. The word search contains a mix of 10 status occupations (advisor, advisee; doctor, hygienist; director, staff; lawyer, paralegal; president, secretary) and a collection of neutral words. The percentage of status words circled compared to total words circled represents our measure of implicit attention to status.

- Face Preference Task: Participants view 20 pairs of faces that have been manipulated to appear more or less feminine. Each pair of images consist of a masculinized and feminized version of the same individual. Participants are asked to choose the face in each pair that is more attractive and to indicate the extent to which the chosen face is more attractive by choosing from the options "slightly more attractive", "somewhat more attractive", "more attractive" and "much more attractive". Previous work indicated that men with high testosterone concentrations show a significant preference for feminine faces relative to men with low testosterone concentrations.

7.2 Descriptive Statistics

Table XI: Descriptive statistics - Other Measures of Tax Evasion

	total		treated		placebo	
	mean	*st.dev*	mean	*st.dev*	mean	*st.dev*
Share of Tax Evaded	0.583	0.457	0.549	0.459	0.616	0.457
Share of Earnings Evaded	0.112	0.088	0.107	0.089	0.117	0.088
Amount of Taxes Evaded	1.966	1.676	1.915	1.695	2.017	1.670
# observations	117		59		58	

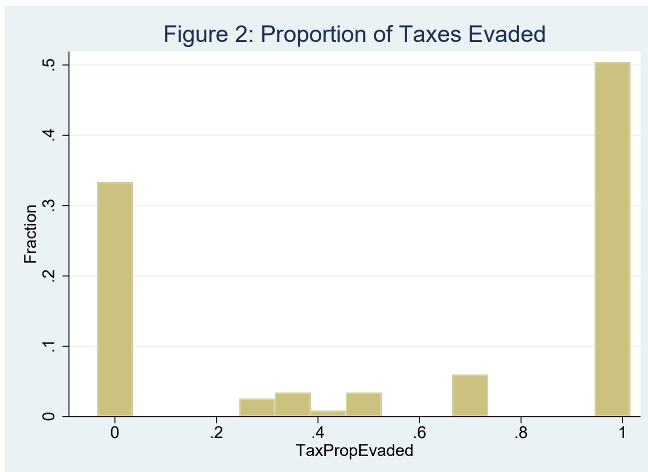

Figure 4: Earnings Distribution

7.3 Testosterone and Other Measures of Tax Evasion

Table XII: Testosterone and Other Measures of Tax Evasion

	Evasion Decision (0 = No, 1 = Yes) coef/sd	Share of Taxes Evaded coef/sd	Shared of Earnings Evaded coef/sd	Amount of Taxes Evaded coef/sd
Drug (0=P, 1=T)	-0.973*	-0.066	-0.010	-0.110
	(0.541)	(0.079)	(0.015)	(0.259)
Baseline Testosterone	-0.171*	-0.015	-0.003	-0.047
	(0.101)	(0.016)	(0.003)	(0.046)
Age	-0.050	-0.004	-0.001	-0.015
	(0.066)	(0.009)	(0.002)	(0.030)
BMI	-0.017	-0.003	-0.001	-0.024
	(0.069)	(0.009)	(0.002)	(0.032)
Average 2D:4D	16.287*	2.793*	0.561**	10.857**
	(9.848)	(1.469)	(0.281)	(5.023)
fWHR	3.824*	0.540	0.109*	2.145*
	(2.179)	(0.331)	(0.063)	(1.100)
Medication Use	2.799***	0.335***	0.063***	1.051***
	(0.900)	(0.100)	(0.019)	(0.346)
Recreational drug use	1.051*	0.144*	0.027*	0.367
	(0.589)	(0.082)	(0.016)	(0.277)
Smoker	-0.661	-0.078	-0.015	-0.227
	(0.565)	(0.087)	(0.017)	(0.305)
Anxiety	0.207	-0.067	-0.012	-0.202
	(0.865)	(0.114)	(0.022)	(0.386)
Dominance	1.430***	0.157***	0.029***	0.491***
	(0.429)	(0.056)	(0.010)	(0.181)
Self-Control	-0.809**	-0.156***	-0.030***	-0.490***
	(0.330)	(0.056)	(0.011)	(0.190)
Self-Construal	0.568*	0.068	0.015*	0.322**
	(0.308)	(0.048)	(0.009)	(0.152)
Trait Aggressiveness	-0.645	-0.035	-0.008	-0.166
	(0.479)	(0.071)	(0.013)	(0.225)
Psychopathy Factor 1	-0.548	-0.071	-0.013	-0.199
	(0.637)	(0.106)	(0.020)	(0.340)
Psychopathy Factor 1	0.293	0.006	-0.001	-0.063
	(0.646)	(0.092)	(0.017)	(0.291)
Taxes Owed	0.452	0.079*	0.022***	0.757***
	(0.318)	(0.041)	(0.007)	(0.138)
Constant	-18.909*	-2.676*	-0.559*	-12.059**
	(10.328)	(1.543)	(0.294)	(5.165)
Adjusted R^2	0.329	0.290	0.320	0.414
# observations	117	117	117	117

