Corruption, institutions, and sustainable development: theory and evidence from inclusive wealth

Rintaro Yamaguchi * Kong Joo Shin†

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Abstract

Institutional quality has been known to be a key factor explaining economic growth, and more recently, sustainable development. Comparing corruption linked to either resource extraction or land development, we first consider theoretically how institutions affect natural capital shadow prices and degradation. In the corrupt land development model, total land value could be positive or negative; and the effect of institutions is not symmetric in both models. Taking corruption control as an example, we then study how institutions affect various components of natural capital, as well as inclusive wealth, using data from Inclusive Wealth Report. Fixed country effects estimates using panel data show significantly positive effect of corruption control on the change of non-renewable resources, and some limited results for forest and agricultural land. Also, the effect of resource abundance on some resources are found. We broadly observe corruption control affects positvely natural capital per capita, but the channels and lead time could be different depending on subcategories.

JEL codes: D73; O43; Q20; Q30

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*Graduate School of Economics, Kyoto University, Yoshidahonmachi 606-8501 Japan. Tel: +81-75-753-3425. E-mail: rintaro.yamaguchi at gmail.com.

†Department of Urban and Environmental Engineering, School of Engineering, Kyushu University, 744 Motooka 819-0395 Japan. Tel: +81-92-802-3429. E-mail: kongjooshin at gmail.com

1 Introduction

Seeking the engine of economic growth other than factors of production has been the pillar theme of modern economic growth theory. In recent decades, one of the active areas of research has been the relationship between various institutions and economic growth. The literature is vast and collated in modern economic growth textbooks (e.g., Barro and Sala-i-Martin 2004; Acemoglu 2009; Aghion and Howitt 2009). As one such aspect of institutions, corruptive behavior of bureaucrats involving the private sector, has been widely debated, and also been known to have mixed effects on economic growth, both theoretically and empirically.

As nicely summed up in Aidt (2009), the effect of corruption on economic growth could go both ways. It can grease the wheel of economic transactions to lead to more investment that had not taken place in the absense of bribery. This comes as intuitive particularly in anecdotal accounts of bribery that corrects prevailing governmental inefficiencies in autocratic or communist regimes. On the contrary, it can sand the wheel of transactions to create more inefficiencies, resulting with stagnant investment and growth. This idea seems consistent with the view that government officials are rent-seeking, rather than maxmizing social well-being, agents (e.g., Murphy et al. 1993).

All these discussions are centered on the nexus between corruption and economic growth, but it is increasingly recognized that it is the increase in comprehensively aggregated wealth that represents intergenerational well-being improvement (e.g., World Bank 2011; Arrow et al. 2012). The discussion on corruption and growth could partially carry on to the expanded debate on corruption-wealth nexus, because "inclusive wealth" is the aggregation of physical, human, and natural capital in dollar terms. For example, if corruption is considered to grease the wheel of investment in traditional sense, the decrease in natural capital is accelerated. If it is regarded to sand the wheel, on the other hand, natural capital degradation is to be mitigated, perhaps for wrong reasons.

So how do institutions come into the picture of sustainable development? The founders of modern sustainability analysis place institutions as enabling assets, as opposed to productive assets that are costituents of inclusive wealth (Dasgupta 2009). Institutional characteristics of an economy determine resource allocation of flow and stock variables from current to future periods, which in turn determine the current shadow prices of stocks in the economy. Therefore, institutions per se do not comprise productive capital assets, but they work, much like catalysits, to improve or worsen shadow prices of those capital assets.

A separate, but closely related literature is that on what is termed resource curse. This huge strand of literature studies the paradoxical hypothesis that (exhaustible) resource rich nations are likely to experience sluggish growth[1]. But if long-run growth is partially determined by savings from resource rents, as was pointed out by Hartwick (1977) and its succeeding studies, the curse, if any, should be traceable to the undersupply of savings into various capital assets. This is where institutions come into play, and indeed, some studies find that good governance and resource abundance could work to turn a potential curse into a blessing (Brunschweiler and Bulte 2008)[2]. Since the depletion of exhaustible resources is a component of the change in inclusive wealth, a more direct nexus that should be studied is the one from governence and institutions to investing resource rents. Atkinson and Hamilton (2003) conducted a cross-section analysis to find that governnce facilitates investing rents into capital assets, i.e., genuine savings. Dietz et al. (2007) extend the analysis to panel data to show that the interaction of resource dependence on the one hand and lack of corruption and rule of law on the other hand significantly reduces the negative impact of resource dependence on genuine savings.

Against this background, we first review theory on the relationship between corruption and the inrease in inclusive wealth, mainly extending Barbier's (2010) corruption-resource model and assuming the sum of bribery and well-being is dynamically maximized. We make sure that corruption makes a downward pressure on overall sustainability, but its effect on specific components of natural capital is different. We then go on to check this theoretical implications using inclusive wealth dataset. What is to be studied principally is the effect of corruption control, not only on inclusive wealth change as an indicator of sustainable development, but also on its component, natural capital.

Two points can be summarized as our contribution. First, our theoretical model is assuming a capital-resource economy in a political setting, following Barbier (2010), but it also includes resource renewability and corruption related to land development. It is found that there is asymmetry between the case for extraction-linked corruption and that for land development-linked corruption, although in both cases more corruptibility is likely to translate into degrading natural capital, with sustainable development at more risk. Although we assume dynamic optimality in the sense that the social planner maximizes the sum of social

[1] van der Ploeg (2011) summarizes the literature, also linking with genuine savings as an indicator of sustainable development.

[2] van der Ploeg and Poelhekke (2010) find that resource volatility is the key to such a curse.

well-being and bribery benefit, this describes capital and shadow price dynamics prevalent in imperfect resource dependent economies, rather than assuming agathotopia.

Second, we also provide new, albeit limited, evidence on the corruption-wealth nexus, ensuring that corruption control could facilitate sustainable development. Aidt (2009) was the first to find empirically the relationship between corruption and the growth in wealth per capita. Given that the nexus from corruption to the growth in GDP per capita is ambiguous, this result is illuminating, However, since the dependent variable is made up of several components, it would be of help to decompose them and trace the channels where investment is affected by corruption. Moreover, it is just a few years since a wide panel data on inclusive wealth is available both from World Bank and UNU-IHDP and UNEP (2014), and to the best of our knowledge few studies have dealth with the effect of corruption for natural capital components and other important capital assets in a parallel fashion. We also control the effect of resource abundance, following the resource curse litereture.

The plan of the paper is as follows. In Section 2, we present our basic model of corruption and sustainable development and study characteristics of the change in wealth. The resource extraction case and the land development case are separetely argued and compared. Section 3 performs empirical analysis using inclusive wealth data by UNU-IHDP and UNEP (2014). Both of cross section and panel data analyses are reported. Section 4 is allocated to some discussion with concluding remarks and future tasks.

