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Drivers of smoking and physical activity in Russia: Do individual time preferences matter?

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Abstract

This article analyzes the relationship between individual decisions to smoke and to do physical exercises. It is assumed that individual time preferences play a major role in explaining individual health behavior. The database is the special survey of Russians' lifestyle conducted in 2017. A multivariate probit model with endogenous binary variable enables to analyze the relationship between smoking, doing physical exercises, and individual time preferences. Individual time preferences are determined through a hypothetical money experiment. An individual discount rate is used as a proxy for the rate of time preferences. We reveal that there is a negative relationship between smoking and doing physical exercises because of unobservable factors. It might be an individual inclination to follow a healthy or unhealthy lifestyle. There is a negative influence of the higher individual discount rate on doing physical exercises and a positive influence of the higher individual discount rate on smoking. Social policy should accentuate the short-term benefits from smoking cessation and regular physical exercises rather than probable future health improvements. For target groups with the higher individual discount rate, highlighting the short-term negative consequences of avoiding healthy behaviors will be more effective than drawing attention to future health risks.

Keywords: smoking, physical exercise, individual discount rate, multivariate probit, Russia.
JEL classification: I12.

1. Introduction

Researchers have long considered the relationship between smoking and doing physical exercises. This relationship seems to be important for policy decisions, since "physical activity may have an important role to play in a smoking prevention program" (Faulkner et al., 1987, p. 155). Charilaou et al. (2009, p. 969) mentioned that "prevention programs that focus on physical activity to address

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the problem of smoking hold promise." Ali et al. (2015) investigated adolescents in the United States with the help of the National Longitudinal Survey of Adolescent Health conducted in 1994 and 1996. The authors showed "that any level of physical activity will have the beneficial impact of reducing smoking... This implies that public policy initiatives focusing on encouraging even moderate levels of physical activity among youth… could result in additional benefits in terms of a reduction in cigarette smoking" (Ali et al., 2015, p. 544).

There is no doubt that the relationship between smoking and doing physical exercise is rather complex. The motives underlying individual health choices have not been fully investigated. Along with the socioeconomic characteristics of an individual, time preferences might be the driver of a choice between healthy or unhealthy behavior. According to Samuelson (1937), all the motives underlying the intertemporal choice can be aggregated into one parameter. This is the individual discount rate, showing the preference of utility from current consumption over utility from consumption in the future. When it comes to healthy behavior, today's decision to engage in physical activity entails a negative utility, since it requires time and effort, and often incurs financial costs. These investments are made for future benefits in the form of likely health benefits. Smoking cessation also results in giving up a perceived pleasant habit. This is a negative utility for the sake of benefiting from probable better health in the future. Individual discounting of future utility determines the decision whether to invest in health at the current moment or not.

This study aims to check the hypothesis that individual time preferences are associated with individual choices regarding smoking and participation in physical activity. A higher individual discount rate indicating an individual's impatience in obtaining utility is associated with the decision to smoke and a refusal to undertake physical exercises. An impatient individual is not ready to postpone utility from consumption. Findings of existing research are expanded by adding individual time preferences into the analysis and examining their role in the relationship between smoking and physical activity. Conclusions are useful for decision-makers who are responsible for the design of public policy aimed at promoting a healthy lifestyle.

2. Measuring individual time preference and its relationship with health behaviors

Identifying individual time preferences is a complex research task. As a rule, individual time preferences are measured through an individual discount rate. It is usually determined during a survey, which can be both hypothetical and real. With that, the result of measuring depends on the object, which the respondent discounts. It can be either a sum of money or an intangible benefit. For example, Grignon (2009) investigated heterogeneity in time preferences and smoking behaviors. The author used data from a survey that included a question asking when an individual would prefer to collect a sum of money. Do and Shin (2017) derived time preference with the help of "the survey question on a hypothetical choice between immediate enjoyment today and likely higher scores on an exam tomorrow" (Do and Shin, 2017, p. 42). While investigating time preference and smoking decision, Khwaja et al. (2007) used two types of questions. They analyzed the choice of payment now versus a year from now and healthy days

tradeoff, which was "the number of extra healthy days in the future equal to 20 extra healthy days this year" (Khwaja et al., 2007, p. 936).