*: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.01$.

Table XIII: Testosterone and Share of Taxes Evaded

Evasion (0 = No, 1 = Yes)	(1) coef/sd	(2) coef/sd	(3) coef/sd	(4) coef/sd	(5) coef/sd	(6) coef/sd	(7) coef/sd
Drug (0=P, 1=T)	-0.067	-0.061	-0.053	-0.050	-0.058	-0.077	-0.066
	(0.085)	(0.084)	(0.085)	(0.084)	(0.084)	(0.081)	(0.079)
Baseline Testosterone		-0.025	-0.021	-0.022	-0.032*	-0.015	-0.015
		(0.019)	(0.020)	(0.020)	(0.017)	(0.015)	(0.016)
Age			-0.009	-0.005	-0.007	-0.002	-0.004
			(0.009)	(0.009)	(0.010)	(0.009)	(0.009)
BMI			0.009	-0.003	-0.004	-0.003	-0.003
			(0.008)	(0.010)	(0.010)	(0.009)	(0.009)
Average 2D:4D				2.768*	3.140**	2.605*	2.793*
				(1.429)	(1.403)	(1.496)	(1.469)
fWHR				0.694*	0.563	0.644*	0.540
				(0.366)	(0.357)	(0.333)	(0.331)
Medication Use					0.393***	0.334***	0.335***
					(0.105)	(0.099)	(0.100)
Recreational drug use					0.192**	0.172**	0.144*
					(0.091)	(0.087)	(0.082)
Smoker					-0.059	-0.091	-0.078
					(0.092)	(0.091)	(0.087)
Anxiety						-0.103	-0.067
						(0.115)	(0.114)
Dominance						0.166***	0.157***
						(0.056)	(0.056)
Self-Control						-0.158***	-0.156***
						(0.056)	(0.056)
Self-Construal						0.061	0.068
						(0.048)	(0.048)
Trait Aggressiveness						-0.045	-0.035
						(0.070)	(0.071)
Psychopathy Factor 1						-0.067	-0.071
						(0.108)	(0.106)
Psychopathy Factor 2						0.002	0.006
						(0.093)	(0.092)
Taxes Owed							0.079*
							(0.041)
Constant	0.616***	0.744***	0.692**	-2.934*	-2.980**	-2.365	-2.676*
	(0.060)	(0.112)	(0.329)	(1.518)	(1.488)	(1.589)	(1.543)
Adj R^2	-0.003	0.005	0.006	0.052	0.111	0.271	0.290
# observations	117	117	117	117	117	117	117

*: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.01$.