2 Theoretical implications

2.1 Model 1: Corruption in resource extraction

To examine the relationship between corruption and inclusive wealth, we employ the objective function of Barbier (2010), who in turn refers to Grossman and Helpman (1994), López and Mitra (2000), and Barbier et al. (2005). The resource allocation mechanism of our economy is corrupt to a certain extent. That extent of corruptibility is expressed by the parameter, $0 \leq \gamma \leq 1$. The social planner has the following objective function:

$$V(t) = \int_t^\infty (\gamma B(R(s)) + (1-\gamma)U(C(s)))\, e^{-\delta(s-t)} ds, \tag{1}$$

where $B(R(s))$ is the benefit function of the government, contingent on the volume of resource extracted at s, $R(s)$. As in Barbier (2010), the benefit function is assumed to be convex, so that $B_R > 0$ and $B_{RR} \geq 0$[3]. $U(C(s))$ is the usual utility function of consumption, C, and δ is the utility discount rate. Population change is assumed away throughout.

In order to keep our framework tied in to that of inclusive wealth accounting (UNU-IHDP and UNEP 2014), we assume renewable resource capitals, along with conventional physical capital, K. To fix ideas, we follow Hamilton and Atkinson (2006) and think of agricultural land, A, forestland L, and forest resource stock, S. Let us describe capital asset dynamics in order. Production from capital, agricultural land, forest resource and forestland is the output of the economy. Output net of consumption and resource extraction cost is invested into physical capital:

$$\dot{K} = F(K, A, R, L) - f(R) - C, \tag{2}$$

where extraction cost function satisfies $f_R > 0$. Each period, an area D of forestland is developed into agricultural land, A. The total land area is fixed at T, so that $A + L = T$. Thus we have

$$\dot{A} = D, \tag{3}$$

$$\dot{L} = -D. \tag{4}$$

Finally, forest resource stock is subject to its regeneration $G(S)$, extractoin R, and development D:

$$\dot{S} = G(S) - R - DS/L, \tag{5}$$

where the last term is the product of the developed area and forest volume density per hectare. Assume also that the productivity of the renewable resource satisfies the usual properties, i.e., $G_S > 0$ and $G_{SS} < 0$. Initial conditions regarding stock variables are given; $K(0) = K_0$, $L(0) = L_0$, $A(0) = A_0$, and $S(0) = S_0$. In addition, we follow Grossman and Helpman (1996) and Barbier (2010) to assume "local truthfulness" of resource extracting firms and political equlibrium between the government and the resource firm. A key assumution here is that government officials use recieved bribes into wasteful, conspicuous consumption overseas, rather than into domestic consumption or expenditure.

[3]The subscript of a function signifies the first-order derivative of the function with regard to the variable. Likewise, the second-order derivative of function F is expressed, for example, F_{xx}.

Our economy is "optimal" in the sense that the social planner maximizes the sum of bribery benefit and social well-being, (1). It goes without saying that this should be suboptimal from the standpoint of a benevolent government who cares only about the well-being of citizens, i.e, the case of $\gamma = 0$. Let us call the full optimum of the economy when $\gamma = 0$ the first best, which is distinct from the dynamic optimality with regard to bribery benefit and social well-being. Writing the shadow prices of K, A, L, and S as p_i for $i = K, A, L$, and S, respectively, the current-value Hamiltonian is

$$\begin{aligned} H =& \gamma B(R) + (1-\gamma)U(C) \\ &+ p_K(F(K, A, R, L) - f(R) - C) + (p_A - p_L)D + p_S(G(S) - R - DS/L). \end{aligned} \tag{6}$$

Static efficiency conditions are

$$(1-\gamma)U_C = p_K, \tag{7}$$

$$\gamma B_R + p_K(F_R - f_R) = p_S, \tag{8}$$

$$p_A = p_L + p_S S/L. \tag{9}$$

(7) shows that, given the shadow price of physical capital, consumption is determined at a level lower than without corruption. (8) says that the shadow price of the resource stock is not equal to the resource rent accruing to the private sector. The former now includes the marginal bribery benefit for the government. It also holds from (9) that, on an efficient path, forestland is developed into agricultural land, to the point where the shadow price of agricultural land exactly matches the opportunity cost of developemt: the sum of the shadow prices of original forestland and timber harvests weighted by the volume density of forest[4].

Dynamic conditions for optimality include

$$p_K F_K = \delta p_K - \dot{p}_K, \tag{10}$$

$$p_K F_A = \delta p_A - \dot{p}_A, \tag{11}$$

$$p_K F_L + p_S DS/L^2 = \delta p_L - \dot{p}_L, \tag{12}$$

$$p_S(G_S - D/L) = \delta p_S - \dot{p}_S. \tag{13}$$

These equations of motion for co-state variables are all subject to usual interpretations.

[4]We could interpret, for example, that the RHS of equation (9) represents regulating service and provisioning service of forest, respectively.

As we have mentioned, resource rent as usually discussed is distinctive from the shadow price of resource in this model, since the former is inclusive of marginal benefit of bribery. One can derive the dynamics of pure resource rent in this economy from the optimality conditions. Combining equations (7), (8), (10) and (13), it is straightforward to show that

$$\begin{aligned}\frac{\dot{\overline{F_R - f_R}}}{F_R - f_R} =& \frac{(\delta - G_S + D/L)(p_S - \gamma B_R) + (\delta - G_S + D/L)\gamma B_R - \gamma \dot{B}_R}{p_S - \gamma B_R} - (\delta - F_K) \\ =& F_K - G_S + D/L + \frac{\gamma}{1-\gamma}\frac{B_R}{U_C(F_R - f_R)}\left(\delta - G_S + D/L - \frac{\dot{B}_R}{B_R}\right)\end{aligned} \tag{14}$$

Eq (14) is what could be called a corruptive version of the Hotelling rule. Set against the increase rate of the resource rent is the rate of return on investment into physical capital, net of the marginal resource productivity of the forest resource less the developed area of the former forestland, adjusted by an extra corruption-related term. This fourth term on the RHS is the product of the relative corruptibility ($\frac{\gamma}{1-\gamma}$), the marginal benefit of resource extraction as bribery relative to that as pure resource, and the effective discount rate of the resource. When the resource is exhaustible and $\gamma = 0$, it collapses to the original Hotelling rule.