There is ample empirical evidence that individual time preferences are associated with the decision to smoke. Ida and Goto (2009) concluded in their research for Japan that current smokers are more impatient than non-smokers. Scharff and Viscusi (2011) argued that smokers have significantly higher rates of time preference than their non-smoking counterparts. Do and Shin (2017, p. 42) revealed that "the higher time discounting results in an increased risk of engaging in smoking and drinking, and conversely, adopting such behaviors leads to a higher discount rate." Bradford et al. (2017) examined how survey-elicited time preferences are related to smoking and other types of consumer behavior. The authors identified that "impatient and present-biased individuals are more likely than others to smoke" (Bradford et al., 2017, p. 138). Although empirical studies differ in the way they measure time preference, the general conclusion about the relationship between the individual discount rate and smoking is similar.

Kosteas (2015) investigated the relationship between time preference and participating in physical activity on a large cross-sectional sample of US adults. He considered savings behavior as a proxy for time preference and identified that "time preference is a significant predictor of the amount of time spent participating in both vigorous and light-to-moderate physical activity for women and vigorous physical activity for men" (Kosteas, 2015, p. 361). Hunter et al. (2018) supported the conclusion that individual discount rate has a significant impact on physical activity level. Important evidence lies in the fact that "individuals with a higher rate of time preference — current smokers — spend less time on exercising, compared with those who never smoked" (Song, 2011, p. 350). This evidence strengthens the assumption that there is interrelation between smoking, physical activity, and individual time preferences. In the next section, we try to model this relationship on the data of a special survey representing the adult population of Russians.

3. Method of estimating the relationship between individual time preferences and smoking and physical activity

The database for investigating the research question consists of a special survey about following healthy lifestyle conducted by Levada analytical center in 2017. The survey is based on a multi-stage stratified probability sample. The sample includes 4006 respondents aged 16 and over. Due to missing answers, the sample for model estimation consists of 3,130 observations. However, descriptive statistics show that there is no significant change in the mean values of the variables. The initial sample represents the adult population of Russia and covers variables such as educational level, region of residence, and the size of the place of residence.

The multivariate probit model was chosen to test relationships of interest. Indicators of smoking (*Smoke*), engaging in physical exercises (*Sport*), and higher individual discount rate (*IDR*) are dependent variables. *IDR* is also a regressor in the equations for smoking and doing physical exercises. This system is estimated with the maximum likelihood method. The estimation procedure involves estimating the coefficients of the equations, as well as estimating the correlation coefficients of random errors of the equations. The significance of the correlation coefficients shows the relationship between the equations of the system.

$$\begin{cases} Sport_i = x_i'\alpha + \gamma IDR_i + \varepsilon_{1i} \\ Smoke_i = x_i'\beta + \mu IDR_i + \varepsilon_{2i} \\ IDR_i = x_i'\delta + \varepsilon_{3i}. \end{cases} \quad (1)$$

We consider a recursive system of binary choice equations since the same unobservable factors might influence an individual decision to smoke and to do physical exercises as well as the higher individual discount rate. Filippini et al. (2018) argued that the recursive system is preferred for estimation over the system of seemingly unrelated probit equations in an instance where data might arise from a recursive multivariate probit process.

For determining the individual discount rates, two questions were asked:

1. Imagine that you can collect a money prize of 10,000 rubles a year from now. However, it is also possible to collect the prize in 6 months in the amount of 9,000 rubles. When do you prefer to collect the prize, in 6 months or in a year?

2. If it were possible to collect the prize immediately, but the amount constitutes fewer than 9,000 rubles, what is the minimum amount you agree to?