Table XIV: Testosterone and Share of Earnings Evaded

Evasion (0 = No, 1 = Yes)	(1) coef/sd	(2) coef/sd	(3) coef/sd	(4) coef/sd	(5) coef/sd	(6) coef/sd	(7) coef/sd
Drug (0=P, 1=T)	-0.010	-0.009	-0.007	-0.007	-0.009	-0.013	-0.010
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.015)
Baseline Testosterone		-0.004	-0.004	-0.004	-0.006*	-0.003	-0.003
		(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
Age			-0.002	-0.001	-0.001	-0.000	-0.001
			(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
BMI			0.002	-0.001	-0.001	-0.001	-0.001
			(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Average2D:4D				0.527*	0.598**	0.508*	0.561**
				(0.278)	(0.272)	(0.287)	(0.281)
fWHR				0.148**	0.123*	0.138**	0.109*
				(0.071)	(0.069)	(0.065)	(0.063)
Medication Use					0.074***	0.062***	0.063***
					(0.021)	(0.020)	(0.019)
Recreational drug use					0.039**	0.035**	0.027*
					(0.018)	(0.017)	(0.016)
Smoker					-0.015	-0.019	-0.015
					(0.018)	(0.018)	(0.017)
Anxiety						-0.022	-0.012
						(0.023)	(0.022)
Dominance						0.031***	0.029***
						(0.011)	(0.010)
Self-Control						-0.031***	-0.030***
						(0.011)	(0.011)
Self-Construal						0.013	0.015*
						(0.009)	(0.009)
Trait Aggressiveness						-0.010	-0.008
						(0.013)	(0.013)
Psychopathy Factor 1						-0.012	-0.013
						(0.021)	(0.020)
Psychopathy Factor 2						-0.002	-0.001
						(0.018)	(0.017)
Taxes Owed							0.022***
							(0.007)
Constant	0.117***	0.140***	0.136**	-0.579**	-0.589**	-0.472	-0.559*
	(0.011)	(0.021)	(0.063)	(0.294)	(0.288)	(0.306)	(0.294)
Adj R^2	-0.005	0.000	-0.001	0.051	0.112	0.272	0.320
# observations	117	117	117	117	117	117	117

*: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.01$.

Table XV: Testosterone and Amount of Taxes Evaded

Evasion (0 = No, 1 = Yes)	(1) coef/sd	(2) coef/sd	(3) coef/sd	(4) coef/sd	(5) coef/sd	(6) coef/sd	(7) coef/sd
Drug (0=P, 1=T)	-0.102	-0.084	-0.055	-0.074	-0.125	-0.211	-0.110
	(0.311)	(0.311)	(0.311)	(0.305)	(0.313)	(0.313)	(0.259)
Baseline Testosterone		-0.074	-0.066	-0.066	-0.103*	-0.042	-0.047
		(0.060)	(0.064)	(0.062)	(0.057)	(0.051)	(0.046)
Age			-0.028	-0.009	-0.012	0.007	-0.015
			(0.032)	(0.034)	(0.035)	(0.033)	(0.030)
BMI			0.025	-0.026	-0.033	-0.030	-0.024
			(0.027)	(0.035)	(0.038)	(0.036)	(0.032)
Average2D:4D				8.671*	9.950**	9.044*	10.857**
				(5.176)	(5.013)	(5.229)	(5.023)
fWHR				3.314**	2.885**	3.150**	2.145*
				(1.336)	(1.306)	(1.238)	(1.100)
Medication Use					1.292**	1.048**	1.051***
					(0.531)	(0.497)	(0.346)
Recreational drug use					0.710**	0.633*	0.367
					(0.338)	(0.363)	(0.277)
Smoker					-0.389	-0.352	-0.227
					(0.345)	(0.348)	(0.305)
Anxiety						-0.554	-0.202
						(0.445)	(0.386)
Dominance						0.573***	0.491***
						(0.215)	(0.181)
Self-Control						-0.514**	-0.490***
						(0.206)	(0.190)
Self-Construal						0.249	0.322**
						(0.169)	(0.152)
Trait Aggressiveness						-0.260	-0.166
						(0.241)	(0.225)
Psychopathy Factor 1						-0.157	-0.199
						(0.385)	(0.340)
Psychopathy Factor 2						-0.093	-0.063
						(0.344)	(0.291)
Taxes Owed							0.757***
							(0.138)
Constant	2.017***	2.396***	2.386**	-10.742**	-10.927**	-9.073	-12.059**
	(0.219)	(0.374)	(1.150)	(5.411)	(5.295)	(5.561)	(5.165)
Adj R^2	-0.008	-0.005	-0.011	0.051	0.104	0.239	0.414
# observations	117	117	117	117	117	117	117

