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The process of deforestation in weak democracies and the role of Intelligence

Anastassia Obydenkova [a,b,*], Zafar Nazarov [c], Raufhon Salahodjaev [d,e,f]

[a] Davis Center for Russian and Eurasian Studies, Harvard University, United States
[b] Center for Institutional Studies at the National Research University Higher School of Economics, Moscow, Russia
[c] Indiana University – Purdue University Fort Wayne, 2101 E Coliseum Blvd, Fort Wayne, IN 46805, United States
[d] Department of Economics, University of South Florida, 4202 E Fowler Ave, Tampa, FL 33620, United States
[e] Global Intelligence for Development Research and Analytics (GIDRA), Colibri Law Firm, 32 Shevchenko Str. 100060, Tashkent, Uzbekistan
[f] Department of Economics, Westminster International University in Tashkent, 12 Istiqbol St., Tashkent 100047, Uzbekistan

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ABSTRACT

This article examines the interconnection between national intelligence, political institutions, and the mismanagement of public resources (deforestations). The paper examines the reasons for deforestation and investigates the factors accountable for it. The analysis builds on authors-compiled cross-national dataset on 185 countries over the time period of twenty years, from 1990 to 2010. We find that, first, nation's intelligence reduces significantly the level of deforestation in a state. Moreover, the nations' IQ seems to play an offsetting role in the natural resource conservation (forest management) in the countries with weak democratic institutions. The analysis also discovered the presence of the U-shaped relationship between democracy and deforestation. Intelligence sheds more light on this interconnection and explains the results. Our results are robust to various sample selection strategies and model specifications. The main implication from our study is that intelligence not only shapes formal rules and informal regulations such as social trust, norms and traditions but also it has the ability to reverse the paradoxical process known as "resource curse." The study contributes to better understanding of reasons of deforestation and shed light on the debated impact of political regime on forest management.

1. Introduction

Over the last decades, there has been an on-going empirical and theoretical debate about the link between political regimes and deforestation. However, the findings of these studies remain inconclusive and even controversial. On the one hand, some work argued that autocratic regimes are the driving force of deforestation in developing countries (e.g. Payne, 1995; Barrett and Graddy, 2000; Shandra, 2007; Morjaria, 2012). Non-democratic regimes suppress information circulation and do not address environmental concerns of society (Kotov and Nikitina, 1995). In contrast, freedom of mass media eliminates restrictions on circulation of information in general, and information on ecological issues in particular (Obydenkova, 2008). Freedom of information might increase the environmental concern of electorate and lead citizens to declare their environmental anxiety. Democratization causes society to be more aware and better coordinated, and thus urges political agents to be more reactive to appeal for environmental preservations (Farzin and Bond, 2006). For example, Didia (1997) shows that there is negative relationship between democracy and forest exploitation in a sample of 55 tropical countries for the period 1981–1985. The author suggests that freedom of press in democratic countries 'places the government under constant scrutiny. Consequently, the government cannot engage in destruction of tropical forests.' More recently, Shandra et al. (2012) has used a sample of 60 countries and analyzed the link between democratic institutions, measured by nongovernmental organizations (NGO), and deforestation for the period 1990–2005. The study concludes that increase in number of NGOs 'are associated with lower rates of deforestation'. Naturally, democracies follow environmental standards, as they are associated with stronger rule of law and market freedoms (Berge, 1994). Some studies argue that another reason for positive association between democracy and efficient environmental politics, is associated with decentralized political system that makes the functioning subnational authorities more efficient (e.g., Wendland et al., 2011).

However, on the other hand, there is set of studies that challenged these conclusions. The controversial impact of democracy

* Corresponding author at: Davis Center for Russian and Eurasian Studies, Harvard University, United States
E-mail addresses: nazarovz@ipfw.edu (Z. Nazarov), rauf.s@colibrilaw.com, rsalaho1@binghamton.edu (R. Salahodjaev).
URL: http://www.salahodjaev.com (R. Salahodjaev).

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and associated with it decentralization on environmental protection was analyzed in a few studies (Ostrom, 1990; Andersson and Ostrom, 2007). Ostrom, for example, challenged the idea of decentralization as a positive factor for environmental protection and questioned whether centralization is always a negative factor for efficiency in governance of commons. Further on, Andersson and Ostrom (2007) developed the theory of "local tyrannies", that is, the subnational regimes where local officials have an exclusive access to natural resources (e.g., woods). If this is a decentralized state with weak democratic institutions, than it is likely that local officials are not accountable to population neither to national central government (Obydenkova, 2006; Libman and Obydenkova, 2014).

In contrast to weak democracies, in consolidated autocracy, the subnational executives can be dismissed by the national executive and, thus, the mechanism of vertical accountability is in force (Obydenkova, 2011). On the other hand, in consolidated democracy, first, there are regular transparent elections take place and subnational politicians are concerned with the public opinion of their electorate and their performance (Obydenkova, 2007; 2012). This leads to development of accountability of the subnational executives to the local population (the horizontal accountability). Second, the respect for the rule of law is another characteristic of democratic society that allows for better environmental protection (the legal framework contains at least basic norms on environmental protection and is against the woods smuggling and illegal trafficking that can be one of the reasons of deforestation). Third, there is freedom of mass media in democratic society that may increase awareness of population about the quality of environmental protection of the government in charge. Thus, both vertical accountability (in *consolidated* autocracy) and horizontal accountability (in *consolidated* democracy) might provide better control over the use national resources in general and forests in particular, as compared to the societies with hybrid regimes (or regimes in transition).

