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Recent Dynamics of Returns to Education in Transition Countries

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Suspicious Blood and Performance in the 2010 Tour de France

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Abstract

In this note, we analyze whether the International Cycling Union's 'index of suspicion', which reflects the extent to which a rider is suspected of using doping, correlates with performance during the 2010 Tour de France and the one year period leading up to the 2010 Tour de France. Though our point estimates suggest a medium sized performance improving effect of being suspected of doping, the index of suspicion can only explain a very small part of the variation in performance. We also present some limited evidence that this could be due to the fact that doping has little effect on the outcome of the Tour de France.

Keywords : Doping, Cycling, Tour de France

JEL codes : L83 (Industry Studies - Sports)

Introduction

The use of past blood tests, the so-called biological passports, to detect suspicious changes in blood values is becoming a more and more widespread weapon in the fight again doping in sports. For example, the 2012 London Olympics will be the first Olympics where such tests will be used for certain competitions (see McGrath 2011[1]). Despite this increasing popularity, the usefulness of such tests to detect doping is still controversial, from an ethical and legal point of view but also from the point of view of its capacity to detect actual doping.

One of the reasons that it is hard to check the usefulness of these tests is that it is very hard to get the biological passport data for a large sample of athletes. In this paper, we use, what is as far as we know, the first such large dataset with publicly available information on the biological passports of almost 200 top level cyclists.

On May 13, the French Sport Newspaper *L'Equipe* published an 'Index of Suspicion', a list containing the names of about 200 professional cyclists and the degree to which their blood values were 'suspicious', that is showed signs of the possible use of doping, at the eve of the 2010 Tour de France, arguable the most important international cycling race. This list, made by a doping (detection) specialist, on demand of the International Cycling Union, is based on an evaluation of blood tests of the cyclists, tests submitted between 2008 and the eve of the Tour 2010. On the basis of this evaluation, the riders were categorized into eleven categories, ranging from 0 (not suspect) to 10 (very suspect).

In this note, we first analyze whether this 'index of suspicion' can help to predict the performance during the 2010 Tour de France. If suspicious blood values are a good indicator of the use of performance enhancing drugs, and if, in addition, performance enhancing drugs actually do enhance performance significantly, there should be a positive correlation between the 'index of suspicion' and performance. The absence of such correlation would suggest either that doping is not effective or alternatively that the 'index of suspicion' is not a good indicator of doping.

We then try to distinguish between these two explanations by running an instrumental variables regression, where we instrument the 'index of suspicion' by other doping-related variables such

[1] http://www.bbc.co.uk/news/science-environment-14307262

as belonging to a team where managers have been suspected of doping, or such as having been suspected of doping based on other indicators than the biological passport. The reason to use instruments is the idea that if the ‘index of suspicion’ is an imperfect indicator of the use of effective performance enhancing drugs, then the coefficient of the ‘index of suspicion’ in a performance regression will be biased towards zero due to the so-called ‘errors in variables” problem. To get an unbiased coefficient of the effectiveness of doping, we can instrument one (imperfect) indicator of doping by other (equally imperfect) indicators of doping (see Wooldridge, pp. 526-527).

This paper is not the first paper that investigates doping in sports (see for example Berentsen, 2001, Haugen, 2004 or Eber, 2008 for a theoretical analysis of doping behavior or Dilger et al. (2007) for a selective survey of doping cases in cycling and other sports) or the determinants of success in cycling (for example, Torgler, 2007). This is the first paper however that studies, using a large sample of athletes, the effectiveness of biological passports as a weapon in the fight against doping[2].