*: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.01$.

Table XVI: Testosterone and Evasion Decision

Evasion (0 = No, 1 = Yes)	(1) coef/sd	(2) coef/sd	(3) coef/sd	(4) coef/sd	(5) coef/sd	(6) coef/sd
Drug (0=P, 1=T)	-0.976*	-0.561	-0.962*	-0.906*	-0.962*	-0.519
	(0.541)	(0.528)	(0.546)	(0.533)	(0.545)	(0.518)
treat_dom	-0.023	1.148**			-0.003	1.136**
	(0.791)	(0.462)			(0.801)	(0.447)
treat_control			0.156	-0.555*	0.156	-0.435
			(0.631)	(0.320)	(0.638)	(0.315)
Baseline Testosterone	-0.171*	-0.182*	-0.173*	-0.179*	-0.173*	-0.194*
	(0.101)	(0.099)	(0.102)	(0.101)	(0.102)	(0.101)
Age	-0.050	-0.064	-0.051	-0.058	-0.051	-0.075
	(0.066)	(0.064)	(0.065)	(0.072)	(0.065)	(0.066)
BMI	-0.017	-0.022	-0.016	-0.022	-0.016	-0.023
	(0.070)	(0.071)	(0.069)	(0.072)	(0.069)	(0.071)
Average2d4d	16.276*	17.372**	16.085	18.149*	16.084	18.462**
	(9.827)	(8.821)	(9.861)	(10.165)	(9.835)	(8.871)
FWHR	3.819*	4.189*	3.842*	3.290	3.841*	3.597
	(2.200)	(2.335)	(2.172)	(2.203)	(2.199)	(2.190)
Medication Use	2.800***	2.545***	2.816***	2.651***	2.816***	2.535***
	(0.907)	(0.860)	(0.924)	(0.857)	(0.928)	(0.847)
Recreational drug use	1.052*	0.688	1.063*	1.065*	1.063*	0.731
	(0.586)	(0.580)	(0.599)	(0.564)	(0.596)	(0.561)
Smoker	-0.661	-0.421	-0.679	-0.690	-0.679	-0.497
	(0.566)	(0.588)	(0.573)	(0.539)	(0.574)	(0.544)
Anxiety	0.204	-0.185	0.220	0.509	0.220	0.157
	(0.846)	(0.738)	(0.869)	(0.796)	(0.847)	(0.688)
Dominance	1.444**		1.438***	1.373***	1.440**	
	(0.729)		(0.440)	(0.401)	(0.734)	
Self-Control	-0.810**	-0.735**	-0.904		-0.904	
	(0.328)	(0.325)	(0.577)		(0.577)	
Self-Construal	0.570*	0.544*	0.574*	0.549*	0.575*	0.523*
	(0.320)	(0.306)	(0.309)	(0.308)	(0.321)	(0.305)
Trait Aggressiveness	-0.643	-0.350	-0.662	-0.466	-0.661	-0.230
	(0.490)	(0.477)	(0.481)	(0.489)	(0.493)	(0.494)
Psycopathy Factor 1	-0.552	-0.024	-0.557	-0.502	-0.557	0.031
	(0.663)	(0.569)	(0.641)	(0.594)	(0.666)	(0.548)
Psycopathy Factor 1	0.292	0.192	0.326	0.328	0.325	0.282
	(0.646)	(0.646)	(0.645)	(0.661)	(0.644)	(0.650)
Taxes Owed	0.452	0.516	0.444	0.498	0.444	0.528
	(0.318)	(0.326)	(0.320)	(0.331)	(0.320)	(0.330)
Constant	-18.878*	-21.595**	-18.754*	-20.813**	-18.750*	-22.592**
	(10.309)	(9.832)	(10.315)	(10.460)	(10.281)	(9.598)
Adj R^2	0.329	0.290	0.329	0.310	0.329	0.270
# observations	117	117	117	117	117	117