Along these lines, the different claims became clear: some scholars argue that democratization (associated with decentralization) may lead to environmental deterioration (Midlarsky, 1998). To secure political victory, democratic governors are likely to satisfy competing elites (Gilens and Page, 2014) that do not pursue environmental sustainability (Dryzek, 1987). Martinez et al. (2002) uses a sample of less developed countries for the period 1980–1995 and investigates the factors associated with deforestation. They document that democracy increases rates of deforestation and this relationship could be operating through either (a) environmental malpractice or (b) a corporate source exploitation (Hardin, 1968).

Some recent studies present empirical evidence of a non-linear relationship between deforestation and democracy (e.g. Li and Reuveny, 2007; Buitenzorgy and Mol, 2011). These studies lend support that forest-cutting radically increases over the process of political regime transition: from non-democratic regimes to higher levels of democracy. Moreover, deforestation rates decline as the countries pass the democratic transition peak. Their argument, following Andersen (2002), is that immature pre-democratic countries cannot enforce environmental policies in the initial stage. However, as the country introduces more democratic institutions, marginal social benefit of environmental policies increases making them more effective. As a result, the government has more incentives to introduce more innovative environmental policies along with to enforce the existing policies.

So far, these studies did not consider the role of the average intelligence of society (or nation)in this discussion. Our paper conjectures that the driving forces behind the U-shaped relationship between democracy and deforestation go beyond the effect of political regimes. In particular, we hypothesize that the driving force of the inverted U-shaped democracy and deforestation link can be the average level of cognitive abilities (proxied by national IQ). Intelligence is the force that shapes formal rules and informal regulations such as social trust, norms and traditions (Kanyama, 2014; Salahodjaev and Azam, 2015). While there is evidence that weak democracies fail to supply institutional incentives to preserve forest cover, intelligence may serve as a substitute for institutional environment that creates order and reduces uncertainty (Morris, 1969). Intelligent societies prioritize inclusive economic growth to achieve the efficient, competitive markets (Lynn and Vanhanen, 2012a). They tend to acknowledge the concerns of prospective generations, because cognitive able agents have longer time horizons (Shamosh and Gray, 2008; Jones, 2011; Jones and Podemska-Mikluch, 2010).Turning to experimental evidence the results are mixed. For example, Jones (2008) documents that intelligence promotes cooperation among economic agents (Jones, 2008). On the other hand, Kanazawa and Fontaine (2013) show that more intelligent individuals are more likely to defect in one-shot Prisoner's Dilemma Games. We may then conjecture that intelligence reduces deforestation as cooperation is associated with fundamental principles such as law enforcement, and development of government accountability and growth-compatible institutions (Tabellini, 2008).

Moreover, intelligence may be linked to deforestation in the context of 'resource curse'. The modern literature pinpoints that natural resource abundance is largely associated with unfavorable economic outcomes (e.g. Sachs and Warner, 2001). Natural wealth reduces economic growth and welfare through policy failures. These failures supply stimulus for political agents to be engaged in exploitation of natural capital to appropriate rents. Indeed, rent seeking behavior is driven by corruption, illegal payments, absence of checks and balances in society, and even historical legacies (Rose-Ackerman, 1999; Obydenkova and Libman 2015b). In this context, intelligence may reduce resource exploitation, measured by deforestation rates, since high-IQ societies are associated with lower corruption (Potrafke, 2012), shadow economy (Salahodjaev, 2015a) and crime (Beaver and Wright, 2011). In addition, intelligence stimulates civic recognition, social trust and political awareness (Kemmelmeier, 2008; Deary et al., 2008; Rindermann et al., 2012) which in turn improves the effectiveness of political system and raises the marginal costs of rent seeking (Bjørnskov, 2003) and forest-cutting (Vainikainen et al., 2008). For example, higher intelligence leads to liberalism and prosociality (Gerber et al., 2010; Solon, 2014). Similarly, on the macro-level, Salahodjaev (2015b), using data from 93 nations, over the period 1970–2013, shows that intelligence may alleviate or diminish the negative effect of weak democratic institutions on development.

In addition management of forest resources is a hard measure of environmentalism a behavioral tendency that has been related to cognitive abilities. Indeed, Kanazawa's (2010a, 2012) Savanna-IQ Interaction Hypothesis (otherwise known as the "intelligence paradox") provides evidence that cognitive able individuals are more likely to possess and support evolutionarily novel preferences and values that our ancestors did not possess. As suggested by Obydenkova and Salahodjaev (2016 p. 83) "[c]oncerns for the environment are distinctly evolutionarily novel. Our ancestors during the Pleistocene Epoch were not concerned about the environment at all, because there was nothing to be concerned about. There were too few humans on earth to do any significant and lasting damage to the environment, and our ancestors could not afford to be concerned about such things because they were in a constant struggle for survival". Therefore the "intelligence paradox" conjectures that societies with higher average level of cognitive abilities are more likely to espouse an evolutionarily novel value of environmentalism, as they do with an equally evolutionarily novel value of representative democracy (Kanazawa, 2012, pp. 199–204; Vanhanen, 2003). For example, intelligence is positively associated with such evolutionary novel values as

liberalism, atheism and preferences for instrumental music (Kanazawa, 2010b; Kanazawa and Perina, 2012).

Most importantly, a number of recent studies highlight the importance of intelligence in environmental sustainability (Salahodjaev, 2016a; Salahodjaev, 2016b). For example, Obydenkova and Salahodjaev (2016) document that intelligence moderates the relationship between democracy and ratification of international environmental agreements. Moreover, the change in greenhouse gas emissions over the past decade has been affected by the level of cognitive abilities of nations (Salahodjaev and Yuldashev, 2016).

