

Wendland, K., Lewis, D.J., and J. Alix-Garcia. 2014. "The Effect of Decentralized Governance on Timber Extraction in European Russia." *Environmental and Resource Economics*, 57: 19-40.

The effect of decentralized governance on timber extraction in European Russia¹

(RUNNING TITLE: Decentralized governance and logging)

Kelly J. Wendland

Address for correspondence:

Department of Conservation Social Sciences

19M Natural Resources, University of Idaho

Moscow, ID 83843

kwendland@uidaho.edu

208-885-7044 (phone)

208-885-5534 (fax)

David J. Lewis

Department of Applied Economics, Oregon State University

Jennifer Alix-Garcia

Department of Agricultural and Applied Economics, University of Wisconsin-Madison

¹ The authors thank Dimitri Aksenov, Matthias Baumann, Yulia Dubinina, David Helmers, Alexander Prishchepov, Yan Zhang and Alexey Yaroshenko for assistance with GIS, data collection, and translations. We extend a special thanks to Scott Gehlbach and Volker Radeloff, who have provided helpful comments on previous versions of this research. We thank participants at the 2011 Midwest International Economic Development Conference and the 2011 Association for Environmental and Natural Resource Economics Conference for comments and suggestions on this work. Additionally, comments by the editor and two anonymous reviewers greatly improved the final paper. Wendland and Lewis acknowledge funding by NASA's Land-Cover and Land-Use Change Program (Project Number: NNX08AK776).

The effect of decentralized governance on timber extraction in European Russia

Abstract

“Good” governance is often promoted for economic growth, but its impact on natural resource use in developing and transitional economies is not well understood. For example, many scholars promote improved governance as a means to slow resource use, whereas others have found that better governance increases extractive resource activities. In this paper we use within-country variation in Russia to test the impact of governance on timber harvesting. Using a reduced form fixed-effects model and satellite-based estimates of forest cover we find a statistically significant and non-linear effect of governance on the area of timber harvested: for a marginal improvement in governance timber harvesting increases, but this effect decreases at high levels of governance. These results are robust to alternative specifications and when instrumenting for economic growth. Governance could impact timber harvesting in Russia through ownership risk (i.e., tenure security), through the costs of doing business (i.e., bribes), or both. Nonparametric regressions and qualitative evidence suggest that both factors are at play in Russia. This analysis provides additional evidence that improving governance may increase natural resource extraction. This has important implications for policy prescriptions that suggest “good” governance will slow resource use in developing and transitional economies.

Keywords: corruption, decentralization, institutions, forests, governance, logging, property rights, Russia

1. Introduction

The role of governance in the creation of economic wealth and development, as well as in sustainable resource management, has received considerable attention in the last decade (Banerjee 1997; Kaufman and Kraay 2002; Deacon and Mueller 2004; Acemoglu et al. 2005; Robinson et al. 2006; Kaufmann et al. 2006; Baland et al. 2010). While it is difficult to pinpoint an exact definition of “governance”, Baland et al. (2010) suggest governance be thought of as a combination of a country’s political institutions, including its electoral system, democracy, and number of political parties, and its capacity and effectiveness at implementing collective choices. Despite increasing attention, the causal relationship between governance and growth has not yet been well identified. This paper focuses on the relationship between natural resource use, a potential driver of economic growth, and governance. In particular, we estimate the impact of regional governance metrics on timber harvesting in European Russia between 1990 and 2005.

The main contribution of our paper is to use within-country variation in governance to examine the relationship between governance and resource extraction. Conducting the analysis within a single country across time allows for the use of panel methods that eliminate various factors that might introduce bias in cross-country work, including exchange rates, trade barriers, and forestry laws. To measure sub-national governance in European Russia we use an average of eight indicators published by the Carnegie Center Moscow for the years 1991-2004 that measure regional – equivalent to states in the United States – political institutions and state capacity and effectiveness (Petrov 2005). The dependent variable in our model is aggregate forest disturbance within Russian districts – equivalent to counties in the United States – measured using remote sensing analysis of forest removal across two time periods: 1990-2000 and 2000-2005. The use of remote sensing data to measure logging mitigates concerns about measurement error, whether

from human error or from “illegal” logging, which affects national forestry statistics in Russia (World Bank 2004; Ottitsch et al. 2005).

In addition to controlling for the impact of governance, our model of forest disturbance controls for other local biophysical and economic determinants of land cover change, including regional and time-period fixed effects. Regional fixed effects control for time-invariant unobservables at the regional level that might be correlated with governance and logging; time-period fixed effects control for changes over time, such as global timber prices, that would affect all regions. The panel structure comes primarily from the grouping of districts into regions, and time variation across two adjacent land-use transition periods (1990-2000 and 2000-2005). As a result, the primary concern for bias in our estimations is from time-varying independent variables at the regional level that might be correlated with changes in regional governance and timber harvesting, which we control for by including a measure of the change in per-capita economic growth for each region.

The data confirm a statistically significant effect of governance on forest disturbance in European Russia. Both a quadratic and a dummy variable specification of governance indicate a non-monotonic effect on logging: a marginal increase in governance in regions with low levels of governance increases forest disturbance but this effect decreases at high levels of governance. These results are consistent with those of Ferreira and Vincent (2010), who also find a non-monotonic effect of governance on logging in their cross-country analysis. Our results are robust to instrumenting for economic growth with industrial output per worker, and we present a number of additional robustness tests.

The rest of this paper proceeds as follows: Section 2 summarizes the linkages between governance and natural resource use broadly and within Russia; Section 3 describes the

conceptual framework, data, and identification strategy; Section 4 presents results; Section 5 discusses our findings and explores the possible mechanisms through which governance works using nonparametric regression; the last section concludes.

2. Governance and Natural Resource Use

2.1 Current literature

Our work builds upon the existing literature on governance and natural resource use, embodied in work by Bohn and Deacon (2000), Deacon and Mueller (2004), Barrett et al. (2005), Ferreira and Vincent (2010), and Laurent-Lucchetti and Santugini (2012). While recognizing that governance is multifaceted, these works point to two primary mechanisms through which “poor” governance impacts natural resource decisions: 1) ownership, or confiscation, risk and 2) corruption. Ownership risk stems from tenure insecurity, and is influenced by many facets of governance, including strength of the judicial system, court of law, and enforcement mechanisms (Arnot et al. 2011). Tenure security is expected to increase economic investments in natural resources through the assurance that the investor will be able to reap the benefits of the investment and through increased access to funds that can be used for investing (Feder and Onchan 1987; Besley 1995; Arnot et al. 2011). However, estimates of the empirical relationship between ownership risk and forest cover are inconclusive: there is just as likely to be a negative as a positive correlation between these factors (Arnot et al. 2011; Robinson et al. 2011).

Corruption influences the ability of the state to carry out collective action, and some hypothesize that corruption is correlated with a country’s political institutions, with more competition reducing corruption (Chowdury 2004). While corruption can directly impact the security of property rights, it can also affect natural resource use by changing the costs of doing business (Bardhan 1997; Aidt 2009). The relationship between corruption and resource use

depends on whether corruption is collusive (e.g., public officials conspire with firms to gain preferential treatment) or non-collusive (e.g., individual officials demand bribes for access) (Ferraro 2005; Barrett et al. 2005; Amacher et al. 2012). With collusive corruption, the cost of doing business for the individual or firm decreases and resource use is expected to accelerate. When corruption is non-collusive the costs of doing business increases and resource use is expected to slow. The impacts of ownership risk and corruption on natural resource use are not unique – similar observations have been made between governance and investments in other sectors, such as agriculture (e.g., Gavian and Fafchamps 1996; Hayes et al. 1997; Jacoby et al. 2002; Kabubo-Mariara 2007).

The empirical work on governance and natural resource use has mostly exploited across country variation. Using an index of ownership risk as a governance measure, Bohn and Deacon (2000) find that ownership risk decreases petroleum extraction, while the correlation between the index and deforestation across countries is positive. Ferreira and Vincent (2010) estimate the impact of cross-country measures of governance on nationally reported timber harvests in developing countries. They separate governance into two components: government stability – which includes measures of ownership risk similar to what is used in Bohn and Deacon (2000) – and government integrity – which includes measures of state capacity and effectiveness such as regulatory quality and corruption. Unlike Bohn and Deacon (2000), Ferreira and Vincent (2010) find a non-linear and non-monotonic impact of governance on resource extraction. They find that a marginal improvement in governance leads to more harvesting in countries with weak governance but decreases harvesting in countries with strong governance. Our paper moves this literature forward through a within-country analysis that circumvents the potential omitted variables issues common in cross-country analyses.