*: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.01$. *Evasion*: binary variable equals to one if a participant evades whether the full or a fraction of the amount taxes owed, and it is zero otherwise. *Drug* captures our treatment assuming the value zero if the participant received a placebo or one if he received 150 mg of Androgel (testosterone). *Baseline T*: baseline level of testosterone. Testosterone exposure during prenatal development and puberty are

7.4 Testosterone, Treatment Beliefs and Tax Evasion

Table XVII: Testosterone, Treatment Beliefs and Tax Evasion

	Evasion Decision (0 = No, 1 = Yes) coef/sd	Share of Taxes Evaded coef/sd	Shared of Earnings Evaded coef/sd	Amount of Taxes Evaded coef/sd
Drug (0=P, 1=T)	-0.952*	-0.065	-0.010	-0.108
	(0.540)	(0.079)	(0.015)	(0.260)
Baseline Testosterone	-0.189*	-0.012	-0.002	-0.043
	(0.107)	(0.016)	(0.003)	(0.048)
Age	-0.048	-0.005	-0.001	-0.016
	(0.066)	(0.009)	(0.002)	(0.030)
BMI	-0.023	-0.001	-0.001	-0.022
	(0.072)	(0.009)	(0.002)	(0.033)
Average 2D:4D	15.921	2.818*	0.565**	10.892**
	(9.971)	(1.470)	(0.281)	(5.037)
fWHR	3.936*	0.537	0.109*	2.142*
	(2.170)	(0.333)	(0.063)	(1.107)
Medication Use	2.743***	0.342***	0.064***	1.062***
	(0.885)	(0.098)	(0.019)	(0.341)
Recreational Drug Use	1.022*	0.153*	0.028*	0.379
	(0.590)	(0.082)	(0.016)	(0.279)
Smoker	-0.719	-0.066	-0.014	-0.211
	(0.562)	(0.089)	(0.017)	(0.313)
Anxiety	0.169	-0.063	-0.012	-0.197
	(0.869)	(0.114)	(0.022)	(0.387)
Dominance	1.451***	0.157***	0.029***	0.492***
	(0.443)	(0.056)	(0.010)	(0.182)
Self-Control	-0.814**	-0.158***	-0.031***	-0.493***
	(0.338)	(0.055)	(0.011)	(0.190)
Self-Construal	0.570*	0.066	0.015*	0.319**
	(0.311)	(0.048)	(0.009)	(0.153)
Trait Aggressiveness	-0.708	-0.026	-0.006	-0.153
	(0.501)	(0.070)	(0.013)	(0.220)
Psychopathy Factor 1	-0.510	-0.071	-0.013	-0.199
	(0.627)	(0.106)	(0.020)	(0.343)
Psychopathy Factor 2	0.335	-0.004	-0.002	-0.076
	(0.648)	(0.092)	(0.017)	(0.292)
Taxes Owed	0.408	0.081**	0.022***	0.761***
	(0.320)	(0.040)	(0.007)	(0.137)
Treatment Beliefs	0.334	-0.081	-0.013	-0.117
	(0.566)	(0.087)	(0.017)	(0.320)
Constant	-18.415*	-2.737*	-0.569*	-12.147**
	(10.425)	(1.547)	(0.295)	(5.180)
Adjusted R^2	0.330	0.289	0.317	0.409
# observations	117	117	117	117

*: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.01$.