Based on the aforementioned discussion of the extant literature, we put forth the following hypotheses to be tested in this paper:

Hypothesis 1. : Intelligence has negative effect on deforestation.

Hypothesis 2. : Intelligence plays an offsetting role in the process of resource conservation in the countries with weak democratic institutions.

2. The model

This section starts by presenting the econometric model the goal of which is to explore the independent and interactive associations of democracy and intelligence with the level of deforestation. In this model, the *ith* country's level of deforestation between 1990 and 2010 is a function of democracy, D, and democracy squared, intelligence, IQ, the interaction of democracy with intelligence, various country level characteristics included in vector X and the random error, ε.

$$DF_i = \alpha_1 D_i + \alpha_2 D_i^2 + \gamma IQ_i + \delta IQ_i D_i + \theta X_i + \varepsilon_i \quad (1)$$

In this model specification, parameters α_1 and α_2 provide an inference about the inverted U-shaped relationship between democracy and deforestation, γ shows the direct association between intelligence and deforestation.

Finally, the principle interest of this study is parameter δ, which tests our hypothesis that higher level of nation IQ offsets countries which have not reached the democratic transition peak in reducing the level of deforestation (see Fig. 1). Further, we discuss our key variables of interest used in our empirical inquiry.

3. The Data

3.1. Dependent variable (DF_i)

The dependent variable in our study is average annual percentage change in forest cover from 1990 to 2010. Note that deforestation is signified by a positive value for understanding purposes. To measure deforestation, we use Forestry Database (FD), available from Food and Agriculture Organization (FAO), that provides the most comprehensive and up to date data on forest cover for majority of countries. Table 1, which provides descriptive statistics on key variables used in the analysis, shows that the annual change in forest cover in the world for the study period averaged 0.05%, and the deforestation rate ranged from 6.93% (Comoros) and −6.17% (Iceland) where the negative number implies the phenomenon known as *re-forestation* or an increase in forest cover.

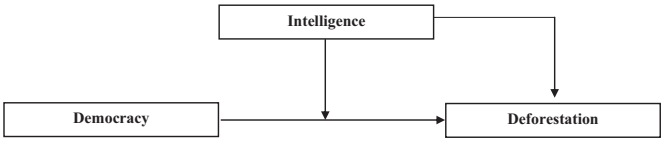

Fig. 1. The potential indirect impact of intelligence in moderating the effect of democracy on deforestation.

Table 1
Descriptive statistics of key variables used in the study.

Variable	Description	Mean	Std. dev.
Deforestation	Average annual deforestation rates (%)	0.054	1.276
Democracy	Democratic index	4.548	1.899
IQ	Nation IQ	84.10	10.88
GDP per capita	GDP per capita	4,962	8,261
GDP growth	GDP growth (annual %)	3.696	2.691
Forest stock	Forest area (% of land area)	32.84	24.87

3.2. Independent variables

3.2.1. Democracy (D_i)

To test the impact of democracy on deforestation, we use 'democratic index' retrieved from Freedom House Indicators (FHI). FHI have been widely used in the empirical studies (see e.g. Hanke and Walters, 1997; Haggard and Tiede, 2011). In this dataset each country is assigned two scores (7 (smallest degree of freedom) to 1 (greatest degree of freedom)) - one for political rights and one for civil liberties – based on its total scores for the political rights and civil liberties questions. The democratic index is calculated as the average of political rights and civil liberty scores. For comparability purposes, we reversed the scores. In our analytical sample, the average (see Table 1) and median democratic index scores in the beginning of the study period were about 4.6 points suggesting that the half of the countries in our sample can be considered as the countries with a certain degree of developed democratic institutions.

3.2.2. Intelligence (IQ_i)

The main independent variable is average national IQ score as a key proxy for the average intelligence of society (or nation). The data on IQ test results is from Lynn and Vanhanen (2012b). In their celebrated work Lynn and Vanhanen (2002) compiled research articles which provided the results of intelligence quotient (IQ) tests conducted in different countries. Based on the results of several thousand studies, they were able to estimate national IQs for 81 countries. In a follow up study, Lynn and Vanhanen (2006) estimated national IQs for an additional 32 nations, bringing the overall number of countries for which IQ scores were available to 113. In their most recent study, Lynn and Vanhanen (2012) revisited their extant studies and updated the cross-national dataset on national IQs for 200 nations. To ensure comparability of intelligence levels across countries, authors have calculated national IQs in relation to a British mean of 100 and standard deviation of 15. For countries with missing data, IQ scores were estimated based on international school assessment studiesor provincial data from neighboring regions with a similar culture. A good number of studies has used this data to explore the effect of intelligence on socio-economic outcomes such as economic growth (Ram, 2007), life satisfaction (Nikolaev and Salahodjaev, 2016), trust (Carl, 2014), alcohol consumption (Belasen and Hafer, 2013) and economic development (Zajenkowski et al., 2013). According to Table 1, the average national IQ score in 2012 was 84.10 points with the maximum score 107.1 points in Singapore. The median score was also close to 84.1 implying that the half of the countries in the sample have the national IQ score above the average level.