2.2 *Russia*

The collapse of the Soviet Union led to spatial and temporal variation in governance across Russian regions (Stoner-Weiss 1997; Hanson and Bradshaw 2000; Gehlbach and Malesky 2010). While decisions were centrally controlled during Soviet times, political and economic authority was transferred toward administrative regions as early as 1985 in Russia. These transfers of power were formalized in 1991 when regions began electing their own governors and ended in 2004 with the recentralization of gubernatorial elections. Between 1991 and 2004 there were wide divergences in the strength of institutions and governance across Russian regions. The reasons for these divergences are complex: ethnicity, geographic location and economic legacies from the Soviet period are a few of the factors that have been related to differences in social, economic and institutional outcomes (Stoner-Weiss 1997; Hanson and Bradshaw 2000; Ickes and Offer 2006).

Several empirical studies find that divergences in regional governance impacted privatization effectiveness, firm productivity and economic investments across Russia (Berkowitz and DeJong 2003; Slinko et al. 2005; Yakovlev and Zhuravskaya 2008; Libman 2010; Granville and Leonard 2010). In particular, variation across regions in the ability to implement reforms and the evolving characteristics of their political institutions, such as openness, transparency, and free and fair elections, have been empirically linked to differences in corruption and ownership risk, which in turn affected economic performance in post-Soviet Russia (Libman 2010; Gehlbach and Malesky 2010). Both collusive and non-collusive forms of corruption have been documented in Russia: many firms receive preferential treatment in Russia, allowing them to purchase favors that lead to better economic performance (Slinko et al. 2005),

and incidents of informal fees and bribes are widely cited across Russian regions and sectors (Dininio and Orttung 2005).

Russia's forestry sector also experienced a number of changes in management and governance after 1991. While forests remained state owned, Russia decentralized forest management to the regional and district level, privatized the timber industry, and transitioned to a system of short- and long-term timber leases to private firms. Russia released official forestry legislation in 1993, 1997, 2004 and 2007 that specified the rights and responsibilities of the public forestry sector and private timber firms, but did not make any changes to the content of property rights until 2007, when it changed the duration of forest leases and responsibilities of lessees. Forestry laws are created at the federal level. Management responsibilities and governance of state-owned forests were shifted to the regional and district levels between 1993 and 2004. While the responsibilities of allocating and monitoring lease contracts moved to the regional and district levels, however, revenues from leases went directly to the federal government before reallocation to the regional and district levels. This period of decentralized forest governance has been characterized as inefficient and corrupt (Eikeland et al. 2004) and the impetus behind the subsequent re-centralization of forest management in 2004.

Qualitative assessments of the impact of changes to governance on the forestry sector indicate that the profitability of timber harvesting was directly affected by weak legal capacity and enforcement of property rights (Torniainen and Saastamoinen 2007; Torniainen 2009) and illegal fees and bribes placed on timber contracts by the state forestry sector (Krott et al. 2000; Eikeland et al. 2004). Assessments of forest outcomes in other post-Soviet countries have come to similar conclusions. For example, an assessment of forest property rights across several Central and Eastern European countries cite ownership risk in the form of timber theft and other

forms of illegal extraction on forest plots as leading to decreased economic profits (Bouriaud and Schmithusen 2005). In Romania, the intersection of privatization and decentralization amidst weak institutions is cited as a primary cause of corruption in community-based forest management (Vasile, *unpublished manuscript*). To date, while strong correlations between regions and timber harvesting in Russia have been identified (Wendland et al. 2011), the impacts of ownership risk or corruption on forest outcomes have not been empirically estimated in post-Soviet countries.

3. Methods

3.1 Framework

We start from the assumption that private timber firms operating in European Russia set out to maximize profits. While many of the factors that might influence timber harvesting (e.g., exchange rates, trade barriers, forestry laws) will be similar within Russia, many biophysical and economic determinants vary within the country. These include: net profits, timber stock, and the firm's discount rate. Net profits vary as a function of the value of timber and the capital costs of timber harvesting (Binkley 1987). The value of timber varies by the type and quality of trees harvested. Capital costs of harvesting are affected by local operating costs (e.g., wages, permit prices), equipment costs, biophysical conditions (e.g., slope) and distance to roads and markets. Timber stock indicates the total growing stock in an area. A firm's discount rate captures the rate of return necessary for a firm to invest in timber harvesting.

Governance could impact the timber harvesting decision through the discount rate or capital costs. While standard economic theory suggests that increases in the discount rate, such as those resulting from risk and uncertainty associated with tenure insecurity, should increase extraction, Farzin (1984) shows that when there are high capital costs, this does not necessarily

hold. Instead, there are two distinct and countervailing effects. The first effect is the one traditionally considered in the literature: the depletion effect, where an increase in the discount rate increases the marginal net benefits of harvesting timber today. This leads to an immediate increase in extraction. The second effect is that a higher discount rate increases the capital costs of extraction, which decreases net profits and therefore discourages extraction. This is known as the investment effect, since firms would want to invest their capital elsewhere. The overall impact of these two effects on resource extraction is theoretically ambiguous. Additionally, corruption could have direct effects on capital costs. With collusive corruption, the cost of doing business for a firm decreases and harvesting is expected to increase; in the case of non-collusive corruption, the costs of doing business increases for the firm and resource extraction is expected to slow. The overall impact of governance on timber harvesting is thus an empirical question.

3.2 Study area and data

3.2.1 Study area

Our study area includes 31 regions and 877 districts (Figure 1)² and is about three million km², or one-third the size of the continental United States. Russia is administratively separated into regions (oblasts) – equivalent to states in the US – and then districts (rayons) – equivalent to counties in the US. Regions were the level of decentralization of political power in Russia and the level where governance was measured. We measure forest disturbance and most independent variables at the district level to more precisely control for biophysical and economic drivers of disturbance that are expected to vary within regions. The number of districts per region varies from a minimum of 20 and a maximum of 112; this variation reflects differences in the size of regions and the size of districts (Figure 1).

² Figure 1 shows 32 regions; remote sensing data exist for all 32 regions but one region lacked data on governance due to redistricting that occurred in 2005. The missing region is Komi-Permyatskiy Autonomous Region, which was merged with Perm Region in 2005.

<Figure 1 near here>

3.2.2 Forest disturbance

We measure forest disturbance using remote sensing data from 1990 to 2000 and 2000 to 2005. The forest disturbance measure for 1990-2000 comes from an unpublished analysis by Greenpeace-Russia (Yaroshenko et al. *unpublished*) and covers 26 regions and 599 districts. The 2000-2005 measure comes from Potapov et al. (2011) and covers all 31 regions and 877 districts.³ The two assessments vary in their classification algorithm and in the sampling design used for their training data. While an accuracy rating is not available for the unpublished dataset⁴, reported overall accuracy for the 2000-2005 assessment is 89 percent (Potapov et al. 2011). Both analyses are based on Landsat images and provide 30-m resolution data on forest disturbance; at this scale, forest degradation and selective logging are not detected.

While remote sensing analysis detects all sources of forest conversion, including natural disturbances, assessments of remote sensing data in the region have concluded that timber harvesting is the primary driver of forest loss (Potapov et al. 2011). State-owned forests cannot be converted to alternative land uses in Russia (i.e., deforestation), only cleared, and during this time period forest cover was expanding due to widespread agricultural abandonment (Prishchepov et al. 2012).

The remote sensing data give us the total area (km²) converted from forest to non-forest within each district for the two time periods: 1990-2000 and 2000-2005. We create a per-year

³ There is some variation and thus overlap in the satellite images from these two analyses. For example, the 2000-2005 analysis uses images from 1999 to 2002 to measure 2000 forest cover and images from 2003 to 2005 to measure 2005 forest cover (Potapov et al. 2011). As long as there is no systematic correlation between measurement errors or overlap of images and our independent variables, then including a time dummy variable in econometric estimation controls for these differences in methodologies and our parameter estimates will be unbiased.