The question posed in terms of a deferred prize eliminates the problem of overstating the individual discount rate due to the risk of the experimenter's default from the respondent's point of view. In our sample, approximately 44% of respondents have an individual discount rate higher than 15%. We take the value of 15% as the threshold value for the higher individual discount rate. A possible benchmark for comparison is the alternative return on investment available to the respondent. For example, the interest rate on deposits. However, in 2017 it was less than 10%. The chosen threshold value for the higher individual discount rate is higher than the alternative rate of return on private investments. We consider this indicator as that one that allows us to separate impatient respondents.

Explanatory variables are the socioeconomic characteristics of respondents. These are indicators of income category, place of residence, marital status, household size, disability, chronic diseases, and others. A description of the variables and descriptive statistics is given in Appendix Tables A1 and A2.

When estimating a recursive system of binary equations, the condition for the identification of model parameters is the presence of instruments, i.e., unique variables, in the equation for the endogenous variable. These are so-called exclusion restrictions that might be either binary or continuous. Discussion of this problem can be found in the article of Han and Vytlacil (2017). In the model, such variables are the presence of a paid job and the absence of a regular additional paid job or accidental paid job. However, it has not yet been proven that the existence of exclusion restrictions is a necessary condition for the identifiability of model parameters. To test the significance of exclusion restrictions, the model with common regressors for all equations is estimated (see Appendix Table A3 for estimation results). The results show that estimates of the model parameters practically do not change. The robustness of the results might be explained by insignificant correlation of random errors in the equations for smoking and the higher individual discount rate as well as in the equations for doing physical exercises and the higher individual discount rate. Correlation coefficients and the results of LR-test are provided in Appendix Table A3.

4. Estimation results and discussion

A correlation coefficient of random errors in equations for smoking and doing physical exercise is significant and negative (–0.17). This fact suggests that there are unobservable factors that simultaneously affect both decisions. They encourage smoking and giving up physical exercise and vice versa. Most likely, this is the individual's propensity for a healthy or unhealthy lifestyle, which determines individual behavior.

Estimation results show that the supply of sports infrastructure at the place of residence or place of work of the respondent is related to the decision to engage in physical activity. Students and pensioners do physical exercises more often than other population categories. Perhaps because they have more time and opportunities for such activities. Sports facilities are often provided by educational institutions where young people study. Besides, active aging programs are being developed. Seniors have more time to take care of their health than the working-age population. Moreover, the quadratic relationship between the decision to do physical exercises and age is confirmed. The least engagement in physical activity occurs in middle age. It is necessary to ensure the availability of sports infrastructure near the place of work and near the home since the working-age population does not have time to find and reach a place where they could do physical exercises. Also, the likelihood of engaging in physical exercises is higher for urban residents compared to those living in rural areas. Most likely, this is due to a different lifestyle.

The maximum likelihood of deciding to smoke is reached at the age of 35. Those with higher education are less likely to smoke. This may be due to greater awareness of the health risks arising from smoking. Significantly, respondents from higher income groups are less likely to smoke compared to those who can hardly make ends meet. Residents of Moscow and St. Petersburg are more likely to smoke than those living outside Moscow and St. Petersburg. Apparently, the lifestyle in the capital is associated with a lot of stress, which translates into unhealthy habits.

Estimating the system of binary equations confirms the negative relationship of the higher individual discount rate with the decision to engage in physical exercises. The relationship between a higher individual discount rate and smoking is positive. Impatient individuals focused on short-term goals are not ready to postpone utility from consumption and give up unhealthy behavior.

To analyze the effect of a higher individual discount rate on smoking and doing physical exercises, average marginal effects (AME) should be estimated. They are determined as follows:

$$AME_{sport} = \frac{1}{n}\sum_{i=1}^{n}(P(Sport_i = 1|ID_i = 1) - P(Sport_i = 1|ID_i = 0)), \quad (2)$$

$$AME_{smoke} = \frac{1}{n}\sum_{i=1}^{n}(P(Smoke_i = 1|ID_i = 1) - P(Smoke_i = 1|ID_i = 0)). \quad (3)$$

Table 1 shows that a higher individual discount rate increases the likelihood of smoking and decreases the likelihood of exercising for health purposes. The hypothesis that the behavioral aspect is important in modeling individual health choices is confirmed. It is worth noting that the probability of engaging in physical exercises is significantly reduced for an individual with a higher individual discount

Table 1
Average marginal effect of individual discount rate on the decision to smoke and undertake physical exercise.