3.2.3. Control variables (X_i)

Depending on the model specification, in vector X_i, we include, gross domestic product (GDP) per capita, the growth rate of GDP

for the study period, and country's forest stock. We hypothesize that GDP per capita should control for the achieved living standard. It is important to control for the level of economic development as it may simultaneously be correlated with the level of democratization, intelligence[1] and deforestation. The growth rate of GDP is a proxy for successfulness of implemented economic and political reforms, which can be correlated, with key variables of interest in our empirical inquiry. We obtain information on GDP per capita and GDP growth from the World Development Indicators (WDI) database. The average GDP per capita in our sample is $4962 dollars per capita measured in 1991 and transformed into 2005 dollars and the average annual growth of output in the countries included in the analytical sample is 3.7% (see Table 1) for the study period. The main reason why we include the measure of GDP per capita assessed in 1991 instead of the contemporary measure is that in our regressions, we control for the variables that were measured before the time when national IQs were assessed. Otherwise, we could encounter in the regression analysis the problem known as the simultaneity problem.

Forest stock, which is approximated by a relative size of forest cover to the total area, controls for the potential level of resources available from pursuing deforestation, furthermore, this variable accounts for the potentially biasing influence of relative wealth or scarcity of forest stock (Rudel, 1998; Lui and Coomes, 2015). The data on forest stock is from the FAO and our descriptive statistics show that the average country in our sample has about 34% forest coverage with the maximum coverage in Suriname about 95% and the minimum coverage in Oman less than 0.01%. Table 2 presents the correlation matrix for main variables.

Table 2
Correlation matrix for main variables.

	I	II	III	IV	V	VI
Deforestation	1					
Democracy	−.16	1				
IQ	−.36	.44	1			
GDP per capita (log)	−.38	.60	.66	1		
GDP growth	−.03	−.28	−.11	−.26	1	
Forest stock	.16	.22	−.06	−.01	−.01	1

4. The results

4.1. The impact of intelligence

Table 3 presents the results from various model specifications.[2] Our results show that without any additional control variables, democracy has a strong and negative association with the level of deforestation. After adding democracy in the quadratic form, in line with the findings of some recent studies (e.g. Ward, 2008), our results show a profound inverted U-shaped relationship between democracy and deforestation. Moreover, Fig. 2 that plots the democratic index and average predicted deforestation rates suggest inverted U-shaped link. The goodness of fit of the quadratic model is substantially higher than the goodness of fit of the bivariate model in column 1. We also obtained the anticipated signs: positive for democratic index and negative for squared democratic index. The democratic transition peak according to the regression is 4.24, which is below the average level, nearly equals to democratic index of Turkey, but less than the democratic index of Mexico.

In column 3, after adding intelligence into our empirical specification, we find that the previous coefficients preserve their signs and statistical significances, although they decrease slightly in magnitudes. As we hypothesize, intelligence is negatively related to deforestation. The estimate is significant at the 1% level and suggests that a 10 points increase in IQ reduces deforestation rates by 0.33 percentage points. In column 4, we further analyze whether the link between democracy and deforestation varies with the level of nation IQ by interacting IQ and democracy variables (*hypothesis 2*). Results show that the interaction between democracy and IQ is positive and statistically significant ($p < 0.05$), signaling that the rate of deforestation decreases in weak democracies, below turning point, with higher national intelligence. This is our main finding of the analysis the implication of which we discuss broader in the conclusion section.

We further check robustness of our main finding by controlling for various country level characteristics. In column 5, variables capturing the living standard (logged GDP per capita) and economic development (average GDP growth rates in the study period) are added in the empirical specification of deforestation. The estimates indicate that both of these factors are associated negatively with the level of deforestation; however, only the variable related to the living standard, logged GDP per person is statistically significant.

Finally, in column 6, we control for the size of forest cover relative to the total area. Our results show that forest stock is positively associated with the level of deforestation, although the parameter associated with the given variable is only marginally significant. Most importantly, the parameters associated with democracy, intelligence and their interactions remain qualitatively unaffected after adding the country-specific control variables. As is expected, we observe quantitative changes in the given parameters, their magnitudes decrease with each additional variable preserving their statistical significances.

5. Robustness tests

To check robustness of our main results to the employed sample selection strategy and estimation technique, we run a number of robustness tests. The results are reported in Table 4. First, we investigate whether the results are affected by the prevalence of countries with substantially large forest cover. In column 1, we remove the countries with forest cover more than 75% of total area and then in column 2, we keep only the countries with forest cover at least more than 5%. As it can be seen, the estimates for intelligence, democracy and their interaction term remain intact in both model specifications. The coefficients for key independent variables are comparable with the coefficients reported in in the previous section. We further test whether our results are sensitive to the presence of outliers in the sample. To address this issue, we fit robust regression using iteratively reweighted least squares (IRWLS). The results show that the inverted U-shaped link between democracy and deforestation retains its sign and significance (See column 3).

Finally, the variance of the error term in the regression analysis may substantially vary with the level of democratic development or GDP per capita of a country. As a result, the inconsistent variance in the econometric analysis may lead to inefficient coefficients for the key variables of interest. One of the conventional ways of obtaining the consistent variance matrix is to employ the weighted least squares regression technique (WLS) (Nielsen, 2007). We use democracy and democracy squared as the variables entering the weighting equation to construct the consistent variance matrix. Column 4 provides the results for WLS regression

[1] See e.g. Meisenberg (2012).

[2] We do not report standardized coefficients as in regressions with interaction terms the standardized betas will be above 1. For a further discussion see http://psychologicalstatistics.blogspot.com/2009/03/dont-standardize-interactionmoderator.html.

Table 3
Regression results.