⁴ While there is no accuracy assessment, conversations with the authors of this dataset and independent verifications by remote sensing experts convinced us that data quality was comparable to other freely-available remote sensing products.

metric by dividing the total area converted by the number of years in that time period (e.g., if 100km² of forest was lost in a district in 1990-2000 we record 10km²/year for this time period). This retains the two data periods in the panel model (see next section) but allows us to interpret regression coefficients on a per-annum basis; this eases interpretation since we have a 10- and 5-year time period. The average area harvested in a district was about six km² per year, with a minimum of zero and a maximum of 215 km² per year (Table I).

<Table I near here>

3.2.3 Governance

Regional-level governance is measured using indicators published by the Carnegie Center Moscow for 1991-2000 and 2000-2004 (Petrov 2005). Governance measures from 1991-2000 are used to represent the period of forest disturbance in 1990-2000 and measures from 2000-2004 represent the period of forest disturbance in 2000-2005. Indicators include: civil society, free and fair elections, political stability, competition in elections, independence of media, government transparency, balance of powers, and quality of district governments (see Table II for definitions). These measures of governance are not specific to the forestry sector and are highly correlated with other indicators of “good” governance in Russia (Appendix I).

<Table II near here>

The Carnegie Center Moscow ranked each indicator on a five-point scale, where five is the highest possible score. For example, a score of five for civil society represents a regional government with more public participation than a region that scored one. We use the average value of these eight indicators to reduce measurement error and to account for high correlation across individual factors – close to 0.8 for most indicators. This average value varies across space and time with a range between 1.5 and 4.3 and a mean of three (Table I). While we cannot

say at what value “poor” governance ends and “good” governance begins, the general assumption is that as one moves from one to five, governance improves. Since the coding of the governance variable is specific to this study, we can only qualitatively interpret whether governance has an impact or not on forest disturbance.

3.2.4 Control variables

We were not able to obtain historical data on local timber prices in Russia. To proxy for differences in timber value we use a measure of the percent of evergreen forest in a district (Table I). In Russia, evergreens, such as fir, pine and spruce, are more valuable for the timber industry since Soviet-era wood processing equipment was designed for these species (Yaroshenko 2009, *personal communication*).

To capture differences in costs across districts we include measures of slope, road density, and distance to major markets. For distance to major markets, we chose Moscow and St. Petersburg because they are by far the biggest domestic consumers of timber in European Russia and thus capture access to markets.⁵ European Russia’s timber exports go predominately to Finland and former Soviet countries (FAO 2009). Given the high spatial correlation between St. Petersburg and Helsinki and between Moscow and former Soviet countries, we only include the distance to Moscow or St. Petersburg.

Ideally we would include a measure of growing stock in our analysis to control for the amount of timber resource in a district. Data on total growing stock in Russia, however, are fraught with measurement error (Kinnunen et al. 2007). Therefore, we use total forest area in a district as a proxy measure for growing stock. Data on total forest area come from the 2000-2005 remote sensing assessment by Potapov et al. (2011). They provide an estimate of the total area of

⁵ Domestic demand for timber dropped precipitously during this transition period due to economic downturn; most timber was exported during this period (Carlsson and Olsson 1998).

forest in 2000 and we approximate the area that was in forest in 1990 by adding the amount of forest lost between 1990-2000 back to the 2000 measure of forest cover.

Finally, we include a measure of change in per-capita regional economic growth. This variable serves as a proxy for factors that could vary across time and regions and that might be correlated with governance and timber harvesting. This reasoning is described in more detail in the next section. Changes in economic growth also capture differences in factors that would impact a firm's discount rate, such as the opportunity costs of investing in timber. Data on per-capita gross domestic product (GDP) come from the national statistical database, Rosstat, and are published on a per-annum basis; however, GDP data are not publically available before 1995. Therefore, we calculate the percent change between the years 1995 and 2000 and 2000 and 2005 as our measure of economic growth.

3.3 Estimation strategy

We start with a reduced-form model to identify the impact of governance on logging, which can be written as:

$$Y_{ijt} = \alpha + \tau G_{jt} + \gamma P_{ijt} + \omega T_t + \mu_j + \delta_{jt} + \varepsilon_{ijt} , \quad (1)$$

where Y_{ijt} is the mean annual forest disturbance in district i , nested in region j , during transition time t , where t reflects the two transition periods of 1990-2000 and 2000-2005. The dependent variable Y_{ijt} is thus the per-year metric of forest disturbance calculated for 1990-2000 ($t=0$) and 2000-2005 ($t=1$). The constant term is α ; G_{jt} is governance in region j in time t ; P_{ijt} is the matrix of district-level covariates described above; T_t is the time dummy variable; and μ_j are time-invariant regional fixed effects. δ_{jt} and ε_{ijt} measure time-varying unobservables that affect timber harvest.

Regional fixed effects account for differences such as historical legacies that affect present-day institutional strength, climate and soil conditions that affect timber growth rates, and the number of wood processing facilities (Carlsson and Olsson 1998; Kortelainen and Kotilainen 2003). The time dummy variable takes on a value of “1” for the 2000-2005 transition period, and zero otherwise. This variable controls for spatially invariant but time varying factors such as national timber prices, trade barriers, export tariffs, and national political and economic trends. The inclusion of these variables means that identification of the governance impact comes from time-variation in the forest disturbance outcome within and across regions.

We decompose the time-varying unobservable variables into a term that is independent of governance and the other independent variables (ε_{ijt}), and a term that may be correlated with either governance or the other independent variables (δ_{jt}). The unobservable δ_{jt} captures multiple time- and regionally-varying factors that influence timber harvesting. Examples include production technology innovations, timber industry size, lending rates, local timber prices and timber demand. Our primary concern with δ_{jt} is the possibility that some of the factors in δ_{jt} could be correlated with our regional governance variable G_{jt} , a fact that would bias our governance estimates from the within estimator.

We address this problem by including percent change in per-capita economic growth for region j over time period t , which is likely to be highly correlated with key omitted variables, in the model.⁶ For example, a technological innovation in timber for region j would likely occur alongside broader innovations that are associated with higher economic growth in that region.

⁶ Wooldridge (2010, p.112-114) refers to this as the “plug-in solution” or “multiple indicator solution”. The idea is that a proxy variable that is strongly correlated with the omitted variable(s) be used in the equation, and that by “plugging-in” this proxy variable, bias induced by these same omitted variables will be reduced.

We specify the following equation, which formalizes the relationship between observed R_{jt} and unobserved δ_{jt} :

$$R_{jt} = \varphi_0 + \varphi_1 \delta_{jt} + e_{jt}, \quad (2)$$

where e_{jt} is a mean zero error that is assumed to be uncorrelated with δ_{jt} and all the independent variables in Equation 1. This assumption is akin to assuming that all non-timber drivers of regional economic growth are uncorrelated with the observed timber harvesting covariates.

Solving (2) for δ_{jt} and plugging into (1) gives:

$$Y_{ijt} = \left[\alpha - \frac{\varphi_0}{\varphi_1} \right] + \tau G_{jt} + \gamma P_{ijt} + \omega T_t + \mu_j + \left(\frac{1}{\varphi_1} \right) R_{jt} + \left[\varepsilon_{ijt} - \left(\frac{1}{\varphi_1} \right) e_{jt} \right], \quad (3)$$

where the last term in square brackets is the time-varying error term.

However, since there is potential reverse causality between timber harvest and economic growth, and Equation 2 shows that R_{jt} is necessarily correlated with e_{jt} , we need to introduce economic growth in an instrumental variables framework. We therefore seek a time-varying plausible instrument for growth. Since timber harvest is strongly correlated with the usual instruments in the growth literature – climate and geography – we instead use change in output per worker to instrument for economic growth (Table I). Output per worker measures industrial activity within a region and so excludes direct earnings from timber harvesting reducing the likelihood that the instrument is correlated with the error term; however, it could still potentially capture revenue from woodworking and pulp and paper mills.