Variable	*N*	Mean	St. dev.	Min	Max
$P(Sport_i = 1 \mid ID_i = 1)$	3,130	0.229	0.118	0.041	0.743
$P(Sport_i = 1 \mid ID_i = 0)$	3,130	0.348	0.132	0.114	0.825
AME_{sport}	3,130	–0.119	0.047	0.047	0.224
$P(Smoke_i = 1 \mid ID_i = 1)$	3,130	0.316	0.215	0.002	0.854
$P(Smoke_i = 1 \mid ID_i = 0)$	3,130	0.230	0.185	0.001	0.761
AME_{smoke}	3,130	0.086	0.044	0.001	0.166

Source: Authors' calculations.

Table 2
The average marginal effect of individual discount rate on the decision to smoke and undertake physical exercise by gender and educational level of a respondent.

Variable	AME_{sport}		AME_{smoke}	
	0	1	0	1
Gender	–0.12	–0.13	0.07	0.11
Higher education	–0.12	–0.15	0.09	0.07

Source: Authors' calculations.

rate in comparison with an individual with a low rate. The reduction is from 0.35 to 0.23. At the same time, the probability of smoking increases significantly for an individual with a higher individual discount rate, i.e., from 0.23 to 0.32.

Table 2 shows whether the size of the average marginal effect of the individual rate on the decision to smoke and to exercise varies depending on the gender and educational level of the respondent. In the table, 1 means the presence of the feature, and 0 means the absence of the feature.

The average marginal effect of individual discount rate on physical exercise is higher by absolute value for respondents with higher education, and it practically does not change depending on the respondent's gender. Regarding the decision to smoke, the average marginal effect is higher for men and respondents without higher education. Respondents with higher education are more likely to do physical exercise and less likely to smoke. For respondents with a higher individual discount rate, the probability of doing physical exercises decreases more than for respondents without higher education, but the probability of smoking decreases less than for respondents without higher education.

The expected result is that women are less likely to smoke than men. For women with a higher individual discount rate, the probability of exercising decreases almost as much as for men, and the probability of smoking increases less than for men. Impatient male respondents are more prone to unhealthy behavior than impatient female respondents.

5. Conclusions

This study confirms the existence of the relationship between the individual decision to smoke and undertake physical exercise for health purposes on the Russian data. There are unobservable factors that drive people to quit smoking and do physical exercises, or vice versa. These can be the views and beliefs

of an individual, formed, among other things, under the influence of promoting a healthy lifestyle. At the same time, the individual rate of time preferences is an important driver of individual health behavior. Impatient individuals pursuing short-run goals are not able to postpone the current utility from smoking and to make efforts to exercise for health purposes. For target groups with the higher individual discount rate, long-term incentives in the form of a likely health improvement in the future will not have the desired effect. Similarly, social advertising, explaining how health may worsen in the future because of smoking or physical inactivity, is unlikely to be successful. An effective intervention design should highlight the short-term benefits of avoiding an unhealthy lifestyle.

Audrain-McGovern and Rodriguez argued that the relationship between the type of physical activity that an adolescent engages in and the uptake of cigarette smoking among adolescents should be taken into consideration while promoting physical activity to prevent smoking uptake (Audrain-McGovern and Rodriguez, 2015, p. 177). Our article extends this conclusion over the adult population of Russia. When developing government anti-tobacco policies, it is necessary to rely not only on the relationship between smoking and undertaking physical exercise, but also to take into consideration the behavioral factor. Individual time preferences play an important role in stimulating the rejection of bad habits, and it is important to be aware of the time preferences of target population groups.

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Appendix A

Table A1
Description of variables included in the analysis.