	(1)	(2)	(3)	(4)	(5)	(6)
Democracy	−0.111**	0.846***	0.772***	0.905***	0.691***	0.632***
	(0.048)	(0.249)	(0.220)	(0.220)	(0.230)	(0.238)
Democracy-sq		−0.110***	−0.091***	−0.107***	−0.075***	−0.071**
		(0.029)	(0.027)	(0.026)	(0.029)	(0.029)
IQ			−0.033***	−0.033***	−0.019**	−0.018**
			(0.007)	(0.007)	(0.008)	(0.008)
IQ*Democracy				0.008**	0.009**	0.009***
				(0.004)	(0.004)	(0.004)
GDP (log)					−0.250**	−0.239**
					(0.100)	(0.096)
GDP growth					−0.032	−0.035
					(0.028)	(0.026)
Forest stock						0.007*
						(0.004)
Intercept	0.610**	−1.076**	1.526**	1.285**	2.269***	2.026**
	(0.236)	(0.477)	(0.672)	(0.635)	(0.806)	(0.802)
N	185	185	181	181	181	181
adj. R^2	0.023	0.088	0.154	0.165	0.190	0.201

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

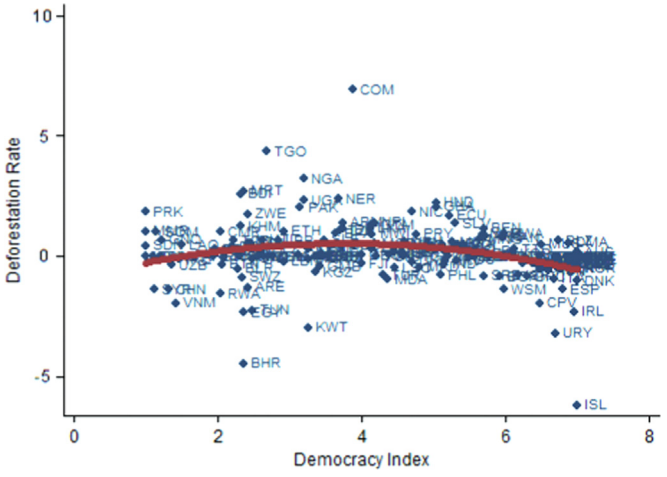

Fig. 2. Scatter plot of deforestation rate and democratic index.
Source: FAO, Freedom House and authors estimations

confirming that the main coefficients are in line with previous results.

Table 4
Robustness tests.

	(1)	(2)	(3)	(4)
Democracy	0.698***	0.742***	0.353**	0.524**
	(0.254)	(0.234)	(0.173)	(0.204)
Democracy-sq	−0.079**	−0.090***	−0.040**	−0.067***
	(0.031)	(0.028)	(0.020)	(0.025)
IQ	−0.019**	−0.023***	−0.016***	−0.022***
	(0.008)	(0.008)	(0.006)	(0.008)
IQ*Democracy	0.010***	0.009***	0.006**	0.010***
	(0.004)	(0.003)	(0.002)	(0.004)
GDP (log)	−0.243**	−0.092	−0.122*	−0.129
	(0.107)	(0.073)	(0.069)	(0.088)
GDP growth	−0.037	−0.014	−0.001	−0.037
	(0.026)	(0.024)	(0.015)	(0.025)
Forest stock	0.008*	0.002	0.005**	0.014**
	(0.005)	(0.004)	(0.002)	(0.006)
Intercept	1.976**	1.479*	1.475***	1.703**
	(0.841)	(0.783)	(0.571)	(0.757)
N	173	154	181	181
adj. R^2	0.214	0.233		0.205
Notes	Forest cover less than 75% of total area	Forest cover at least 5% of total area	Robust regression	WLS

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

6. Causal channels and mechanisms

Broadly speaking and summarizing the above discussion, intelligence may alleviate negative impact of weak democratic policies on deforestation via its effect on institutions, social capital and resource curse offsetting.

Rindermann and Thompson (2011) estimated cognitive competence sums for the mean and for upper- and lower-level groups for 90 countries. Using various statistical methods, the authors report that cognitive skills are instrumental to the quality of formal institutions and political regimes, which then destine the economic wealth of countries. Cognitive abilities facilitate the development of capitalism and the rise of wealth. In a follow up study, Rindermann and Coyle (2014) show that cognitive competence appear to be more decisive for explaining wealth differences between countries. The mechanism is in line with the Rindermann and Thompson (2011): the effect of innovation on economic development is greater in nations with higher scores on cognitive abilities and greater economic freedoms. More recently, Salahodjaev (2015a p. 133) argues, "if a government implements policies designed to reduce underground economy, intelligence offers a reasonable estimate of the level of acceptance of these policies." The study reports that a one standard deviation rise in national intelligence is associated with an 8.5 percentage point reduction in an underground economy relative to GDP. Indeed, societies that are more intelligent understand the principles that run operate efficiently functioning institutions, as intelligent individuals are associated with greater patience (Jones and Schneider, 2010) and proficiency (Kyllonen and Tirre, 1998; Barbuto, Beenen and Tran, 2015).

In a separate strand of studies scholars argue that intelligence intervenes development through social capital. Frederick (2005) documents experimental evidence linking cognitive ability, time and risk preferences. In a similar vein, Benjamin et al. (2006) supply experimental evidence that greater intelligence is positively correlated with more moderate and less risk averse

Table 5
Cluster analysis between deforestation and intelligence for countries below democratic transition peak.

Cluster	*N*	Deforestation rate
Countries with nation IQ below 73	24	1.08
Countries with nation IQ from 73 to global average (84)	24	0.36
Countries with nation IQ above global average (84)	28	−0.24

behavior. Thus, lower intelligence would then be correlated with a higher uncertainty aversion, making interpersonal trust less likely. Sturgis et al. (2010), use data from two British birth cohort studies, provides robust evidence that cognitive abilities (intelligence) measured in childhood is a robust determinant of generalized trust in adulthood, even after controlling for individual characteristics. Carl (2014, p. 84) suggests that 'individuals with higher intelligence may be better at evaluating others' trustworthiness, meaning that they tend to have relationships with people who are unlikely to betray their trust. … [T]hey may be better at identifying when any particular person has a strong incentive not to reciprocate trust'.