Given the skewed distribution of forest disturbance we log-transform Y_{ijt} and district-level covariates in P_{ijt} in Equation 3. We checked whether slopes were the same across the two time periods by interacting each covariate with the time dummy, T_t , and testing whether the estimated parameters were statistically equivalent. Road density and distance to markets were different across time periods, and so we present results with these time interactions. We test a

quadratic and dummy variable specification for governance in all regressions. For the dummy variable specification we create three categories: a “poor” governance score of 1-2, a “neutral” score of 2.1-4, and a “good” governance score of 4.1-5. We exclude the “poor” category and interpret the impacts of governance relative to this baseline. Finally, robust standard errors clustered at the regional level j are included to control for correlation in the residual error. Cluster-robust standard errors allow spatial correlation across units, in our case, correlation across districts within the same region. This specification also controls for most functional forms of serial correlation and heteroskedasticity in panel data (Cameron and Trivedi 2005).

In sum, our identification strategy combines panel data and instrumental variables techniques to minimize the endogeneity concerns that generally confound estimation of the effects of governance on natural resource use. We first break the unobservable in our forest disturbance model into three components: 1) a time-invariant regional unobservable μ_j , 2) a time-varying regional unobservable δ_{jt} , and 3) a time-varying district level unobservable ε_{ijt} . Since our governance variable (G_{jt}) is measured at the regional level, our primary endogeneity concerns arise from correlation between G_{jt} and the regional unobservables μ_j and δ_{jt} . Regional fixed effects can be introduced to control for μ_j since our governance variable is time-varying. The within estimator transforms all variables as differences from their time-average, and so μ_j is differenced out of the model. Since the time-varying regional unobservables δ_{jt} will not be differenced out of the model, we proxy for δ_{jt} with regional economic growth and correct for any remaining correlation between growth and unobserved timber determinants with output per worker as an instrument. Identification of the effects of governance on forest disturbance is thus facilitated by 1) the grouping of districts within multiple regions, and 2) time-variation in regional-level governance.

4. Results

We first present results without instrumenting for economic growth (Table III). Under the quadratic specification for governance we find a statistically significant and apparently non-monotonic effect of governance on logging. Panel A shows the non-monotonic effect of governance on logging and Panel B shows the marginal effect of governance on logging at the mean value of governance as 3.4: regions scoring below this turning point would experience an increase in logging for a marginal increase in governance and regions scoring above 3.4 would experience a decrease. This interpretation comes with the caveat that it is difficult to assess whether an increase in governance from 2 to 3 is a change of the same magnitude as an increase from 3 to 4. That is to say, the measure is ordinal rather than cardinal. The dummy variable structure for governance indicates a similar effect: as governance improves from “poor” to “neutral” we find a statistically significant and positive impact on logging. A move from “poor” to “good” governance is also significant and positive but with a smaller coefficient than the “neutral” dummy variable. Economic growth has a positive effect on logging and is statistically significant in the quadratic specification. All other covariates are statistically significant and, in general consistent with profit maximization.

<Table III near here>

Results instrumenting for economic growth are similar to the previous results: we find a statistically significant relationship between governance and timber harvest with a turning point around 3.9 in the quadratic specification and a similar non-linear effect using the dummy variable specification (Table III).⁷ The coefficient on governance increases slightly under both

⁷ We also instrumented for economic growth using a measure of percent change in expenditures on alcohol between 1995-2000 and 2000-2005. Increased alcohol consumption is strongly associated with the rapid social and economic transition in Post-Soviet Russia (Bloom and Canning 2000), and is unlikely to be directly affected by forest disturbance. Using this instrument we found results consistent with those reported in Table III for both governance

specifications, with the largest increase in the impact under the dummy variable specification and the move from “poor” to “neutral” governance. Economic growth is weakly significant and the size of the coefficient is statistically similar to when economic growth is not instrumented; estimated parameters for all other covariates are similar to the previous results.

In Panel D, the statistical tests described below provide confidence in our choice of instrument. Underidentification tests reject the null hypothesis of underidentification at the 95 percent level or higher. F-statistics are all larger than 10 in Panel D and using the Stock and Yogo (2005) critical values (not presented) the null hypothesis of weak identification is rejected⁸. The first stage regression results also validate the instrument with a partial R^2 between the excluded instrument and economic growth of 0.54 (Appendix II).

The results in Table III are robust to several changes in sample size and model specification. First, we varied the sample size by excluding: 1) Moscow region, since Potapov et al. (2011) find the largest incidence of forest disturbance not due to timber harvesting, but instead due to urbanization, around Moscow city; 2) the six regions that had no data on forest disturbance in 1990-2000; 3) the two regions that were outliers in our test of correlation across governance measures (Appendix I, Figure A); and 4) regions where more than 5, 10 or 15 percent of gross domestic product was from the wood sector to mitigate concerns about our instrument choice. Second, we estimated Equation 3 with a measure of national timber prices. We used data on roundwood prices from the UNECE/FAO timber database and introduced this variable as an interaction term between temporally-variant national prices and spatially-variant

specifications; these results can be obtained by request from the authors. However, since the Kleibergen-Paap Wald F-statistic was less than 10 in the dummy variable specification we chose not to present this regression output in the paper.

⁸ With cluster-robust standard errors, the Kleibergen-Paap Wald F-statistic is presented but critical values are not available. Baum et al. (2007) suggest that the critical values from the Stock and Yogo (2005) test that assumes i.i.d. standard errors can be used with caution, or that the general “rule of thumb” that the F-statistic should be at least 10, can be used.

distance to nearest market. The coefficient on governance did not change when the sample size was changed or when price was added.

As a final check on our results we randomly assigned governance measures within the range of the data, i.e., 1.5 to 4.5, to regions. We did this five times and re-estimated the parameters in Equation 3 under the quadratic and dummy variable specifications. An insignificant effect on these “false” governance scores helps eliminate concern of spurious correlation between our main variable of interest and logging. Overall, the average value on these randomly generated governance measures is slightly less than the average value found in Table I with a mean of 2.85. We do not find a statistically significant relationship between governance and logging in regressions using these generated values of governance, providing additional support that our results in Table III are not spurious (Appendix III).

5. Discussion

Our results are similar to previous findings on governance and resource extraction (i.e., Bohn and Deacon [2000] and Ferreira and Vincent [2010]): “good” governance increases natural resource extraction, but this effect decreases at higher levels of governance. This comes with the caveat, however, that measures of governance differ significantly across studies, and it is therefore difficult to compare the quantitative results. Previous studies emphasize the channel of ownership risk; however, corruption is also likely to have a direct impact on extraction decisions by influencing the costs of doing business in countries where state-owned forests are leased to private firms.

While we are not able to test which mechanism is at work using our within estimator – something that will be challenging for any empirical analysis to test given the correlation across the two mechanisms – nonparametric regressions between regional governance and national

forestry statistics can shed light on how these two factors are affecting firm decisions in Russia. We use kernel-weighted (Epanechnikov kernel) local polynomial regressions with a bandwidth of 0.3⁹ to test the correlation between governance and percent of timberland leased, number of lease contracts and percent of allowable timber stock harvested. These data come from the Federal Agency of Forestry in Russia and were only obtained for the years 1994 to 2002.

Figure 2.A. shows the relationship between governance and forest leased as a percent of total forest area in a region. The overall pattern suggests a positive relationship between better governance and percent of forest leased. At the highest level of governance the graph slopes down, but variance in this range of the graph is quite high. Figure 2.B. shows the relationship between number of lease contracts and governance. Again, the relationship suggests that regions with better governance have a higher number of lease contracts. The nonparametric relationship between governance and leases is in line with qualitative reports of bribes placed on timber contracts in Russia (Krott et al. 2000; Eikeland et al. 2004) and suggests that non-collusive corruption was one factor affecting timber firms in our sample.

<Insert Figure 2 near here>

Figure 2.C. shows the percent of reported timber stock harvested out of the total allowable harvest – a quantity set annually by the federal government based on biological conditions of the resource stock. There is a noticeable difference in this graph between low levels of governance and higher levels of governance. At low levels of governance the percent cut is the lowest. At higher levels of governance (i.e., 2.5-3 range) changes in the percent harvested levels off. At the highest end of the governance range (i.e., 4) the percent cut starts to decline slightly. The difference at low levels of governance is consistent with reports that timber

⁹ This is the “rule-of-thumb” bandwidth default chosen by Stata, which is a reasonable choice if the true density is close to normal.

harvesting was directly affected by weak legal capacity and enforcement of property rights (Torniainen and Saastamoinen 2007; Torniainen 2009). As ownership risk decreases, more harvesting occurs, suggesting that the “investment” effect is greater than the “depletion” effect.