However, it is the change, not in resource rent, but in social well-being, $\dot{V}$, that matters to sustainable development. Taking the change rate in social well-being, inclusive wealth accounting reports the following well-being improvement index:

$$\frac{\dot{V}}{V} = \frac{\dot{H}}{H} = \frac{p_K}{V}\left(\dot{K} + \frac{p_A}{p_K}\dot{A} + \frac{p_L}{p_K}\dot{L} + \frac{p_S}{p_K}\dot{S}\right). \tag{15}$$

The first equality is due to the well-known result since Weitzman (1976) that the current-value Hamiltonian is the return on social well-being, thereby holding the linear relationship with the latter. The term within the bracket is often called genuine savings, or the dollar value of the change in inclusive wealth. Corruption is expected to decrease the value of (15), by wasting real resources that could otherwise have been either (rightfully) consumed to raise current well-being, or saved to raise future well-being. When the RHS of (15) works out to be negative, social well-being (plus the resources for bribery) is bound to decrease.

Non-negativity of (15) is a necessary condition for sustainable development. It also helps to keep track of each and every component of the RHS of (15), for at least two reasons. As we mentioned, corruption is expected to decrease genuine savings in general, but given that saving is considered not to be a mere residual of consumption but a proactive investment, it helps to see the channels in which institutions have an affect. Moreover, negative genine savings is a violation of weak sustainability criterion, so delving into the bracket of the RHS of (15) would also be beneficial from a strong sustainability perspective.

Thus, in the following we sum up the effect of corruption on each component of inclusive wealth change, all of which can be derived with ease from (7)-(9).

- The change in agricultural land:

$$\frac{p_A}{p_K}\dot{A} = \frac{p_A}{(1-\gamma)U_C}D \geq 0. \tag{16}$$

  The value of agricultural land increases by assumption.

- The change in forestland:

$$\frac{p_L}{p_K}\dot{L} = -\frac{p_L}{(1-\gamma)U_C}D = \left(\left(F_R - f_R + \frac{\gamma B_R}{(1-\gamma)U_C}\right)\frac{S}{L} - \frac{p_A}{(1-\gamma)U_C}\right)D \leq 0. \tag{17}$$

  In contrast, the value of forestland decreases, again by assumption of the model.

- The change in total land (agricultural land and forestland):

$$\frac{p_A}{p_K}\dot{A} + \frac{p_L}{p_K}\dot{L} = \left(F_R - f_R + \frac{\gamma B_R}{(1-\gamma)U_C}\right)D\frac{S}{L} \geq 0. \tag{18}$$

  Althogh total land change is not reported in inclusive wealth accounting, it is of theoretical interest. The change in the value of agricultural land and forestland goes in the opposite directions, but their combined change should be non-negative, even though the total land mass is constant. Furthemore, the more corruptibility, the more (less) this increase becomes, since it holds that $\partial\left(\frac{p_A}{p_K}\dot{A} + \frac{p_L}{p_K}\dot{L}\right)/\partial\gamma = (B_R/[(1-\gamma)^2 U_C])DS/L \geq 0$.

- The change in forest resources:

$$\frac{p_S}{p_K}\dot{S} = \left(F_R - f_R + \frac{\gamma B_R}{(1-\gamma)U_C}\right)\left(G(S) - R - \frac{DS}{L}\right). \tag{19}$$

The sign of the above is subject to whether resources are extracted beyond the regenerative capacity. The shadow price of forest resource (as timber) now includes the marginal relative bribery benefit. When the net change of the resource is negative, one can see in the same way as the total land change that more corruptibility translates into more degradation of the resources, i.e., $\partial\left(\frac{p_S}{p_K}\dot{S}\right)/\partial\gamma = (B_R/[(1-\gamma)^2 U_C])(G(S) - R - DS/L)$.

- The change in total forest (forestland and timber resources):

$$\frac{p_L}{p_K}\dot{L} + \frac{p_S}{p_K}\dot{S} = \left(F_R - f_R + \frac{\gamma B_R}{(1-\gamma)U_C}\right)(G(S) - R) - \frac{p_A}{(1-\gamma)U_C}D. \tag{20}$$

  Forest resources, broadly defined, indicate timber resources as well as non-timber forest benefits (UNU-IHDP and UNEP 2014). The latter is deemed to be roughly proportional to forestland area, so the above value can be a proxy for total forest resources[5]. However, the sign of this aggregate is ambiguous in the model.

- The change in natural capital (agricultural land, forestland and forest resources):

$$\frac{p_A}{p_K}\dot{A} + \frac{p_L}{p_K}\dot{L} + \frac{p_S}{p_K}\dot{S} = \left(F_R - f_R + \frac{\gamma B_R}{(1-\gamma)U_C}\right)(G(S) - R). \tag{21}$$

  This is the bottom line natural capital change, by which we mean total renewable resources change.

One thing to note from all the obove accounting predictions is that controlling corruption and making regimes cleaner (a smaller value in γ) would change the shadow prices of all of the natural capital assets in this economy. In this sense, coruuption control as an institution works as an enabling asset (UNU-IHDP and UNEP 2014). This affects the value of total land change through the land-resource nexus (condition (9)). Also, forest loss due to land development (DS/L) is absent from the change in total natural capital, because the former is compensated by the rise in total land value. This can be observed by comparing (18), (19), and (21). Finally, by setting $\gamma = 0$, all the equations above would reduce to the first-best case.

[5]Note, however, that the non-timber forest benefit is evaluated in increasingly scrutiny, so that it might not be considered to be proportional to forest land area in a more recent accounting.

By partial differentiation, we have

$$\frac{\partial}{\partial\gamma}\left(\frac{p_A}{p_K}\dot{A}+\frac{p_L}{p_K}\dot{L}+\frac{p_S}{p_K}\dot{S}\right)=\frac{B_R}{(1-\gamma)^2U_C}(G(S)-R). \tag{22}$$

In a setting we are interested in, resource is extracted beyond the level of regeneration, so that the sign of the above becomes negative, and it is confirmed that more corruptibility would lead to more depletion. The flip side of the same coin is that, as long as extraction remains within regenerative capacity, a small change in γ works to push up the change in natural capital.