As, deforestation in weak democratic nations is caused by market collapses such as rent seeking and corruption. Extant literature shows that informed individuals are less likely to involve in rent seeking (Pasour, 1987), cooperate in favor of long-term benefits (Proto et al., 2014) and possess greater liberal attitude (Kanazawa, 2010b).

In Table 5, we further validate our finding of the insurance effect of intelligence in the democracy and deforestation relationship by showing that weak democracies (the countries with democracy levels below the transition peak) with lower nation IQs have higher average rates of deforestation. We cluster the countries with democracy below the transition peak level, 4.24, into three groups: the first group includes 24 countries with nation IQ one standard deviation below the average level, the second group includes 24 countries with nation IQ between the average level and one standard deviation below the given level and the third group includes 28 countries with nation IQ above the average level. The results of the cluster analysis show that in the countries with weak democracy and with the low national IQ level the average rate of deforestation is 1.08%. However, as the level of national IQ increases, the rate of deforestation declines and reaches even negative levels (re-forestation) holding democracy status constant. This finding direct us toward the conclusion that in the countries with weak democracies intelligence plays an offsetting role in the negative effect of democracy on deforestation.

7. Conclusion

This study has investigated the impact of intelligence on deforestation and its offsetting role in weak democratic societies. We find that the countries with high national IQ have a lower-level of deforestation. We also show that in the countries with undeveloped democratic institutions, national intelligence decreases the level of deforestation. Probably, intelligence does not only shape formal rules and informal regulations such as social trust, norms and traditions but also it has the ability to reverse the so-called "resource curse" mechanism.

The findings, however, do not suggest that deforestation should be overlooked in the countries with high national IQ and weak democratic institutions and public participation. In contrast, our results suggest that more superior environmental outcomes can be achieved in the societies where citizens can openly declare their environmental anxiety and governments do not restrict the freedom of mass media (Obydenkova, 2008). More than that, we believe that various democratic institutions in the form of NGOs must be actively involved not only in discussions of current ecological issues faced by the population but also in development and adoption of various environmental policies targeted at resolving such issues. Increasing the role of NGOs in decision making would definitely increase population's awareness of current ecological problems and most importantly it would improve participation and coordination of all interested parties (i.e., consumers, corporations, and government officials) in environmental preservation initiatives. From our findings, we can also infer that intelligence through informal regulations, traditions and social norms improves the coordination between the parties in recognition of importance and development of environmental preservation initiatives.

One of the possible shortcomings of our study is the fact that our main findings can be driven by simultaneity of democracy, intelligence and deforestation processes. The interconnection between democracy and deforestation we have partially resolved by controlling for the level of democracy in the beginning of the study period. Unfortunately, data on intelligence is only available for the recent years that inevitably limits further investigation. Due to the cross-national nature of data, the use of more complex estimation techniques that address potential endogeneity such as the general method of moments approach seems to be unfeasible for the present and has to be left on the agenda for future studies.

The prospective research should also address the endogeneity concern with respect to the role of intelligence in the democratization process. For example, Vanhanen (2003) suggests that intelligence is causally prior to democratization; intelligence partly causes some populations to become more democratic. Scholars highlight a number of factors that are endogenous to democracy and democratization (such as economic wealth and economic growth, international impact as prerequisite but also as a consequence, education, civil society, and even freedom of mass media are all debated as endogenous to democracy (Obydenkova and Libman 2012; 2015a). Therefore, scholarly literature may further explore the effect of intelligence (measured by Raven tests) on perceptions of democracy in countries that undergo democratization processes such as Post-Communist economies, for example. Moreover, experimental replication may also assess whether cognitive able individuals are associated with greater environmentalism.

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References

Andersen, M.S., 2002. Ecological modernization or subversion? The effect of europeanization on Eastern Europe. Am. Behav. Sci. 45 (9), 1394–1416.
Andersson, K., Ostrom, E., 2007. An analytical agenda for the study of decentralized resource regimes. Off. Int. Res. Educ. Dev., Virginia Tech, USA
Barbuto, J.E., Beenen, G., Tran, H., 2015. The role of core self-evaluation, ethnocentrism, and cultural intelligence in study abroad success. Int. J. Manag. Educ. 13 (3), 268–277.
Barrett, S., Graddy, K., 2000. Freedom, growth, and the environment. Environ. Dev. Econ. 5 (4), 433–456.
Beaver, K.M., Wright, J.P., 2011. The association between county-level IQ and county-level crime rates. Intelligence 39 (1), 22–26.