Ferreira and Vincent (2010) find a statistically significant and non-monotonic effect of governance on logging in their cross-country analysis. Our fixed effects estimates and nonparametric regressions strongly suggest a non-linear relationship between governance and timber extraction: both the quadratic and dummy variable specifications indicate that as governance improves, so does harvesting, but not linearly. A non-linear relationship between governance and timber extraction could mean several things: that there are decreasing returns to governance, that “good” governance leads to less myopic behavior (as concluded by Ferreira and Vincent [2010]), or that “good” governance increases the costs of doing business relative to slightly lower levels of governance (e.g., if environmental regulations are more strictly enforced).

Since governance is made up of a “bundle” of institutions, it would be informative to unbundle this cluster of institutions (as Baland et al. [2010] recommend for the relationship between governance and economic growth). However, this is complicated by the high correlation between different types of institutions and the fact that most data on governance is collected through secondary sources and therefore not designed with hypothesis testing in mind. We attempted to use the eight indicators from the Carnegie Center Moscow as individual covariates or averaged across two or three “types” of institutions in our estimations, but high collinearity precluded consistent estimation. However, one positive side to the high correlation across types of institutions is that incremental changes in any one of these indicators are likely to impact other indicators leading to non-uniform gains in governance.

Despite the difficulties of unbundling governance or structurally estimating the influence of ownership risk or corruption on resource extraction, understanding the reduced form relationship between governance and natural resource use provides important information for policy. Many policy prescriptions in developing and transitional countries focus on the assumed relationship that improving governance will slow resource use. These prescriptions come primarily from results that suggest “good” governance can reduce deforestation and illegal logging (Barbier et al. 2005; Bulte et al. 2007; Burgess et al. 2011). Our results, and results from other papers on governance and natural resource extraction, suggest the opposite. As governance improves, more capital-intensive resource uses, such as commercial logging, may become more attractive in areas where weak institutions currently undermine property rights and increase the costs of doing business.

There are two caveats to this conclusion. First, similar to previous research, we cannot comment on the long-term economic or ecological impacts of increased or decreased harvest rates that would come with better governance. Thus, commercial logging could increase or decrease the sustainable use of forests, and our analysis cannot detect impacts of governance on forest degradation or selective logging. Second, since ownership risk and corruption can increase or decrease resource use depending on the particular conditions of the resource use, and since these two factors can interact, the relationship between governance and natural resource extraction could vary based on the type of corruption (i.e., collusive versus non-collusive), the relative influence of the “investment” versus “depletion” effect, and the overall profitability of the resource use.

6. Conclusion

This paper contributes to a growing body of literature on the political economy of natural resource extraction (Bohn and Deacon 2000; Ferreira and Vincent 2010). Its main contribution relative to previous analyses of governance and natural resource extraction is the use of within-country variation in governance rather than cross-country analysis, which render causal interpretation difficult. In addition, the use of remotely sensed data on timber extraction reduces concerns about measurement error, while the combination of fixed-effects estimation that draws on regional-level variation over time and instrumenting for regionally- and temporally-variant unobservables with economic growth diminishes the possibility of omitted variables biasing the results. We find a statistically significant and non-linear impact of governance on logging using both a quadratic and dummy variable specification for governance. We identify two possible mechanisms through which governance would impact natural resource use: ownership risk and corruption. Nonparametric regressions and qualitative literature suggest that both are at work in Russia, leading to the positive relationship between improving governance and increased timber harvests.

References

- Acemoglu, D., S. Johnson and J. A. Robinson. 2005. Institutions as fundamental determinants of long run growth. In: Aghion, P. and S. Durlauf (eds.), *The Handbook of Economic Growth* Volume 1A. Amsterdam: North-Holland.
- Aidt, T. S. 2009. Corruption, institutions, and economic development. *Oxford Review of Economic Policy* 25(2): 271-291.
- Amacher, G.S., M. Ollikainen, and E. Koskela. 2012. Corruption and forest concessions. *Journal of Environmental Economics and Management* 63(1): 92-104.
- Arnot, C.D., M.K. Luckert, and P.C. Boxall. 2011. What is Tenure Security? Conceptual Implications for Empirical Analysis. *Land Economics* 87(2): 297-311.
- Baland, J.M., K.O. Moene and J.A. Robinson. 2010. Chapter 69 - Governance and Development. In: Rodrik, D. and M. Rosenzweig (eds.), *Handbook of Development Economics*, Volume 5: 4597-4656, Elsevier.
- Banerjee, A. V. 1997. A theory of misgovernance. *Quarterly Journal of Economics* 112: 1289–1332.
- Barbier, E.B., R. Damania and D. Leonard. 2005. Corruption, trade, and resource conversion. *Journal of Environmental Economic and Management* 50: 276-299.
- Bardhan, P. 1997. Corruption and development: A review of issues. *Journal of Economic Literature* 35(3): 1320–1346.
- Barrett, C.B., C.C. Gibson, B. Hoffman and M.D. McCubbins. 2005. The complex links between governance and biodiversity. *Conservation Biology* 20(5): 1358-1366.
- Baum, C.F., M.E. Schaffer and S. Stillman. 2007. Enhanced routines for instrumental variables/GMM estimation and testing. Boston College Economics Working Paper No. 667.

- Berkowitz, D. and D.N. DeJong. 2003. Accounting for growth in post-Soviet Russia. *Regional Science and Urban Economics* 32: 221-239.
- Besley, T. 1995. Property rights and investment incentives: theory and evidence from Ghana. *The Journal of Political Economy* 103(5): 903-937.
- Binkley, C.S., 1987. Economic models of timber supply. In: Kallio, M., Dykstra, D., Binkley, C.S. (eds) *The global forest sector: an analytical perspective*. John Wiley & Sons, Chichester, UK.
- Bloom, E.D. and D. Canning. 2000. The Health and Wealth of Nations. *Science* 287(5456): 1207-1209.
- Bohn, H. and R.T. Deacon. 2000. Ownership risk, investment, and the use of natural resources. *American Economic Review* 90: 526-549.
- Bouriaud, L., and F. Schmithusen. 2005. Allocation of property rights on forests through ownership reform and forest policies in Central and Eastern European countries. *Schweizerische Zeitschrift für Forstwesen* 156(8): 297–305.
- Bulte, E.H., R. Damania and R. Lopez. 2007. On the gains of committing to inefficiency: Corruption, deforestation and low land productivity in Latin America. *Journal of Environmental Economics and Management* 54(3): 277-295.
- Burgess, R., M. Hansen, B. Olken, P. Potapov and S. Sieber. 2011. The Political Economy of Deforestation in the Tropics. Viewed online: <https://www.ucl.ac.uk/economics/seminarpapers/february11/sticerd21feb11.pdf>
- Cameron, A.C., and P.K. Trivedi. 2005. *Microeconometrics: Methods and applications*. Cambridge Press.

- Carlsson, L. and M.O. Olsson (eds.). 1998. Initial Analyses of the Institutional Framework of the Russian Forest Sector. IIASA Interim Report (IR-98-027). Laxenburg, Austria.
- Chowdury, S.K. 2004. The effect of democracy and press freedom on corruption: an empirical test. *Economics Letters* 85(1): 93-101.
- Deacon, R. and B. Mueller. 2004. Political economy and natural resource use. Department of Economics Working Paper, UCSB.
- Dininio, P. and R. Orttung. 2005. Explaining patterns of corruption in the Russian regions. *World Politics* 57(4): 500-529.
- Eikeland, S., E. Eythorsson and L. Ivanova. 2004. From management to mediation: local forestry management and the forestry crisis in post-socialist Russia. *Environmental Management* 33: 285-293.
- FAO. 2009. State of the World's Forests 2009. Rome. Italy.
- Farzin, Y.H. 1984. The effect of the discount rate on depletion of exhaustible resources. *The Journal of Political Economy* 92: 841-851.
- Feder, G. and T. Onchan. 1987. Land ownership security and farm investment in Thailand. *American Journal of Agricultural Economics* 69(2): 311-320.
- Ferraro, P. 2005. Corruption and conservation: The need for empirical analyses. *Oryx* 39(3): 1-3.
- Ferreira, S. and J.R. Vincent. 2010. Governance and Timber Harvests. *Environmental and Resource Economics* 47(2): 241-260.
- Gavian, S. and M. Fafchamps. 1996. Land tenure and allocative efficiency in Niger. *American Journal of Agricultural Economics* 78(2): 460-471.
- Gehlbach, S. and E.J. Malesky. 2010. The Grand Experiment That Wasn't? New Institutional Economics and the Postcommunist Experience. Working Paper.