Variable	Description
sport	1, if the respondent does physical exercises in health purposes, 0, otherwise
smoke	1, if the respondent smokes 0, otherwise
infrastructure	1, if there are sports facilities at the place of residence, work and study of the respondent 0, otherwise
IDR	1, if respondent's individual discount rate is higher than 15% 0, otherwise
disable	1, if the respondent has a disability 0, otherwise
chronic	1, if the respondent has chronic diseases 0, otherwise
age	Age of the respondent, number of years
gender	1, if the respondent is a male 0, if the respondent is a female
marital status	1, if the respondent is single 0, otherwise
household size	Number of household members
income1	1, if the respondent classifies himself as someone with enough money for food, but buying clothes is a problem 0, otherwise

(continued on next page)

Table A1 *(continued)*

Variable	Description
income2	1, if the respondent classifies himself as someone with enough money for food and clothes, but buying durables is a problem 0, otherwise
income3	1, if the respondent classifies himself as someone with enough money for durables, but buying a car is a problem 0, otherwise
income4	1, if the respondent classifies himself as someone with enough money for a car, but we cannot say that he is not constrained in funds 0, otherwise
income5	1, if the respondent classifies himself as someone who can buy really expensive items, and he is not constrained in funds 0, otherwise
student	1, if the respondent is a student at school, technical school, university, 0, otherwise
pensioner	1, if the respondent is a pensioner 0, otherwise
job	1, if the respondent has a a paid job 0, otherwise
add_job	1, if the respondent did not have a a regular additional paid job or accidental paid job in the last month 0, otherwise
educ_higher	1, if the respondent has higher education 0, otherwise
city	1, if the respondent lives in the city 0, otherwise
Moscow or St. Petersburg	1, if the respondent lives in Moscow or St. Petersburg 0, otherwise

Table A2
Descriptive statistics of the sample.

Variables	*N*	Mean	St. dev.	Minimum	Maximum
sport	3,130	0.307	0.461	0	1
smoke	3,130	0.255	0.436	0	1
infrastructure	3,130	0.603	0.489	0	1
IDR	3,130	0.452	0.497	0	1
disable	3,130	0.093	0.29	0	1
chronic	3,130	0.430	0.495	0	1
age	3,130	46.89	17.483	16	97
gender	3,130	0.347	0.476	0	1
marital status	3,130	0.520	0.499	0	1
household size	3,130	2.385	1.215	1	10
income1	3,130	0.220	0.414	0	1
income2	3,130	0.494	0.500	0	1
income3	3,130	0.203	0.402	0	1
income4	3,130	0.020	0.140	0	1
income5	3,130	0.001	0.039	0	1
student	3,130	0.046	0.209	0	1
pensioner	3,130	0.307	0.461	0	1
job	3,130	0.554	0.497	0	1
add_job	3,130	0.917	0.274	0	1
educ_higher	3,130	0.319	0.466	0	1
city	3,130	0.590	0.491	0	1
Moscow or St. Petersburg	3,130	0.126	0.332	0	1