2.2 Model 2: Corruption in land development

Informal reporting in some Asian and Latin American countries suggest that there is rampant corruption in land development, not necessarily linked to resource extraction. It is then helpful to study the modification of our model, since natural capital in wealth accounting, as it stands, is comprised of resources and land (forestland, agricultural and pasture land). Past research does not necessarily argue corruption in land trading and sustainable development. The value function should be changed to

$$V^d(t)=\int_t^\infty\Big(\phi B^d(D(s))+(1-\phi)U(C(s))\Big)e^{-\delta(s-t)}ds, \tag{23}$$

where ϕ represents, by the same token with bribery on resource extraction, the weight of bribery reception depending on the land area developed. $B^d(D)$ is the bribery benefit arising from land development that satisfies $B^d_D>0$ and $B^d_{DD}>0$. All the stock equations of motion (2)-(5), and therefore, co-state equations of motion (10)-(13), hold. Static efficiencies (7)-(9) are now replaced by

$$(1-\phi)U_C=p_K, \tag{24}$$

$$p_K(F_R-f_R)=p_S, \tag{25}$$

$$\phi B^d_D+p_A=p_L+p_S S/L. \tag{26}$$

Equations (25) and (26) show respectively that resource rents are now typical Hotelling rents and that the marginal social benefit of developing forestland now includes private benefit to the bureaucrats. They straightforwardly imply that resource rents, or shadow prices of the resource, move according to

$$\frac{\dot{\overline{F_R-f_R}}}{F_R-f_R}=F_K-G_S+D/L, \tag{27}$$

which is explicitly free from the degree of corruption, ϕ; what is now distorted in the presence of courruption is the level of land developed. The change in natural capital per capita can be described as follows:

- The change in agricultural land:

$$\frac{p_A}{p_K}\dot{A} = \frac{p_A}{(1-\phi)U_C}D \geq 0. \tag{28}$$

- The change in forestland:

$$\frac{p_L}{p_K}\dot{L} = -\frac{p_L}{(1-\phi)U_C}D = \left((F_R - f_R)\frac{S}{L} + \frac{-p_A - \phi B_D^d}{(1-\phi)U_C}\right)D \leq 0. \tag{29}$$

- The change in total land (agricultural land and forestland):

$$\frac{p_A}{p_K}\dot{A} + \frac{p_L}{p_K}\dot{L} = \left((F_R - f_R)\frac{S}{L} + \frac{-\phi B_D^d}{(1-\phi)U_C}\right)D. \tag{30}$$

  By assumption, the change in agricultural land is positive and the change in forestland is negative, but the sign of the combined change in total land value is ambiguous. In particular, if marginal payment of bribery is so large that it eats up the resource opportunity cost of land development ($(F_R - f_R)\frac{S}{L}$), the value of total land change could be negative, even if total land area is fixed, and even if development in general is meant to be raising the value of capital assets.

- The change in forest resources:

$$\frac{p_S}{p_K}\dot{S} = (F_R - f_R)\left(G(S) - R - \frac{DS}{L}\right). \tag{31}$$

  As we have seen in (25) and (27), there is no direct effect of corruption on the increase in forest resources as biomass, in the case of corruption related to land development.

- The change in total forest (forestland and forest resources):

$$\frac{p_L}{p_K}\dot{L} + \frac{p_S}{p_K}\dot{S} = (F_R - f_R)(G(S) - R) + \frac{-p_A - \phi B_D^d}{(1-\phi)U_C}D. \tag{32}$$

  The change in total forest is composed of regeneration net of extraction, minus the social value of land development. The latter of which includes (the negative of) the loss of forest mass due to land development.

- The change in natural capital (agricultural land, forestland and forest resources):

$$\frac{p_A}{p_K}\dot{A} + \frac{p_L}{p_K}\dot{L} + \frac{p_S}{p_K}\dot{S} = (F_R - f_R)(G(S) - R) - \frac{\phi B_D^d D}{(1-\phi)U_C}. \tag{33}$$

  The change in overall natural capital is now adjusted downwards to such an extent that corruption takes place with regard to land development. Without any corruption, natural capital changes exactly by the the value of forest mass regeneration net of its extraction, and accounting for pure deforestation would be double counting, since the marginal benefit of land development would be equal to its cost due to (26).

As is the case with the extraction-corruption model, they collapse to the first-best case by setting $\phi = 0$. More importantly, increasing the corruptibility of the economy would worsen the increase in natural capital, by observing that

$$\frac{\partial}{\partial \phi}\left(\frac{p_A}{p_K}\dot{A} + \frac{p_L}{p_K}\dot{L} + \frac{p_S}{p_K}\dot{S}\right) = -\frac{B_D^d D}{(1-\phi)^2 U_C} < 0. \tag{34}$$

2.3 Implications toward empirics

At the risk of repeating, let us summarize predictions from the above argument that are to be used for empirical testing in the next section. In both models, the sign of the total natural capital change (i.e., renewable resources here) is ambiguous. In Model 1, however, total natural capital change hinges on the sign of $G(S) - R$, rather than $G(S) - R - DS/L$, because in an efficient state the negative effect of pure land development (aside from pure timber logging) is completely made up for by the land value change.

More importantly, the corruption's effect on total natural capital is not symmetric. In Model 1, it affects natural capital degradation through the shadow price effect, so that the overall effect again depends on the sign of $G(S)-R$, i.e., whether the pure resource use is within regenerative capacity, whilst in Model 2, corruption worsens natural capital change in a clearly negative fashion because it distorts land development. Which model of the two approximates the economy cannot determined a priori in a general context, but as long as $G(S)-R < 0$, corruption always exacerbates the overall renewalble resource depletion.

A few caveats are in order. First, by assumption, agricultural land increases and forestland decreases in both models, but the effect of corruption is not symmetric. In the extraction-corruption model, the change in total land value is positive and more corruptibility increases total land value. On the other hand, the change in total land value could be positive or negative in Model 2, and corruption is likely to be a downward pressure on the total land value.

Second, if we apply Model 1 to the case of an exhaustible resource, it trivially holds from setting $G(S) = 0$ that more corruption is expected to have an unamiguously negative effect on the degradation of the resource. Ideally we should prepare a separete model for exhaustible resources with corruption, but we interpret empirical results in this reduced-form framework.

3 Evidence from inclusive wealth index

3.1 Data

Our dependent variables are the growth rates in capital assets per capita, extending Aidt (2009), who studies growth rates in wealth per capita[6]. Specifically, we try to explain growth rates in natural capital and its components (renewable resources, non-renewable resources, agricultural land, total forest, fossil fuels, and mineral resources), as well as, for reference, inclusive wealth, physical capital and human capital.

There are several macroeconomic indicators of corruption that are often cited. Of them, we use "corruption control" of Kaufmann et al. (2010), "The Worldwide Governance Indicators, 2015 Update," but to check robustness we also use from time to time Transparency International's corruption perception index (CPI). Also, rule of law and regulatory quality, two indicators from Worldwide Governance Indicators, are also used for a reference purpose, to follow Dietz et al. (2007)[7].

Following the resource curse literature, arguing resource abundance has a role to play in explaining poor economic performance of resource rich nations, we also include an index of resource abundance. Resource abundance has been proxied by resource dependence in terms of the share of exhaustible resources in total exports, but ideally resource stock data should be used (Bulte et al. 2005). Fortunately, capital stock data, including renewable and non-renewable resources, are provided in Inclusive Wealth Report, so we use initial capital stock data at year 1990, as well

[6]Note that the dependent variables are not the share of genuine savings out of output, or the increase in capital assets.