- Granville, B. and C.S. Leonard. 2010. Do informal institutions matter for technological change in Russia? The impact of Communist norms and conventions, 1998-2004. *World Development* 38(2): 155-169.
- Hanson, P. and M. Bradshaw. 2000. *Regional Economic Change in Russia*. Edward Elgar Publishing.
- Hayes, J., M. Roth and L. Zepeda. 1997. Tenure security, investment and productivity in Gambian agriculture: A generalized probit analysis. *American Journal of Agricultural Economics* 79: 369-382.
- Ickes, B.W. and G. Ofer. 2006. The political economy of structural change in Russia. *Journal of Political Economy* 22: 409-434.
- Jacoby, H.G., G. Li and S. Rozelle. 2002. Hazards of expropriation: tenure insecurity and investment in Rural China. *American Economic Review* 92(5): 1420-1477.
- Kabubo-Mariara, J. 2007. Land conservation and tenure security in Kenya: Boserup's hypothesis revisited. *Ecological Economics* 64: 25-35.
- Kaufmann, D. and A. Kraay. 2002. Growth without governance. *Economica* 3: 169-229.
- Kaufmann, D., A. Kraay and M. Mastruzzi. 2006. Governance Matters V: Governance Indicators for 1996-2005. World Bank Policy Research Department Working Paper No. 4012.
- Kaufmann, D., A. Kraay and M. Mastruzzi. 2007. The Worldwide governance Indicators Project: Answering the Critics. World Bank Policy Research Department Working Paper No. 4149.
- Kaufmann, D., A. Kraay and M. Mastruzzi. 2009. What do the Worldwide Governance Indicators Measure? Viewed online:
<http://info.worldbank.org/governance/wgi/resources.htm>.

- Kaufmann, D., A. Kraay and M. Mastruzzi. 2010. Response to: “The Worldwide Governance Indicators: Six, One, or None”. Viewed online:
<http://info.worldbank.org/governance/wgi/resources.htm>.
- Kinnunen, J., M. Maltamo and R. Paivinen. 2007. Standing volume estimates of forests in Russia: how accurate is the published data? *Forestry* 80(1): 53-64.
- Kortelainen, J. and J. Kotilainen. 2003. Ownership Changes and Transformation of the Russian Pulp and Paper Industry. *Eurasian Geography and Economics* 44(5): 384-402.
- Krott, M., I. Tikkanen, A. Petrov, Y. Tunytsya, B. Zheliba, V. Sasse, I. Rykounina and T. Tynytsya. 2000. *Policies for Sustainable Forestry in Belarus, Russia and Ukraine*. Leiden: Koninklijke Brill NV.
- Laurent-Lucchetti, J. and M. Santugini. 2012. Ownership risk and the use of common-pool natural resources. *Journal of Environmental Economics and Management* 63(2): 242-259.
- Libman, A. 2010. Democracy, size of bureaucracy, and economic growth: Evidence from Russian regions. Working Paper.
- Ottitsch, A., A. Moiseyev, N. Burdin and L. Kazusa. 2005. Impacts of Reduction in Illegal Logging in European Russia on the EU and European Russia Forest Sector and Trade. European Forest Institute Technical Report, Finland.
- Petrov, N. 2005. *Demokratichnost’ Regionov Rossii*. Moscow. Moscow.
- Potapov P., S. Turubanova S. and M.C. Hansen. 2011. Regional-scale boreal forest monitoring using Landsat data composites: first results for European Russia. *Remote Sensing of Environment* 115(2): 548-561.
- Prishchepov, A., V.C. Radeloff, M. Baumann, T. Kuemmerle, and D. Muller. 2012. Effects of institutional changes on land use: agricultural land abandonment during the transition from

- state-command to market-driven economies in post-Soviet Europe. *Environmental Research Letters* 7(2): 13pp.
- Robinson, B.E., M.B. Holland, and L. Naughton-Treves. 2011. Does secure land tenure save forests? A review of the relationship between land tenure and tropical deforestation. CGIAR Working Paper No. 7.
- Robinson, J. A., Torvik, R., and Verdier, T. 2006. The political foundations of the resource curse. *Journal of Development Economics* 79: 447–468.
- Slinko, I., E. Yakovlev and E. Zhuravskaya. 2005. Laws for Sale: Evidence from Russia. *American Law and Economics Review* 7(1): 284-318.
- Stock, J. H. and M. Yogo. 2005. Testing for Weak Instruments in Linear IV Regression. In: Andrews, D.W. and J.H. Stock (eds.), *Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg*, Cambridge University Press.
- Stoner-Weiss, K. 1997. *Local Heroes: The political economy of Russian regional governance*. Princeton University Press.
- Torniainen, T.J. and O.J. Saastamoinen. 2007. Formal and informal institutions and their hierarchy in the regulation of the forest lease in Russia. *Forestry* 80(5): 489-501.
- Torniainen, T. 2009. Institutions and forest tenure in the Russian forest policy. Dissertationes Forestales 95. Finnish Society of Forest Science, Vantaa, Finland.
- Vasile, M. Unpublished. Decentralization as an aid to enhancing corruption in Romania forests. University of Bucharest.
- Wendland, K.J., Lewis, D.J., Alix-Garcia, J., Ozdogan, M., Baumann, M. and V.C. Radeloff. 2011. Regional- and district-level drivers of timber harvesting in European Russia after the collapse of the Soviet Union. *Global Environmental Change* 21(4): 1290-1300.

Wooldridge, J.M. 2010. *Econometric Analysis of Cross Section and Panel Data*, 2nd Edition.
MIT Press.

World Bank. 2004. *Key Challenges of the Russian Forest Policy Reform*. Washington, D.C.
Washington, D.C.

Yakovlev, E. and E. Zhuravskaya. 2008. *Reforms in Business Regulation: Evidence from Russia*.
Working Paper, Centre for Advanced Studies, Moscow, Russia.

Yaroshenko, A. *Unpublished results*. TM-ETM forest classification 1990-2000. Moscow:
Greenpeace Russia. Moscow.

Yaroshenko, A. *Personal communication*. August 10, 2009.