Belasen, A., Hafer, R.W., 2013. IQ and alcohol consumption: International data. Intelligence 41 (5), 615–621.
Benjamin, D.J., Brown, S.A., Shapiro, J.M., 2006. Who is Behavioral? Cognitive Ability and Anomalous Preferences. Mimeo, Harvard University.
Berge, E., 1994. Democracy and human rights: conditions for sustainable resource utilization. In: Johnson, B.R. (Ed.), Who Pays the Price? The Sociocultural Context of Environmental Crisis. Island Press, Covelo, CA.
Bjørnskov, C., 2003. Corruption and Social Capital. Aarhus School of Business, Department of Economics.
Buitenzorgy, M., Mol, A.P., 2011. Does democracy lead to a better environment? Deforestation and the democratic transition peak. Environ. Resour. Econ. 48 (1), 59–70.
Carl, N., 2014. Does intelligence explain the association between generalized trust and economic development? Intelligence 47, 83–92.
Deary, I.J., Batty, G.D., Gale, C.R., 2008. Childhood intelligence predicts voter turnout, voting preferences, and political involvement in adulthood: the 1970 British Cohort Study. Intelligence 36 (6), 548–555.
Didia, D.O., 1997. Democracy, political instability and tropical deforestation. Global Environ. Change 7 (1), 63–76.
Dryzek, J.S., 1987. Rational Ecology: Environment and Political Economy. Blackwell, Oxford.
Farzin, Y.H., Bond, C.A., 2006. Democracy and environmental quality. J. Dev. Econ. 81 (1), 213–235.
Frederick, S., 2005. Cognitive reflection and decision making. J. Econ. Perspect. 19, 25–42.
Gerber, A.S., Huber, G.A., Doherty, D., Dowling, C.M., Ha, S.E., 2010. Personality and political attitudes: relationships across issue domains and political contexts. Am. Polit. Sci. Rev. 104 (01), 111–133.
Gilens, M., Page, B.I., 2014. Testing theories of American politics: elites, interest groups, and average citizens. Perspect. Polit. *12* (03), 564–581.
Haggard, S., Tiede, L., 2011. The rule of law and economic growth: where are we? World Dev. 39 (5), 673–685.
Hanke, S.H., Walters, S., 1997. Economic freedom, prosperity, and equality: a survey. Cato J. 17 (2), 117–146.
Hardin, G., 1968. The tragedy of the commons. Science 162, 1243–1248.
Jones, G., 2008. Are smarter groups more cooperative? Evidence from prisoner's dilemma experiments, 1959–2003. J. Econ. Behav. Organ. 68 (3), 489–497.
Jones, G., 2011. National IQ and national productivity: the hive mind across Asia. Asian Dev. Rev. 28 (1), 51–71.
Jones, G., Podemska-Mikluch, M. (2010). IQ in the utility function: Cognitive skills, time preference, and cross-country differences in savings rates.
Jones, G., Schneider, W.J., 2010. IQ in the production function: evidence from immigrant earnings. Econ. Inq. 48, 743–755.
Kanazawa, S., 2010a. Evolutionary psychology and intelligence research. Am. Psychol. 65, 279–289.
Kanazawa, S., 2010b. Why liberals and atheists are more intelligent. Soc. Psychol. Q. 73 (1), 33–57.
Kanazawa, S., 2012. The Intelligence Paradox: Why the Intelligent Choice Isn't Always the Smart One. Wiley, New York.
Kanazawa, S., Perina, K., 2012. Why more intelligent individuals like classical music. J. Behav. Decis. Mak. 25 (3), 264–275.
Kanazawa, S., Fontaine, L., 2013. Intelligent people defect more in a one-shot prisoner's dilemma game. J. Nuerosci. Psycol. Econ. 6 (3), 201.
Kanyama, I.K., 2014. Quality of institutions: does intelligence matter? Intelligence 42, 44–52.
Kemmelmeier, M., 2008. Is there a relationship between political orientation and cognitive ability? A test of three hypotheses in two studies. Personal. Individ. Differ. 45 (8), 767–772.
Kotov, V., Nikitina, E., 1995. Russia and international environmental cooperation. Green globe yearbook of international cooperation on environment and development.
Kyllonen, P.C., Tirre, W.C., 1988. Differences in associative learning and forgetting. Intelligence 12, 393–421.
Li, Q., Reuveny, R., 2007. The Effects of Liberalism on the Terrestrial Environment. Confl. Manag. Peace Sci. 24 (3), 219–238.
Libman, A., Obydenkova, A., 2014. Governance of commons in a large nondemocratic country: the case of forestry in the Russian federation. Publius: J. Fed. 44 (2), 298–323.
Lui, G.V., Coomes, D.A., 2015. Tropical nature reserves are losing their buffer zones, but leakage is not to blame. Environ. Res.
Lynn, R., Vanhanen, T., 2002. IQ and the Wealth of Nations. Praeger Publishers, Westport, CT.
Lynn, R., Vanhanen, T., 2006. IQ and Global Inequality. Washington Summit Publishers, Augusta, GA.
Lynn, R., Vanhanen, T., 2012a. National IQs: a review of their educational, cognitive, economic, political, demographic, sociological, epidemiological, geographic and climatic correlates. Intelligence 40 (2), 226–234.
Lynn, R., Vanhanen, T., 2012b. Intelligence. A unifying Construct for the Social Sciences. Ulster Institute for Social Research, London.
Martinez, K.E., Crenshaw, E.M., Jenkins, J.C., 2002. Deforestation and the environmental kuznets curve: a cross national investigation of intervening mechanisms. Soc. Sci. Q. 83 (1), 226–243.
Meisenberg, G., 2012. National IQ and economic outcomes. Personal. Individ. Differ. 53 (2), 103–107.
Midlarsky, M., 1998. Democracy and the environment: an empirical assessment. J. Peace Res. 35, 341–361.
Morjaria, A., (2012). Electoral Competition and Deforestation: Evidence From Kenya, Working Paper: Prepared for World Bank.
Morris, D., 1969. The Human Zoo. Cape, London.