[7]The Worldwide Governance Indicators also report government effectivenss, political stability, and voice and accountability.

as 1, 3, and 5 years lagged capital stock, to represent resource abundance.

For other usual independent variables to be included in the regressions are: Polity2 (Marshall and Jaggers 2005), population growth rate, and regional dummies from ACLP Political and Economic Database. Polity2 score from the Polity IV project is one of the most commonly used measures of democracy, ranging from -10 to 10. We also use a democracy dummy, to be substituted for Polity2 to check robustness, from the ACLP dataset that divides country-year observations into democracy and dictatorship using the minimalist definition of democracy. An observation is coded as democracy if the political leaders are selected via "competitive" election. An election is considered competitive if multiple parties participate and each involved party has a positive likelihood of winning.

3.2 Results

We now move on to panel data analysis with fixed effects estimates, to address unobserved time-invariant variation in country-specific factors, with robust standard errors. We use the dataset of inclusive wealth 1990-2010, but institutional variables reduce the number of observations to half of the potential size. The model can be described as

$$g_{it}^{j} = \beta_0 + \beta_1 k0_{i,t-s} + \beta_2 g_{it}^{p} + \beta_3 corrupt_{i,t-s} + \beta_4 polity2_{i,t-s} + \beta_5 j_{i,t-s} + \epsilon_{it}. \tag{35}$$

All the dependent variables use one-, three-, or five-year lagged variable ($s = 1, 3, 5$).

Table 4 presents a preliminary regression results on inclusive wealth, as well as physical, human, and natural capital, using just one-year lag. The positive significant effect of corruption control on physical capital can be seen, in line with the literature on corruption and growth. The insignificance of corruption control on natural capital on the whole is observed here too. The negative effect of resource abundance on growth rates is observed only for inclusive wealth and human capital.

Detaild results for specific non-renewable and renewable capital stocks are presented on Tables 6-9. For non-renewable resources (Table 6), whatever we do (using difference lags, putting interaction terms or not, employing random effect or fixed effect models), corruption control has positive impact on their growth rates, confirming previous studies. Interaction with resource abundance is negative, so one could interpret that positive impact of corruption control is discounted for countries with high endowment of non-renewable resources.

For renewable resources (Table 7-9), no corruption control effect is observed in total, regardless of full, G¿R (growth exceeding extraction), or G¡R samples (the latter two samples are not reported). However, positive effect of corruption control on forest is found, although for one- and three-year lagged variables Interaction is negative and significant only for lagged forest variables, but disappears for L3, only for ramdom-effect, and not for fixed-effect model. Moving on to five-year lagged variables, no significant results are obtained, but the sample size is almost cut to half, compared to that of one-year lagged variable, so probably we should cut off five-year lagged results altogether. found nothing for positive and negative change rate, same as in the case of renewable as DV. For agricultural land, there seems to be no corruption control effect, but some negative effect of resource abundance is found. The resource curse literature has suggested that resource abundance effect tends to be relevant for point-source resources, rather than more dissipative resources like agricultural land.

Comparing non-renewable and renewable resources, it could be the case that the lead time or political channel of the effect of corruption control on natural capital might be different. Institutional quality affects regeneration of renewable resources, which naturally takes time. In contrast, production of oil, natural gas, and mineral resources is considered to respond to exogenous shocks and decision making in a more timely manner. Of course, oil production exhibits some inelasticity to exogenous shocks, so this could be a matter of comparison.

Table 4. Corruption control and inclusive wealth

	(1)	(2)	(3)	(4)
	g_w	g_k	g_h	g_n
L.k	-0.000	-0.000	0.000**	-0.000
	(-0.55)	(-1.42)	(2.38)	(-0.99)
g_pop	-0.369***	-0.507***	0.122***	-1.097***
	(-12.89)	(-8.46)	(3.14)	(-12.31)
L.corrupt	0.000	0.031**	-0.000	-0.003
	(0.07)	(2.42)	(-0.06)	(-0.19)
L.polity2	0.000***	0.001***	0.000	0.000
	(3.96)	(4.15)	(0.99)	(0.33)
L.w	-0.000**			
	(-2.53)			
L.h			-0.000***	
			(-4.79)	
L.n				-0.000
				(-0.41)
_cons	0.010***	0.015**	0.031***	-0.002
	(2.92)	(2.12)	(4.84)	(-0.20)
N	1401	1401	1401	1401
R^2	0.135	0.070	0.022	0.131

t statistics in parentheses

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

Table 6: Corruption control and non-renewable resources

	(1)	(2)	(3)	(4)	(5)	(6)
	cr_non	cr_non	cr_non	cr_non	cr_non	cr_non
lag_nonrenew	0.000	0.000				
	(0.000)	(0.000)				
lag_corruption	0.017***	0.014**				
	(0.005)	(0.005)				
lag_corruption_nonrenew	-0.000	-0.000				
	(0.000)	(0.000)				
lag_pcapital	-0.000***	-0.000***				
	(0.000)	(0.000)				
lag_popgrowth	-1.344***	-1.340***				
	(0.055)	(0.056)				
nonrenew1990	0.000***	0.000	-0.000	0.000	-0.000***	0.000
	(0.000)	(.)	(0.000)	(.)	(0.000)	(.)
lag_polity2	-0.000	-0.000*				
	(0.000)	(0.000)				
lag3_nonrenew			0.000***	0.000***		
			(0.000)	(0.000)		
lag3_corruption			0.031***	0.023***		
			(0.007)	(0.008)		
lag3_corruption_nonrenew			-0.000***	-0.000***		
			(0.000)	(0.000)		
lag3_pcapital			-0.000***	-0.000***		
			(0.000)	(0.000)		
lag3_popgrowth			-0.321***	-0.241***		
			(0.082)	(0.084)		
lag3_polity2			-0.000	-0.001*		
			(0.000)	(0.000)		
lag5_nonrenew					0.000***	0.000***
					(0.000)	(0.000)
lag5_corruption					0.034***	0.023***
					(0.008)	(0.008)
lag5_corruption_nonrenew					-0.000***	-0.000***
					(0.000)	(0.000)
lag5_pcapital					-0.000***	-0.000***
					(0.000)	(0.000)
lag5_popgrowth					0.640***	0.891***
					(0.116)	(0.119)
lag5_polity2					-0.000	-0.001***
					(0.000)	(0.000)
N	1131	1131	851	851	665	665