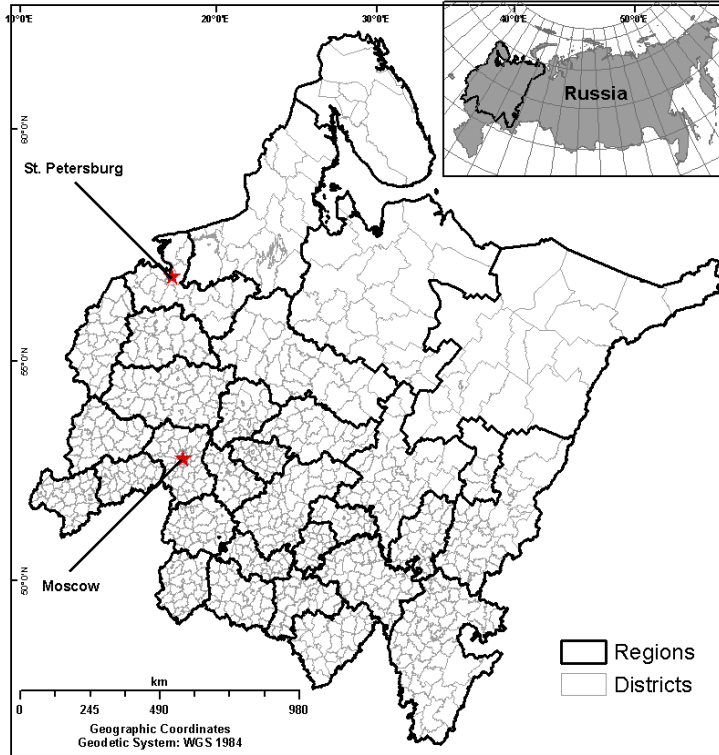
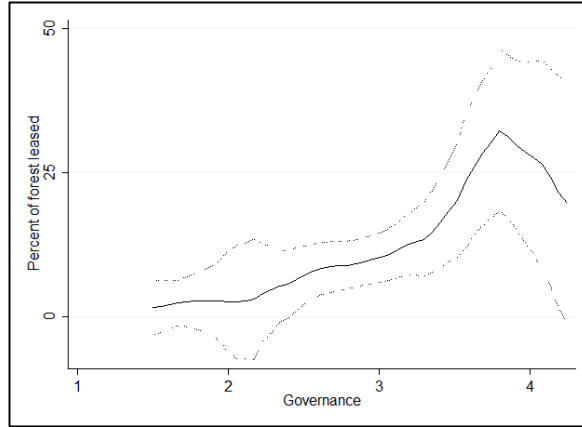
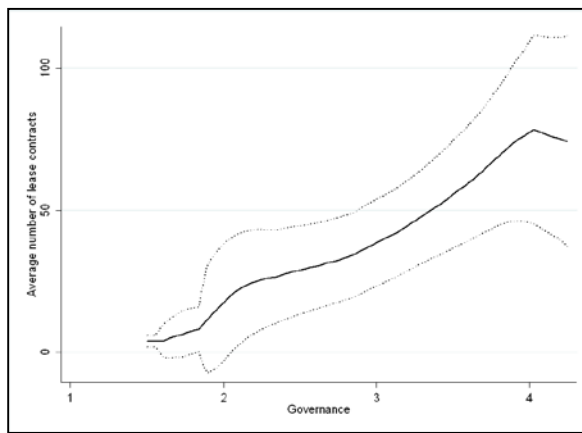


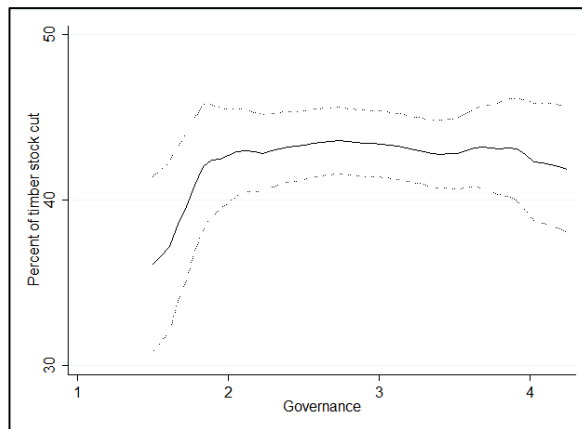
Figure 1. Map of study area



A



B



C

Figure 2. Nonparametric regression^a of governance on: A) percent of forest leased out of total forest; B) number of timber leases; C) percent of reported timber cut out of annual allowable cut

^aResults from kernel-weighted (Epanechnikov kernel) local polynomial regression of governance on variable of interest (bandwidth = 0.3; This is the “rule-of-thumb” bandwidth default chosen by Stata, which is a reasonable choice if the true density is close to normal.). Dotted line is the 95% confidence interval. Regional data are used (N=62). Percent of total forest leased calculated as average area leased during time period (e.g., 1994-2000 or 2000-2002) divided by total forest area. Number of timber contracts calculated as average number of contracts during time period. Percent of reported timber cut calculated as average reported timber harvested during time period (e.g., 1994-2000 or 2000-2002) divided by the annual allowable cut each year – a quantity set by the government.

Table I. Description, data source and summary statistics for data**Panel A: Description and data source**

Variable	Description	Data source
Forest disturbance	Dependent variable. Measured at the district level from satellite imagery as the area (km ²) converted from forest to non-forest. Remote sensing analysis gives total area converted between 1990-2000 and 2000-2005; authors translate total area to a per-year metric by dividing the total area by the number of years in that period (so, 10 years for 1990-2000 and 5 years for 2000-2005). This retains the two data periods in the panel model, but allows an interpretation of coefficients and marginal effects based on area harvested per year.	1990-2000 data from Greenpeace-Russia (Yaroshenko et al., <i>unpublished results</i>) and 2000-2005 data from Boreal Forest Monitoring Project ^a (described in: Potapov et al. 2011)
Governance	Measured at the regional level. There are 8 indicators (see Table II) and each is measured on a scale of 1 to 5 with 5 high. We take the average of these 8 indicators.	Carnegie Center Moscow (Petrov 2005) and online ^b

Evergreen	Measured at the district level as percent of evergreen forest in 2005; time-invariant.	Moderate Resolution Imaging Spectroradiometer imagery
Slope	Measured at the district level as average variation in slope (degrees); time-invariant.	NOAA's Global Land 1-km Base Elevation Project
Road density	Measured at the district level as total length of roads (meters) in a district divided by area of that district (m ²); time-invariant.	1:500,000 topographic maps published around 1990
Distance	Measured at the district level as the distance (km) from centroid of a district to closest market, defined as either Moscow city or St. Petersburg; time-invariant.	Calculated by authors
Forest area	Measured at the district level as total forest area (km ²).	2000 measure from Boreal Forest Monitoring Project and 1990 measure recreated by authors (see text)
Economic growth	Measured at the regional level as percent change in per capita gross regional product between 1995-2000 and 2000-2005.	National statistical database, Rosstat

Output per worker Measured at the regional level as National statistical database,
percent change in output per worker Rosstat
between 1995-2000 and 2000-2005.

Panel B: Summary statistics

Variable	Observations ^c	Mean	Standard deviation	Minimum	Maximum
Forest disturbance (km ²)	1,476	6	15	0	215
Governance (1-5)	62	3	0.6	1.5	4.3
Evergreen (%)	1,476	47	36	0	100
Slope (degrees)	1,476	0.74	0.57	0	5.78
Road density (m/ m ²)	1,476	0.01	0.03	0	0.40
Distance (km)	1,476	528	327	0	1,837
Forest area (km ²)	1,476	1,895	3,706	0.06	33,957
Economic growth (%)	62	21	26	-33	69
Output per worker (%)	62	14	26	-41	63

^a<http://kea.sdstate.edu/projects/boreal/>

^bhttp://www.socpol.ru/atlas/indexes/index_democr.shtml

°Variables with 1,476 observations are measured at the district level; variables with 62 observations are measured at the regional level (2 times periods * 31 regions = 62 observations).

Table II. Definitions of indicators used in governance measure^a

Indicator	Description
Civil society	Measures presence of NGOs, referenda, and freedom of public political activity such as rallies and demonstrations.
Free and fair elections	Measures whether elections are free and fair at national, regional and local levels.
Political stability	Measures the representation of political parties in regional legislature and the stability of these parties.
Competition in elections	Measures the existence of multiple political parties and the effectiveness of leadership changes through elections.
Independence of media	Measures the independence of the media from authorities.
Government transparency	Measures the transparency of regional political life.
Balance of powers	Measures the balance of power between the executive and the legislative branches, the independence of the judiciary, and effectiveness of law enforcement.
District government	Measures the ability of district governments to carry out collective actions.

^aIndicator names and descriptions are based on http://www.socpol.ru/atlas/indexes/index_democr.shtml and Libman (2010); however, some names have been changed to more fully represent their definitions.