Nikolaev, B., Salahodjaev, R., 2016. The role of intelligence in the distribution of national happiness. Intelligence 56, 38–45.
Nielsen, A.A., (2007). Least squares adjustment: Linear and nonlinear weighted regression analysis. Danish National Space Center/Informatics and mathematical modelling, Technical Univ. of Denmark.
Obydenkova, A., 2007. The International Dimension of Democratization: test the parsimonious approach. Camb. Rev. Int. Aff. 20 (N 3), 473–490.
Obydenkova, A., 2006. New regionalism and regional integration: the role of national institutions. Camb. Rev. Int. Aff. 19, 589–610.
Obydenkova, A., 2008. Regime transition in the regions of russia: the freedom of mass media: transnational impact on sub-national democratization? Eur. J. Polit. Res. 47 (2), 221–246.
Obydenkova, A., 2011. A triangle of russian federalism: democratization, (De-) centralization, and local politics. Publius: J. Fed. 41 (4), 734–741.
Obydenkova, A., 2012. Democratization at the grassroots: the European Union's external impact. Democratization 19 (2), 230–257.
Obydenkova, A., Libman, A., 2012. The impact of external factors on regime transition: lessons from the Russian regions. Post Sov. Aff. 28 (3), 346–401.
Obydenkova, A., Libman, A., 2015a. Causes and Consequences of Democratization: The regions of Russia. Routledge, London and New York.
Obydenkova, A., Libman, A., 2015b. The survival of post-communist corruption in contemporary russia: the influence of historical legacies. Post-Sov. Aff. 31 (4), 304–338.
Obydenkova, A., Salahodjaev, R., 2016. Intelligence, democracy, and international environmental commitment. Environ. Res. 147, 82–88.
Ostrom, E., 1990. Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press, Cambridge.
Pasour Jr, E.C., 1987. Rent seeking: some conceptual problems and implications. Rev. Austrian Econ. 1 (1), 123–143.
Payne, R.A., 1995. Freedom and the environment. J. Democr. 6 (3), 41–55.
Potrafke, N., 2012. Intelligence and corruption. Econ. Lett. 114 (1), 109–112.
Proto, E., Rustichini, A., and Sofianos, A. (2014). Higher intelligence groups have higher cooperation rates in the repeated prisoner's dilemma.
Ram, R., 2007. IQ and economic growth: further augmentation of Mankiw–Romer–Weil model. Econ. Lett. 94, 7–11.
Rindermann, H., Coyle, T.R., 2014. Cognitive capitalism: economic liberty increases the effects of cognitive competence on innovation and wealth. Innovation 72, 86.
Rindermann, H., Thompson, J., 2011. Cognitive capitalism: the effect of cognitive ability on wealth, as mediated through scientific achievement and economic freedom. Psychol. Sci. 22, 754–763.
Rindermann, H., Flores-Mendoza, C., Woodley, M.A., 2012. Political orientations, intelligence and education. Intelligence 40 (2), 217–225.
Rose-Ackerman, S., 1999. Corruption and Government: Causes, Consequences and Reform. Cambridge University Press.
Rudel, T.K., 1998. Is there a forest transition? Deforestation, reforestation, and development. Rural Sociol. 63 (4), 533–552.
Sachs, J.D., Warner., A.M., 2001. The curse of natural resources. Eur. Econ. Rev. 45 (4), 827–838.
Salahodjaev, R., 2015a. Intelligence and shadow economy: a cross-country empirical assessment. Intelligence 49, 129–133.
Salahodjaev, R., 2015b. Democracy and economic growth: the role of intelligence in cross-country regressions. Intelligence 50, 228–234.
Salahodjaev, R., 2016a. Does intelligence improve environmental sustainability? An empirical test. Sustain. Dev. 24, 32–40.
Salahodjaev, R., 2016b. Intelligence and deforestation: international data. For. Policy Econ. 63, 20–27.
Salahodjaev, R., Azam, S., 2015. Intelligence and gender (in) equality: Empirical evidence from developing countries. Intelligence 52, 97–103.
Salahodjaev, R., Yuldashev, O., 2016. Intelligence and greenhouse gas emissions: Introducing Intelligence Kuznets curve. MPRA Paper No. 68997.
Shandra, J.M., 2007. The world polity and deforestation: a quantitative, cross-national analysis. Int. J. Comp. Sociol. 48 (1), 5–27.
Shandra, J.M., Esparza, L.E., London., B., 2012. Nongovernmental organizations, democracy, and deforestation: a cross-national analysis. Soc. Nat. Resour.: Int. J. 25 (3), 251–269.
Shamosh, N.A., Gray, J.R., 2008. Delay discounting and intelligence: a meta-analysis. Intelligence 36 (4), 289–305.
Solon, I., 2014. How intelligence mediates liberalism and prosociality. Intelligence 47, 44–53.
Sturgis, P., Read, S., Allum, N., 2010. Does intelligence foster generalized trust? An empirical test using the UK birth cohort studies. Intelligence 38 (1), 45–54.
Tabellini, G., 2008. Institutions and culture. presidential address european economic association. J. Eur. Econ. Assoc. 6, 255–294.
Ward, H., 2008. Liberal democracy and sustainability. Environ. Polit. 17 (3), 386–409.
Wendland, K.J., Lewis, D.J., Alix-Garcia, J., Ozdogan, M., Baumann, M., Radeloff, V.C., 2011. Regional-and district-level drivers of timber harvesting in European Russia after the collapse of the Soviet Union. Glob. Environ. Chang. 21 (4), 1290–1300.
Vainikainen, N., Kangas, A., Kangas, J., 2008. Empirical study on voting power in participatory forest planning. J. Environ. Manag. 88 (1), 173–180.
Vanhanen, T., 2003. Democratization: a comparative analysis of 170 countries. Routledge, London; New York.
Zajenkowski, M., Stolarski, M., Meisenberg, G., 2013. Openness, economic freedom and democracy moderate the relationship between national intelligence and GDP. Personal. Individ. Differ. 55 (4), 391–398.