Analysis

a. Does the ‘index of suspicion’ predict performance

Our main variable of interest is the categorical variable which reflects the score on the ‘Index of Suspicion’. Categorical variables are typically included as explanatory variables in regression analysis by creating a dummy variable for each specific category. However, given that there are a lot of categories (11 categories, ranging is from 0 to 10) and some of these categories have only few observations in them, one might want to consider this index as almost continuous and hence, include the index as just one variable. Below we also present a specification where, instead of the index, we included 2 dummies each grouping a number of categories – an omitted first dummy for category 0 and 1 reflecting little or no suspicion of doping, a second dummy for categories 2,3, and 4 reflecting a medium level of suspicion, the third dummy being for categories 5 and up, reflecting high levels of suspicion. In this way, we allow for a non-linear effect of the doping categories on performance. The first two dummies represent each about 40 % of the riders in the

[2] Zorzoli (2011) presents a graph showing that after the introduction of the passports the percentage of suspicious blood samples has decreased substantially.

sample, while the last category represents about 20 percent. A third specification compares the performance of those with little or no suspicion of doping (categories 0 and 1) to the other cyclists.

Table 1 gives the results of regressions where we run a specific dimension of performance on a constant and our doping variable(s). As performance measures we use the final standing for the yellow jersey (the ranking based on time needed to finish the race, both the rank and the time behind the winner are used as dependent variable), the final standing for the green jersey (rewards sprinting success, both rank and number of points) and the final standing for the climbers jersey (rewards performance in climbing, both rank and number of points).

[Insert table 1 here]

We do not find an effect of our 'suspicion of doping' variables on performance in terms of sprinting or climbing but we do find a significant effect on the time needed to finish the race: a rider in the highest category of doping (category 10) needed about 25 to 40 minutes less to finish the 2010 Tour de France and would finish 16 to 24 places higher than a rider in the lowest category of doping (category 0). These differences are statistically significant (or close to being significantly different from 0, depending on the specification, but the explanatory power, as reflected in the adjusted R^2, is very low at 1 to 2 percent. The 'best' specification in terms of significance and adjusted R^2 is the one where we use the dummy that compares those with little or no suspicion of doping (categories 0 and 1) to the other cyclists.

In addition to the regressions of table 1, we also checked whether being more suspect increases the chance to finish the Tour de France and whether the results of specific stages (there were 21 stages in the tour de France 2010) are correlated with the 'index of suspicion'. While we did not find an effect on the chance to finish the 2010 Tour de France, we found (see table 2) a strong negative correlation between the level of significance of the doping variable(s) and the level of difficulty of the stage as measured by the sum of the kilometers where riders have to climb, weighted by the steepness of the various climbs (the average slope coefficient times length in kilometers of each hill or mountain[3]).

[Insert table 2 here]

For example table 2 shows that stage 17 which has the second highest degree of difficulty shows that riders in the lowest category needed about 7 minutes more (a rider in category 10 needs 10*-0.75 minutes less, significant at 10 percent) than riders who were in the highest category of suspicion The correlation between the t statistic (which is negative) of the doping variables and the level of difficulty of the race is about -0.5, hence the higher the difficulty the more negative the t statistic is[4].

Table 3 runs the same regressions as in Table 1 but adds a number of reasonably exogenous variables that could influence performance[5].

[Insert table 3 here]

Following Torgler (2007), we include the body mass index (weight divided by the square of length in meters) and a dummy for French riders, the latter reflecting the higher incentives the home riders have. We also include the age at the start of the 2010 Tour.

When adding these additional variables to our regression (Table 3), the results are largely unaffected, with doping related categories only being significant for the final standing of the 2010 Tour but not for competition for the green jersey or the climbers' jersey[6]. A higher BMI is bad for a rider's final standing (and for his climbing performance, but good for his sprinting performance) and older riders have a better rank at the end (and climb better). Similarly, French riders are higher ranked in the final standing and are better at climbing. Comparing the size of

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[3] Stage 9 is the hardest of all stages with a series of 5 famous mountains as follows: Côte de Châtillon - 2.1 km climb to 3.9 %, Col de la Colombière - 16.5 km climb to 6.7 %, Col des Aravis - 7.6 km climb to 5.9 %, Col des Saisies - 14.4 km climb to 5.1 %, Col de la Madeleine - 25.5 km climb to 6.2 %. The average difficulty score for this stage is 2.1 x 3.9 + 16.5 x 6.7 + 7.6 x 5.9 + 14.4 x 5.1 + 25.5 x 6.2 = 395.12.