Standard errors in parentheses
* $p < .1$, ** $p < .05$, *** $p < .01$

Table 7: Corruption control and renewable resources

	(1)	(2)	(3)	(4)	(5)	(6)
	cr_renew	cr_renew	cr_renew	cr_renew	cr_renew	cr_renew
lag_renew	0.000**	0.000**				
	(0.000)	(0.000)				
lag_corruption	0.011	-0.009				
	(0.009)	(0.017)				
lag_corruption_renew	-0.000	0.000				
	(0.000)	(0.000)				
lag_pcapital	0.000	0.000				
	(0.000)	(0.000)				
lag_popgrowth	-1.016***	-1.125***				
	(0.090)	(0.156)				
renew1990	-0.000**	0.000	-0.000	0.000	0.000	0.000
	(0.000)	(.)	(0.000)	(.)	(0.000)	(.)
lag_polity2	-0.000	0.001				
	(0.000)	(0.001)				
lag3_renew			0.000	-0.000		
			(0.000)	(0.000)		
lag3_corruption			0.012	-0.002		
			(0.012)	(0.028)		
lag3_corruption_renew			-0.000	-0.000		
			(0.000)	(0.000)		
lag3_pcapital			0.000	-0.000		
			(0.000)	(0.000)		
lag3_popgrowth			-0.953***	-0.274		
			(0.135)	(0.245)		
lag3_polity2			-0.000	-0.000		
			(0.000)	(0.001)		
lag5_renew					0.000	-0.000*
					(0.000)	(0.000)
lag5_corruption					0.005	-0.015
					(0.017)	(0.027)
lag5_corruption_renew					-0.000	-0.000
					(0.000)	(0.000)
lag5_pcapital					0.000	-0.000
					(0.000)	(0.000)
lag5_popgrowth					-0.664***	0.079
					(0.207)	(0.299)
lag5_polity2					-0.001	-0.001
					(0.000)	(0.001)
N	1563	1563	1172	1172	912	912

Standard errors in parentheses
* $p < .1$, ** $p < .05$, *** $p < .01$

Table 8: Corruption control and forest

	(1)	(2)	(3)	(4)	(5)	(6)
	cr_forest	cr_forest	cr_forest	cr_forest	cr_forest	cr_forest
lag_forest	0.000	0.000				
	(0.000)	(0.000)				
lag_corruption	0.020**	0.015				
	(0.009)	(0.016)				
lag_corruption_forest	-0.000*	-0.000				
	(0.000)	(0.000)				
lag_pcapital	0.000*	-0.000				
	(0.000)	(0.000)				
lag_popgrowth	-1.136***	-1.042***				
	(0.111)	(0.209)				
forest1990	-0.000	0.000	-0.000	0.000	-0.000	0.000
	(0.000)	(.)	(0.000)	(.)	(0.000)	(.)
lag_polity2	-0.000	0.001				
	(0.000)	(0.001)				
lag3_forest			0.000	-0.000		
			(0.000)	(0.000)		
lag3_corruption			0.019**	0.000		
			(0.010)	(0.019)		
lag3_corruption_forest			-0.000	-0.000		
			(0.000)	(0.000)		
lag3_pcapital			0.000	-0.000		
			(0.000)	(0.000)		
lag3_popgrowth			-1.032***	-0.427*		
			(0.126)	(0.253)		
lag3_polity2			-0.000	0.000		
			(0.000)	(0.001)		
lag5_forest					0.000	-0.000
					(0.000)	(0.000)
lag5_corruption					0.012	-0.018
					(0.011)	(0.015)
lag5_corruption_forest					-0.000	0.000
					(0.000)	(0.000)
lag5_pcapital					0.000*	-0.000**
					(0.000)	(0.000)
lag5_popgrowth					-0.536***	0.291
					(0.163)	(0.230)
lag5_polity2					-0.000	-0.001
					(0.000)	(0.001)
N	1411	1411	1155	1155	899	899

Standard errors in parentheses
* $p < .1$, ** $p < .05$, *** $p < .01$

Table 9: Corruption control and agricultural land

	(1)	(2)	(3)	(4)	(5)	(6)
	cr_agri	cr_agri	cr_agri	cr_agri	cr_agri	cr_agri
lag_agri	-0.000***	-0.000***				
	(0.000)	(0.000)				
lag_corruption	-0.006	-0.022				
	(0.013)	(0.028)				
lag_corruption_agri	-0.000	-0.000				
	(0.000)	(0.000)				
lag_pcapital	-0.000	-0.000*				
	(0.000)	(0.000)				
lag_popgrowth	-0.978***	-0.870***				
	(0.161)	(0.293)				
agri1990	0.000***	0.000	0.000***	0.000	0.000***	0.000
	(0.000)	(.)	(0.000)	(.)	(0.000)	(.)
lag_polity2	-0.001	0.000				
	(0.000)	(0.001)				
lag3_agri			-0.000***	-0.000***		
			(0.000)	(0.000)		
lag3_corruption			-0.001	-0.007		
			(0.016)	(0.032)		
lag3_corruption_agri			-0.000	-0.000		
			(0.000)	(0.000)		
lag3_pcapital			-0.000	-0.000		
			(0.000)	(0.000)		
lag3_popgrowth			-0.816***	-0.393		
			(0.206)	(0.337)		
lag3_polity2			-0.001	-0.001		
			(0.001)	(0.001)		
lag5_agri					-0.000***	-0.000***
					(0.000)	(0.000)
lag5_corruption					0.004	0.017
					(0.023)	(0.036)
lag5_corruption_agri					-0.000	-0.000
					(0.000)	(0.000)
lag5_pcapital					-0.000	-0.000
					(0.000)	(0.000)
lag5_popgrowth					-0.582*	-0.349
					(0.339)	(0.497)
lag5_polity2					-0.001	-0.001
					(0.001)	(0.001)
N	990	990	810	810	630	630

Standard errors in parentheses
* $p < .1$, ** $p < .05$, *** $p < .01$

4 Concluding remarks

We have shown theoretical implications that corruption could work to various types of natural capital in a different manner, as well as some, although limited, evidence that corruption control has indeed affected natural capital degradation. Fixed country effects estimates using panel data show significantly positive effect of corruption control on the change of non-renewable resources. Some corruption control effect is also observed for forest models, but its robustness is not strong as the case for non-renewables. We could broadly argue that corruptive control should be strengthened to improve sustainability assessments based on inclusive wealth per capita, but we also have to note that the channels and time spans of its effect are different, so the bottom line figure should be closely examined.

There are some limitations in the presented paper. Some of the subtlty of our empirical observation is partly traceable to our economywide institutional variables. Ideally, cross-country data on institutional variables, separately addressing each and every class of natural capital, should be collected to explain growth rates in natural capital, but they are sparce as of now[8]. The assumption that land is developed into agricultural land is obviously not typical in developed countries, to which we should also include urban land to improve the model. In fact, agricultural land is decreasing in most of the sample 140 countries, so empirical data could also be confined to less developed nations. These are major challenges of our current study, to which we should get back as future research agenda.