Table III. Econometric results with and without instrumenting for economic growth^a

Variable	Quadratic specification		Dummy variable specification	
	No instrument	Instrument	No instrument	Instrument
Panel A: Regression output				
Governance	2.355*** (0.726)	2.870** (1.138)		
Governance squared	-0.336*** (0.120)	-0.414** (0.182)		
Governance dummy “neutral”			0.256*** (0.724)	0.425*** (0.092)
Governance dummy “good”			0.213*** (0.031)	0.245*** (0.034)
Economic growth	0.003** (0.001)	0.005* (0.003)	0.001 (0.002)	0.006** (0.003)
Ln(Forest area)	0.344*** (0.034)	0.344*** (0.033)	0.344*** (0.034)	0.344*** (0.034)
Ln(Evergreen)	0.928*** (0.144)	0.929*** (0.142)	0.925*** (0.143)	0.929*** (0.141)
Ln(Slope)	-0.490*** (0.152)	-0.494*** (0.150)	-0.471*** (0.149)	-0.470*** (0.146)
Ln(Road density)	5.558*** (1.157)	5.652*** (1.167)	5.406*** (1.155)	5.548*** (1.172)
Ln(Road	-1.634***	-1.803***	-1.6347***	-1.594***

density)*time	(0.372)	(0.426)	(0.390)	(0.475)
dummy				
Ln(Distance)	0.401***	0.391***	0.414***	0.393***
	(0.076)	(0.078)	(0.075)	(0.080)
Ln(Distance)*time	-0.302***	-0.282***	-0.325***	-0.285***
dummy	(0.049)	(0.048)	(0.045)	(0.052)
Time dummy	1.785***	1.573***	2.001***	1.562***
	(0.318)	(0.346)	(0.308)	(0.392)
Constant	-7.497***		-3.906***	
	(1.152)		(0.494)	

Panel B: Marginal effect of governance at mean value (quadratic specification)^b

Governance +	0.337***	0.387***
Governance squared	(0.115)	(0.125)

Panel C: Additional information

Observations	1,476	1,476	1,476	1,476
Number of regions	31	31	31	31
R ² (centered)	0.74	0.55	0.74	0.54

Panel D: Test of instruments

Underidentification test, Chi-squared p-value		0.007***		0.014**
---	--	----------	--	---------

Weak

23.770

16.299

identification test,

Wald F-statistic

*** p<0.01, ** p<0.05, * p<0.1

^aThe dependent variable is the log-transformed value of area of timber harvested. Standard errors are clustered at the regional level. The unit of observation is districts. In dummy variable specification governance dummy “poor” is omitted. Economic growth is instrumented for using change in output per worker. In Panel D, test statistics were generated using Stata 11. The underidentification test is the Lagrange Multiplier test of whether the equation is identified; the null is that the equation is underidentified. The weak identification test is the cluster-robust Kleibergen-Paap Wald F-statistic; critical values are not reported for this test but a “rule of thumb” is that a F-statistic greater than 10 rejects the null hypothesis of weak identification (Baum et al. 2007).

^bMarginal effects are relative to the values on governance used in this study and cannot be generalized to other studies.

Appendix I. Validity test of governance measure

To establish validity of the average governance score for a region we compare it to an assessment of the investment potential of Russian regions. Measurements of governance are by nature subjective, and even widely used measures are open to criticism (for example, see: Kaufmann et al. 2007; Kaufmann et al. 2009; Kaufmann et al. 2010). Expert RA Rating Agency is part of an international group of publishing and research companies within Russia and has published rankings of investment potential across Russian regions since 1995. These rankings include aspects of investment potential that go beyond governance: they also rate potential based on economic, social, and biophysical factors. Despite this broader definition, a strong correlation between Expert RA rankings and the average value of the Carnegie Center Moscow indicators provides additional confidence in our governance measure (Figure A). The scatter plot between governance – where higher indicates better governance – and investment potential – where higher indicates greater investment potential – is strong, with two regional outliers. Both outliers rank poorly in governance because elections are not free and fair and there is little public participation in government, but score high in investment potential due to heavy Soviet period industrialization.

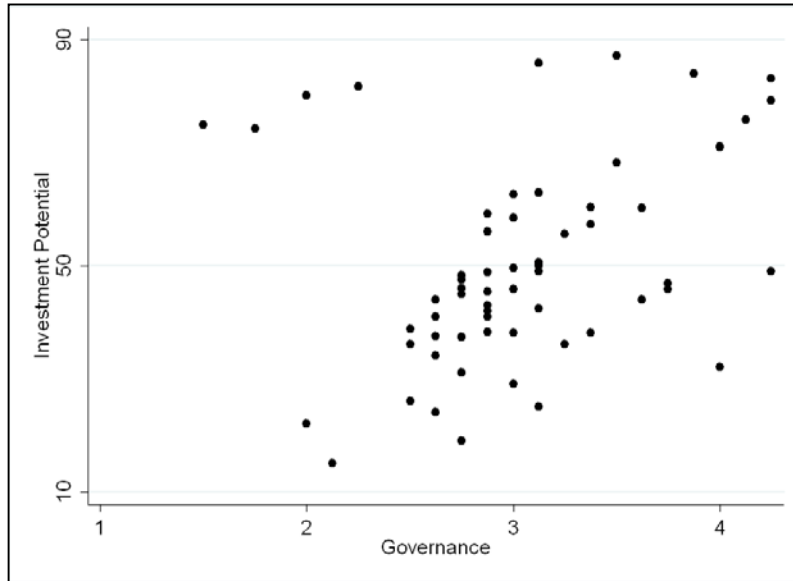


Figure A. Governance versus ranking of investment potential by region^a

^aGovernance is the average value of indicators measuring political institutions and state capacity and effectiveness; indicators come from the Carnegie Center Moscow. Scores range from 1.5 to 4.3 with higher representing better governance. Investment potential is the average annual ranking given by Expert RA Ranking Agency to a region and is based on the composite investment potential of economic, political, social, and biophysical factors. Regions are ranked from 1 to 89; in this graph 89 indicates the highest investment potential. There are 62 observations: 31 regions with values for two time periods.

Appendix II. First stage regression output for instrumental variable regression^a

Variable	Quadratic specification	Dummy variable specification
Panel A: Regression output		
Governance	-187.255*** (51.817)	
Governance squared	28.169*** (9.470)	
Governance dummy “neutral”		-14.261** (6.555)
Governance dummy “good”		0.619 (2.689)
Ln(Forest area)	-0.033 (0.053)	-0.052 (0.050)
Ln(Evergreen)	-0.503* (0.279)	-0.335 (0.312)
Ln(Slope)	0.377 (0.150)	-0.916 (1.003)
Ln(Road density)	-32.103*** (9.524)	-25.580** (10.474)
Ln(Road density)*time dummy	57.969*** (17.404)	43.766** (18.823)
Ln(Distance)	1.690	1.955

	(1.718)	(1.562)
Ln(Distance)*time dummy	-2.841	-3.442
	(3.127)	(2.925)
Time dummy	46.634***	49.307**
	(18.718)	(18.513)
Output per worker	0.500***	0.486***
	(0.103)	(0.120)

Panel B: Additional information

Observations	1,476	1,476
Number of regions	31	31
R ² (centered)	0.91	0.89
Shea Partial R ² of excluded instruments	0.542	0.438

*** p<0.01, ** p<0.05, * p<0.1

^aThe dependent variable is economic growth. Standard errors are clustered at the regional level. The unit of observation is districts. In Panel B, test statistics were generated using Stata 11. The Shea partial R² isolates the explanatory power of output per worker (the excluded instrument) in explaining economic growth.

Appendix III. Econometric estimates from falsification test without instrumenting for economic growth^a

Variable	Draw 1	Draw 2	Draw 3	Draw 4	Draw 5
Governance (Mean and Std Dev)	2.78 (1.16)	2.89 (1.08)	2.84 (1.06)	2.95 (1.05)	2.86 (1.01)
Panel A: Regression output					
Quadratic specification					
Governance	-0.157 (0.129)	0.042 (0.268)	0.054 (0.164)	0.277 (0.165)	
Governance squared	0.024 (0.020)	-0.007 (0.044)	-0.011 (0.026)	-0.050* (0.028)	
Ln(Governance)					-0.054 (0.093)
Dummy variable specification					
Governance dummy “neutral”	-0.069 (0.069)	0.011 (0.092)	-0.019 (0.071)	0.095 (0.058)	-0.026 (0.066)
Governance dummy “good”	-0.042 (0.090)	-0.013 (0.057)	-0.090 (0.069)	-0.027 (0.083)	-0.044 (0.081)
Panel B: Marginal effect of governance at mean value (quadratic specification)					
Governance + squared	-0.013 (0.026)	0.002 (0.012)	-0.012 (0.020)	-0.023 (0.030)	

*** p<0.01, ** p<0.05, * p<0.1

^aRandom integers between 1.5 and 4.5 were assigned to regions using the random number generator in Stata 11.

^bThe dependent variable is the log-transformed value of area of timber harvested and all covariates were included as specified in Equation 3. For the quadratic specification, in draw 5, the turning point for governance is not within the range of the data so a log-transformation is used. Similar regression results are found when instrumenting for economic growth and can be obtained from the authors by request.