[4] Given the different nature of the stages, the time between riders varies quite a lot from one race to another and hence coefficients are not really comparable across races. Hence, we focus on t statistics. Note also that some easy races ended in sprints of (almost) the whole group of riders and hence have little variation in the dependent variable. Table 2 only shows results for the regression with the index as explanatory variable. Using dummies for specific groups of categories gives similar results.

[5] They are only 'reasonably' exogenous as one could argue that doping could influence weight and the length of a riders' career, the latter being correlated highly with the age of the rider.

[6] Similar tables for the green jersey and the climbers' jersey are available upon demand from the authors.

the effects, one can see, for example, that being somewhat or highly suspect will about offset the effect on the general standing of the Tour de France of having a BMI that is one point higher or is about equivalent to the effect of being 8 to 10 years older.

In addition to these reasonably exogenous additional variables, we also have measures of past performance in our dataset (the best place in the last 3 tours, whether the person participated in the Tour before). Unlike Torgler (2007), in our case, it might be preferable not to include such past performance rankings, however, as these could be influenced by doping themselves. If we do include these variables, our doping variables become insignificant, including in the final standing regression.

b. The effect of doping on performance

So far we showed that the index of suspicion does 'affect' performance somewhat, but we also showed that variations in doping can only explain a small part of the variation in performance.

This could be interpreted as meaning that the index of suspicion is not a very good indicator of doping. However, such interpretation would rely on the assumption that performance enhancing drugs is indeed effective in enhancing performance. Of course, this underlying assumption might be wrong, and maybe, performance enhancing drugs does not enhance performance much[7].

To be able to find the performance enhancing effects of doping (in contrast to 'effect' of the 'index of suspicion'), we treat the 'index of suspicion' as variable that measures doping use with error. To find the effect of doping we thus need to solve an error-in-variable problem, which can be done by instrumenting our 'index of suspicion' by other (possibly imperfect) measures of the use of doping.

There are several possible instruments. First from the "cyclisme-dopage[8]" website, a website that collects information about doping in cycling we create a dummy that indicates whether a 2010 Tour de France participant has ever been caught using doping[9]. Second, we use the same source

[7] An alternative but not testable hypothesis would be that riders are all equally doped which also would lead to the conclusion that doping has no effect on the race outcome.
[8] http://www.cyclisme-dopage.com/chiffres/tdf2010.htm
[9] It includes the cyclists that have had a positive doping control, have admitted they used doping or have been sanctioned (by Court, Federation or Team) in the framework of a doping affair.

to create two team-level variables: one variable that indicates the percentage of team managers[10] of a given team who were ever been caught using doping (as a former rider) and another variable that indicates the percentage of team mates that have been caught using doping. The idea behind these two variables is that an individual is more likely to be using doping in an environment where doping is more common (either because there is a less negative attitude to doping use or because there is an easier access to doping products). Note that recently the UCI introduced a new rule that bans passed doping convicts of ever managing a team[11].

Table 4 gives the first stage result of our instrumental variable regressions. Table 5 gives the second stage results[12].

From table 4, one can see that our instruments are only weakly correlated with our doping indicator which means we have to interpret our IV regression results with care. A rider's own doping past is correlated with his suspicion index score, but neither is the doping past of the managers or of other team members. The second stage regression result shows a sizeable point estimate of the effect of doping, but also that this point estimate is insignificantly different from zero. The latter suggests that the low predictive power of the index of suspicion could be related to the fact that doping enhancing techniques are not very effective. Of course, the weakness of our instruments makes it hard to make strong conclusions about this. Still, the latter is consistent with Enserink (2008) who wrote: "By the tough standards of modern medicine, there's little hard evidence for the efficacy of dozens of compounds on the list of the World Anti-Doping Agency (WADA). They are rarely tested in placebo-controlled trials; for most, the evidence is what medical researchers would call "anecdotal."