7.5 Testosterone, Interactions and Other Measures of Tax Evasion

Androgen Exposure

Table XVIII: Testosterone, Interactions, and Other Measures of Tax Evasion

	Evasion Decision (0 = No, 1 = Yes) coef/sd	Share of Taxes Evaded coef/sd	Shared of Earnings Evaded coef/sd	Amount of Taxes Evaded coef/sd
Drug (0=P, 1=T)	-18.350	-1.674	-0.365	-7.080
	(17.535)	(2.639)	(0.502)	(8.974)
Baseline Testosterone	-0.199*	-0.016	-0.003	-0.049
	(0.105)	(0.016)	(0.003)	(0.046)
Drug*Average 2D:4D	18.082	1.679	0.371	7.280
	(18.304)	(2.756)	(0.524)	(9.323)
Constant	-9.989	-1.814	-0.368	-8.320
	(14.268)	(2.252)	(0.430)	(7.523)
Adjusted R^2	0.336	0.286	0.317	0.413
# observations	117	117	117	117

*: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.01$. All other controls included.

Table XIX: Testosterone, Interactions, and Other Measures of Tax Evasion

	Evasion Decision (0 = No, 1 = Yes) coef/sd	Share of Taxes Evaded coef/sd	Shared of Earnings Evaded coef/sd	Amount of Taxes Evaded coef/sd
Drug (0=P, 1=T)	-13.460*	-1.255	-0.230	-3.604
	(7.608)	(0.875)	(0.166)	(2.890)
Baseline Testosterone	-0.180*	-0.016	-0.003	-0.049
	(0.105)	(0.016)	(0.003)	(0.047)
Drug*fWHR	7.184*	0.687	0.127	2.018
	(4.237)	(0.496)	(0.094)	(1.652)
Constant	-15.321	-2.130	-0.458	-10.453*
	(11.561)	(1.607)	(0.305)	(5.359)
Adjusted R^2	0.349	0.296	0.325	0.416
# observations	117	117	117	117

*: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.01$. All other controls included.

Personality Traits

Table XX: Testosterone, Interactions, and Other Measures of Tax Evasion

	Evasion Decision (0 = No, 1 = Yes) coef/sd	Share of Taxes Evaded coef/sd	Shared of Earnings Evaded coef/sd	Amount of Taxes Evaded coef/sd
Drug (0=P, 1=T)	-1.237	0.248	0.026	-0.528
	(3.687)	(0.453)	(0.086)	(1.484)
Baseline Testosterone	-0.191	-0.017	-0.003	-0.040
	(0.132)	(0.017)	(0.003)	(0.048)
Drug*Self-Construal	0.215	0.041	0.007	0.171
	(0.609)	(0.093)	(0.017)	(0.302)
Drug*Dominance	1.390	0.175	0.035	0.650*
	(1.080)	(0.116)	(0.022)	(0.370)
Drug*Self-Control	0.283	0.063	0.015	0.417
	(0.782)	(0.123)	(0.023)	(0.411)
Drug*Aggressiveness	-1.495	-0.090	-0.013	-0.201
	(0.996)	(0.142)	(0.027)	(0.455)
Drug*Anxiety	3.639**	0.238	0.052	1.418*
	(1.759)	(0.223)	(0.043)	(0.748)
Drug*PsyFactor1	-1.989	-0.262	-0.054	-1.157
	(1.698)	(0.229)	(0.043)	(0.743)
Drug*PsyFactor2	0.887	0.030	0.010	0.389
	(1.194)	(0.208)	(0.039)	(0.678)
Constant	-20.778*	-2.969*	-0.605**	-12.386**
	(11.360)	(1.577)	(0.300)	(5.163)
Adjusted R^2	0.372	0.267	0.299	0.410
# observations	117	117	117	117

*: $p < 0.10$, **: $p < 0.05$, ***: $p < 0.01$. All other controls included.