Table A3
Results of estimating coefficients in the system of binary equations.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	sport	smoke	IDR	sport	smoke	IDR
infrastructure	0.3350***			0.3380***		
	(0.0521)			(0.0521)		
city	0.1740***	0.0140	–0.1420***	0.1710***	0.0112	–0.1420***
	(0.0583)	(0.0628)	(0.0528)	(0.0582)	(0.0627)	(0.0528)
Moscow or	0.0535	0.188**	0.0292	0.0453	0.1810*	0.0294
St. Petersburg	(0.0874)	(0.0940)	(0.0813)	(0.0873)	(0.0937)	(0.0813)
gender	0.0606	1.047*0**	0.1360***	0.0727	1.0620***	0.1360***
	(0.0530)	(0.0568)	(0.0492)	(0.0524)	(0.0564)	(0.0492)
age	–0.0214**	0.0416***	–0.00468	–0.0198**	0.0439***	–0.00468
	(0.00922)	(0.0112)	(0.00859)	(0.00916)	(0.0111)	(0.00859)
age^2	0.000163*	–0.000599***	6.99e^{-5}	0.000145	–0.000623***	6.99e^{-5}
	(9.51e^{-5})	(0.000122)	(8.77e^{-5})	(9.48e^{-5})	(0.000122)	(8.77e^{-5})
marital status	–0.0540	–0.0187	–0.0281	–0.0560	–0.0205	–0.0280
	(0.0587)	(0.0647)	(0.0552)	(0.0587)	(0.0646)	(0.0552)
disable	–0.0262	–0.0733	0.1200	–0.0278	–0.0764	0.1200
	(0.0932)	(0.1110)	(0.0851)	(0.0932)	(0.111)	(0.0851)
household size	0.0371	–0.0253	0.0285	0.0331	–0.0298	0.0285
	(0.0247)	(0.0272)	(0.0234)	(0.0245)	(0.0270)	(0.0234)
income1	–0.1050	–0.2100*	0.0377	–0.0999	–0.1960	0.0369
	(0.1140)	(0.1210)	(0.1040)	(0.1140)	(0.1200)	(0.1040)
income2	–0.0628	–0.3190***	–0.0498	–0.0552	–0.2990***	–0.0505
	(0.1100)	(0.1160)	(0.1010)	(0.1090)	(0.1150)	(0.1010)
income3	0.0280	–0.4850***	–0.2180*	0.0431	–0.4560***	–0.2190*
	(0.1220)	(0.1310)	(0.1130)	(0.1210)	(0.1300)	(0.1130)
income4	0.1420	–0.5650**	–0.5420***	0.1640	–0.5240**	–0.5430***
	(0.2010)	(0.2210)	(0.1970)	(0.2010)	(0.2190)	(0.1970)
income5	0.3860	0.3200	–0.1170	0.3830	0.3330	–0.1190
	(0.5570)	(0.6040)	(0.5860)	(0.5580)	(0.6050)	(0.5840)
student	0.5560***	–0.8140***	–0.0539	0.5220***	–0.888*0**	–0.0522
	(0.1520)	(0.1910)	(0.1470)	(0.1370)	(0.1750)	(0.1470)
pensioner	0.2880**	–0.0594	–0.0812	0.2290**	–0.1670*	–0.0795
	(0.1240)	(0.1330)	(0.1130)	(0.0911)	(0.101)	(0.1130)
educ_higher	0.4280***	–0.4260***	0.0300	0.4340***	–0.4160***	0.0301
	(0.0537)	(0.0615)	(0.0516)	(0.0536)	(0.0612)	(0.0516)
chronic	–0.0636	0.0291	–0.0295	–0.0587	0.0346	–0.0295
	(0.0563)	(0.0612)	(0.0525)	(0.0563)	(0.0611)	(0.0525)
job	0.0578	0.1130	–0.1490*			–0.1470*
	(0.0906)	(0.0969)	(0.0839)			(0.0837)
add_job	–0.1990**	–0.1920**	–0.1570*			–0.1560*
	(0.0863)	(0.0918)	(0.0832)			(0.0838)
IDR	–0.2850**	0.2110*		–0.2650**	0.2180*	
	(0.1290)	(0.1270)		(0.1290)	(0.1260)	
constant	–0.2280	–1.0570***	0.2200	–0.4020	–1.1980***	0.2180
	(0.2820)	(0.3130)	(0.2550)	(0.2640)	(0.2940)	(0.2550)
$corr(\varepsilon_1, \varepsilon_2)$	–0.172***					
$corr(\varepsilon_1, \varepsilon_3)$	0.107					
$corr(\varepsilon_2, \varepsilon_3)$	–0.105					
N	3,130	3,130	3,130	3,130	3,130	3,130

Note: Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Likelihood ratio test of $H_0: corr(\varepsilon_1, \varepsilon_2) = corr(\varepsilon_1, \varepsilon_3) = corr(\varepsilon_2, \varepsilon_3) = 0$, $\chi^2(3) = 28.32$, Prob > $\chi^2 = 0.0000$.
Likelihood ratio test of $H_0: corr(\varepsilon_1, \varepsilon_3) = corr(\varepsilon_2, \varepsilon_3) = 0$, $\chi^2(2) = 3.93$, Prob > $\chi^2 = 0.1401$.