Conclusion

In this paper, we investigate to what extent the 'Index of Suspicion' of doping, which was used by the International Cycling Union to monitor participants of the 2010 Tour de France, correlates with the performance of these participants. Our point estimates show a medium sized

[10] We get info about team managers of the 2010 Tour de France from the http://www.cyclisme-dopage.com website.
[11] http://velonews.competitor.com/2011/06/news/uci-to-ban-doping-violators-from-team-staff-positions_179000
[12] We only present the IV results for the Yellow jersey competition. We find no effects for other competitions. We use both 2SLS IV and CMP procedure (Roodman, 2007), with both techniques leading to the same conclusion. Using dummies rather than the full index of suspicion leads to similar conclusions.

performance improving effect of not having a low suspicion index on the overall standing at the end of the Tour de France and on the results of some difficult stages, but not on the competition for the green or the climbers' jersey. At the same time, even the significant effects we find often have large standard errors and in all cases, the suspicion index can only explain a very small part of the variation in performance, this despite the fact that there is a substantial variation in the degree to which riders are suspected of using doping.

Using an instrumental variable approach, we then try to establish whether this lack of predictive power is due to the low effectiveness of performance enhancing drug or because the index of suspicion is not a good indicator of the use of performance enhancing drugs. Using instruments based on (alleged) past doping of the rider, his team mates and managers, we find little evidence that doping actually enhances performance, but the weakness of our instruments means we have to interpret this finding with care.

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Table 1 – Regressing different measures of performance on the Index of Suspicion

	Yellow					
	Time	Time	Time	Rank	Rank	Rank
Index of Suspicion	-3.94*			-2.388		
	(-1.74)			(-1.60)		
Index of Suspicion [2-4]		-26.72**			-17.345**	
		(-2.09)			(-2.05)	
Index of Suspicion [5-10]		-22.78			-14.188	
		(-1.49)			(-1.40)	
Index of Suspicion [2-10]			-25.310**			-16.213**
			(-2.20)			(-2.11)
_cons	154***	158***	158***	92***	96***	96***
	(18.9)	(17.7)	(17.8)	(17)	(15.9)	(15.9)
Adj R^2	0.012	0.016	0.021	0.009	0.015	0.02
N	170	170	170	170	170	170

Omitted category is the no suspicion category, which consists of categories 0 and 1. We use robust standard errors.

	Green Jersey						Climbers Jersey					
	Time	Time	Time	Rank	Rank	Rank	Time	Time	Time	Rank	Rank	Rank
Index of Suspicion	0.515			-0.044			-0.182			0.497		
	(0.42)			(-0.03)			(-0.22)			(0.56)		
Index of Suspicion [2-4]		2.851			3.703			-3.578			3.846	
		(0.39)			(0.45)			(-0.74)			(0.76)	
Index of Suspicion [5-10]		7.785			-0.284			-3.96			5.901	
		(0.83)			(-0.03)			(-0.66)			(1.01)	
Index of Suspicion [2-10]			4.62			2.274			-3.715			4.583
			(0.71)			(0.30)			(-0.83)			(1.00)
_cons	29***	28***	28***	85***	84***	84***	17***	19***	19***	64***	63***	63***
	(6.4)	(6.3)	(6.3)	(15.8)	(14.8)	(14.9)	(5.6)	(5.2)	(5.2)	(19.4)	(16.8)	(16.8)
Adj R^2	-0.005	-0.008	-0.003	-0.006	-0.01	-0.005	-0.006	-0.008	-0.002	-0.004	-0.005	0

N	170	170	170	170	170	170	170	170	170	170	170	170

Omitted category is the no suspicion category, which consists of categories 0 and 1. We use robust standard errors.