[8]See, for example, Smith et al. (2003) for Indonesian forest, Zinnes et al. (2007) for Romanian forest, among others.

A Cross-section results

In this appendix, we report preliminary results of cross-section analysis. We relegate this to appendix mainly because of the limited sample size. We use where available the average of corruption control for 1996-1999 and 200-2005, to avoid reverse causality from institutions to inclusive wealth growth in the period 2000-2005 and 2005-2010, respectively. An alternative to address reverse causality is to use instrument variables that are uncorrelated with the growth rate of capital assets, but it has been pointed out that currently proposed instruments, such as ethnolinguistic fractionalization (Mauro 1995) or the extent of democracy, have limitations. The 2000s is chosen for the sample of inclusive wealth data, partly because of data availability of corruption control.

A.1 Model

The econometric model for cross section analysis is thus

$$g_i^j = \beta_0 + \beta_1 k0_i + \beta_2 g_i^p + \beta_3 corrupt_i + \beta_4 polity2_i + \beta_5 j0_i + \epsilon_i, \tag{36}$$

along with regional dummies. In the above, for country i, g_i^j are the growth rate of capital asset of type j, $k0$ is the initial physical capital per capita, g_i^p is the population growth rate, $corrupt_i$ is the corruption control, $polity2_i$ is the democracy dummy, $j0_i$ is the initial stock of the capital per capita in question, and ϵ_i is an error term. For subscript j, we use 'w' for inclusive wealth, 'k' for physical capital, 'h' for human capital, 'n' for natural capital, 'ren' for renewable resources, 'agr' for agricultural land, 'for' for total forest, 'non' for non-renewable resources, 'fos' for fossil fuels, and 'min' for mineral resources.

A.2 Results: cross section, 2000-2005 and 2005-2010

A.2.1 Corruption control and inclusive wealth, 2000-2005 and 2005-2010

We first see how corruption affects the higher level of inclusive wealth accounting: inclusive wealth, physical, human, and natural capital. In all cross section results, regional dummies and coefficients are not reported. In Table 1, population growth naturally affects capital assets growth negatively, and its effect is significantly negative in inclusive wealth and natural capital. Corruption control has a significantly positive effect on the growth of inclusive wealth per capita, which is consistent with the results of Aidt (2009). Corruption control also works to improve the growth in physical capital per capita. This broadly corresponds to the literature on corruption and growth. We could not find a significant relationship between corruption control and the growth rate in natural capital per capita, as is shown in the model (4)-(6). In one model, the initial level of natural capital has a

Table 1-1. Corruption control and growth in wealth pc, 2000-2005.

	(1)	(2)	(3)	(4)	(5)	(6)
	g_w	g_k	g_h	g_n	g_n	g_n
k0	0.000	-0.000	0.000	0.000	0.000	0.000
	(0.29)	(-1.28)	(1.14)	(1.37)	(1.35)	(1.15)
g_pop	-0.359***	-0.296	-0.049	-0.800***	-0.860***	-0.861***
	(-3.69)	(-0.88)	(-0.69)	(-5.52)	(-5.92)	(-5.92)
corrupt	14.511***	24.646*	0.558	-2.659	-3.499	-1.883
	(3.85)	(1.88)	(0.20)	(-0.47)	(-0.63)	(-0.32)
polity2	-0.121	-0.752**	-0.022	-0.081	-0.084	-0.089
	(-1.22)	(-2.17)	(-0.30)	(-0.55)	(-0.57)	(-0.61)
n0					0.000**	0.000
					(2.21)	(1.30)
n0*corrupt						-0.000
						(-0.73)
N	132	132	132	132	132	132
R^2	0.547	0.231	0.078	0.485	0.506	0.508

t statistics in parentheses

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

significantly positive effect on natural capital growth. One has to be careful about interpreting these results, because natural capital is a composite of several subcategories, to which we turn in the following subsections. Polity2, as well as democracy dummies, are negatively affecting growth rates of capital assets in general.

A.2.2 Corruption control and renewable resources, 2000-2005 and 2005-2010

Results presented in Table 2 are narrowing down natural capital to renewable resources. In all but one model, population growth makes a significantly negative effect on growth rates, as expected. The effects of corruption control are found to be all positive, but significant only in two models for agricultural land.and total forest. Corruption control is generally improving growth rates of agricultural land and total forest, but significantly in the presence of initial capital stock and its interaction with corruption control. The

Table 1-2. Corruption control and growth in wealth pc, 2005-2010.

	(1)	(2)	(3)	(4)	(5)	(6)
	g_w	g_k	g_h	g_n	g_n	g_n
k0	-0.000**	-0.000	-0.000**	-0.000	-0.000	-0.000
	(-2.19)	(-1.50)	(-1.99)	(-0.55)	(-0.62)	(-0.69)
g_pop	-0.166***	-0.357*	0.108***	-0.512***	-0.504***	-0.497***
	(-3.09)	(-1.93)	(3.83)	(-5.82)	(-5.78)	(-5.67)
corrupt	20.034***	13.978	4.696**	-6.282	-6.701	-5.077
	(4.68)	(0.95)	(2.09)	(-0.89)	(-0.96)	(-0.69)
polity2	-0.103	-0.733**	-0.066	0.115	0.125	0.123
	(-1.00)	(-2.07)	(-1.22)	(0.68)	(0.75)	(0.74)
n0					0.000**	0.000
					(1.99)	(1.24)
n0*corrupt						-0.000
						(-0.73)
N	134	134	134	134	134	134
R^2	0.541	0.342	0.332	0.565	0.579	0.581

t statistics in parentheses

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

latter has a counterveiling effect on the growth rates, potentally showing that corruption control may not work well where resource is abundant or dispersed geographically within a country.

A.2.3 Corruption control and nonrenewable resources 2000-2005 and 2005-2010

In Table 3, we show the regression results for nonrenewable resources. Population growth continues to be negative, and significant in 6 out of 8 models shown. Corruption control, our center of interest, however, turned out to be not significant in any of the models. and even be negative in some of them, in contrast to the results of renewable resources. The number of observations of mineral resources is relatively small (44), which warrants caution in interpreting models of this category.

Summing up, our cross section analysis covering the period 2000-2005 implies corruption control improves the change in capital assets per capita, for some categories of renewable resources, along with inclusive wealth and physical capital.

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Table 2-1. Corruption control and renewable resources, 2000-2005.