Table 2: Regressing the results of different stages (expressed as time behind the winner) on the Index of Suspicion

	Race1	Race2	Race3	Race4	Race5	Race6	Race7	Race8	Race9	Race10	Race11
Index of Suspicion	-0.021	-0.008	-0.186	-0.175	-0.004	0	-0.007	-0.568***	-0.254	-0.669*	0.1
	(-1.35)	(-0.36)	(-1.43)	(-1.24)	(-0.22)	(0.01)	(-0.12)	(-2.62)	(-0.81)	(-1.90)	(1.55)
_cons	1.123***	0.125*	7.433***	6.357***	0.251***	0.592***	0.556**	14.695***	19.393***	23.464***	14.122***
	(16.47)	(1.70)	(14.41)	(11.60)	(3.25)	(4.23)	(2.43)	(16.74)	(15.89)	(18.85)	(41.98)
Adj R^2.	0.005	-0.004	0.004	0.003	-0.005	-0.005	-0.005	0.024	-0.002	0.014	0.004
N	197	195	193	189	189	188	188	186	186	181	181
Difficulty	0	0	113.64	4.76	6.24	14.7	43.94	259.57	225.58	395.12	125.65

	Race12	Race13	Race14	Race15	Race16	Race17	Race18	Race19	Race20	Race21
Index of Suspicion	-0.023	-0.326**	0.071	-0.369	-0.164	-0.752*	-0.346	-0.003	-0.094	0.001
	(-0.24)	(-2.53)	(0.72)	(-0.90)	(-0.53)	(-1.91)	(-1.05)	(-0.18)	(-1.34)	(0.24)
_cons	2.125***	6.615***	3.068***	22.549***	19.276***	24.712***	20.461***	0.276***	7.754***	0.025**
	(5.87)	(11.17)	(8.62)	(14.97)	(17.42)	(16.57)	(17.32)	(3.91)	(28.60)	(2.04)
Adj R^2	-0.005	0.025	-0.003	-0.001	-0.004	0.014	0.001	-0.006	0.005	-0.006
N	178	176	175	175	174	172	171	170	170	170
Race Difficulty	29.5	165.92	80.1	186.41	198.55	406.36	316.2	0	0	0

We use robust standard errors.

Table 3: Adding additional controls

	Yellow					
	Time	Time	Time	Rank	Rank	Rank
Index of Suspicion	-3.276			-2.102		
	(-1.44)			(-1.39)		
Index of Suspicion [2-4]		-24.441*			-16.405**	
		(-1.97)			(-2.02)	
Index of Suspicion [5-10]		-19.558			-13.038	
		(-1.26)			(-1.27)	
Index of Suspicion [2-10]			-22.805**			-15.276**
			(-1.99)			(-2.02)
Body Mass Index	20.121***	20.046***	19.997***	13.324***	13.250***	13.216***
	(4.66)	(4.64)	(4.65)	(4.66)	(4.65)	(4.66)
Age	-2.891*	-2.907*	-2.883*	-1.575	-1.58	-1.563
	(-1.93)	(-1.93)	(-1.92)	(-1.59)	(-1.59)	(-1.58)
French	-16.636	-17.235	-17.677	-13.268	-13.822	-14.127*
	(-1.30)	(-1.32)	(-1.37)	(-1.56)	(-1.60)	(-1.67)
_cons	-184.524*	-177.338*	-176.856*	-140.861**	-135.417*	-135.085*
	(-1.78)	(-1.71)	(-1.71)	(-2.05)	(-1.96)	(-1.96)
Adj. R^2	0.099	0.104	0.109	0.097	0.103	0.108
N	170	170	170	170	170	170

Omitted category is the no suspicion category, which consists of categories 0 and 1. We use robust standard errors.

Table 4: First stage IV regression – the determinants of the Index of Suspicion

	Index
Body Mass Index	-0.23
	(-1.47)
Age	0.04
	(0.73)
French	-1.73***
	(-4.02)
Percentage of Teammates with Doping Past	-0.72
	(-0.47)
Percentage of Managers with Doping Past	-0.07
	(-0.06)
Doping Past Dummy	1.17*
	(1.90)
_cons	6.75***
	(2.14)
Adj. R^2	0.12
N	170

Table 5: IV Results

	Yellow Jersey -Time
Index of Suspicion	-20.729
	(-1.06)
Body Mass Index	15.413**
	-2.26
Age	-1.764

	(-0.86)
French	-47.04
	(-1.29)
_cons	-64.159
	(-0.37)
Adj. R^2	
N	170