	(1)	(2)	(3)	(4)	(5)	(6)
	g_ren	g_ren	g_ren	g_agr	g_agr	g_agr
k0	0.000**	0.000**	0.000*	0.000	0.000	0.000
	(2.06)	(2.05)	(1.79)	(0.86)	(0.40)	(0.50)
g_pop	-1.009***	-1.009***	-0.991***	-0.567**	-0.644**	-0.447
	(-7.43)	(-7.39)	(-7.17)	(-2.06)	(-2.35)	(-1.53)
corrupt	5.226	5.232	7.119	11.593	11.208	18.023**
	(1.04)	(1.04)	(1.30)	(1.39)	(1.36)	(2.00)
polity2	-0.292**	-0.293**	-0.298**	-0.587**	-0.500**	-0.589**
	(-2.23)	(-2.22)	(-2.26)	(-2.40)	(-2.04)	(-2.38)
ren0		0.000	0.000			
		(0.03)	(0.84)			
ren0*corrupt			-0.000			
			(-0.89)			
agr0					-0.000*	0.000
					(-1.85)	(1.03)
agr0*corrupt						-0.001*
						(-1.76)
N	129	129	129	91	91	91
R^2	0.602	0.602	0.605	0.282	0.313	0.341

t statistics in parentheses

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

	(1)	(2)	(3)
	g_for	g_for	g_for
k0	0.000	0.000	0.000
	(1.38)	(1.38)	(0.91)
g_pop	-1.081***	-1.080***	-1.047***
	(-8.32)	(-8.27)	(-8.13)
corrupt	5.432	5.503	9.444*
	(1.19)	(1.20)	(1.96)
polity2	-0.064	-0.065	-0.077
	(-0.54)	(-0.54)	(-0.66)
for0		0.000	0.000**
		(0.30)	(2.27)
for0*corrupt			-0.000**
			(-2.31)
N	126	126	126
R^2	0.725	0.726	0.738

Table 2-2. Corruption control and renewable resources, 2005-2010.

	(1)	(2)	(3)	(4)	(5)	(6)
	g_ren	g_ren	g_ren	g_agr	g_agr	g_agr
k0	-0.000	-0.000	-0.000*	-0.000	-0.000	-0.000
	(-1.49)	(-1.50)	(-1.80)	(-0.47)	(-0.51)	(-0.51)
g_pop	-0.470***	-0.473***	-0.459***	-0.459***	-0.484**	-0.459**
	(-4.18)	(-4.17)	(-4.07)	(-2.65)	(-2.57)	(-2.18)
corrupt	1.792	1.889	6.850	-21.980	-21.610	-19.867
	(0.23)	(0.24)	(0.81)	(-1.55)	(-1.51)	(-1.25)
polity2	0.094	0.095	0.078	0.026	0.041	0.020
	(0.49)	(0.50)	(0.41)	(0.07)	(0.10)	(0.05)
ren0		-0.000	0.000			
		(-0.31)	(1.40)			
ren0*corrupt			-0.000			
			(-1.62)			
agr0					-0.000	0.000
					(-0.35)	(0.14)
agr0*corrupt						-0.000
						(-0.26)
N	132	132	132	91	91	91
R^2	0.408	0.408	0.422	0.258	0.259	0.259

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1)	(2)	(3)
	g_for	g_for	g_for
k0	-0.000	-0.000	-0.000
	(-1.04)	(-1.01)	(-1.40)
g_pop	-0.250**	-0.250**	-0.236**
	(-2.31)	(-2.30)	(-2.20)
corrupt	14.491**	14.388**	18.642***
	(2.55)	(2.52)	(3.13)
polity2	0.004	0.004	-0.009
	(0.03)	(0.03)	(-0.06)
for0		0.000	0.000**
		(0.53)	(2.19)
for0*corrupt			-0.000**
			(-2.13)
N	129	129	129
R^2	0.562	0.563	0.580

Table 3-1. Corruption control and nonrenewable resources, 2000-2005.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	g_non	g_non	g_fos	g_fos	g_fos	g_min	g_min	g_min
k0	-0.000	-0.000*	-0.000	-0.000	-0.000	-0.000*	-0.000*	-0.000*
	(-1.63)	(-1.82)	(-0.91)	(-1.07)	(-1.31)	(-1.82)	(-1.89)	(-1.91)
g_pop	-0.308	-0.438*	-0.305	-0.444*	-0.513**	-0.799**	-0.876**	-0.876**
	(-1.39)	(-1.95)	(-1.29)	(-1.85)	(-2.07)	(-2.25)	(-2.49)	(-2.47)
corrupt	1.631	-0.907	0.120	-2.675	0.376	-4.188	-8.005	-5.712
	(0.19)	(-0.11)	(0.01)	(-0.29)	(0.04)	(-0.48)	(-0.90)	(-0.61)
polity2	0.038	0.057	0.081	0.103	0.098	-0.022	0.037	0.089
	(0.17)	(0.26)	(0.34)	(0.44)	(0.42)	(-0.09)	(0.16)	(0.36)
non0		0.000**						
		(2.16)						
fos0				0.000**	0.000			
				(2.11)	(1.44)			
fos0*corrupt					-0.000			
					(-1.08)			
min0							0.001	0.005
							(1.50)	(1.06)
min0*corrupt								-0.005
								(-0.80)
N	96	96	88	88	88	44	44	44
R^2	0.242	0.284	0.223	0.268	0.280	0.562	0.594	0.603

t statistics in parentheses

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

Table 3-2. Corruption control and nonrenewable resources, 2005-2010.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	g_non	g_non	g_fos	g_fos	g_fos	g_min	g_min	g_min
k0	-0.000*	-0.000**	-0.000	-0.000	-0.000	-0.000*	-0.000*	-0.000*
	(-1.91)	(-2.21)	(-0.80)	(-1.07)	(-1.13)	(-1.80)	(-1.78)	(-1.77)
g_pop	-0.330**	-0.317**	-0.365**	-0.352**	-0.340**	-0.893*	-1.102*	-1.113*
	(-2.49)	(-2.44)	(-2.62)	(-2.58)	(-2.49)	(-1.72)	(-2.01)	(-2.00)
corrupt	7.580	7.009	-0.789	-1.429	3.748	4.500	-1.722	0.078
	(0.61)	(0.57)	(-0.06)	(-0.11)	(0.27)	(0.31)	(-0.11)	(0.00)
polity2	-0.043	-0.005	0.024	0.065	0.072	-0.111	-0.025	0.029
	(-0.15)	(-0.02)	(0.08)	(0.22)	(0.24)	(-0.30)	(-0.07)	(0.07)
non0		0.000**						
		(2.17)						
fos0				0.000**	0.000			
				(2.13)	(1.46)			
fos0*corrupt					-0.000			
					(-1.17)			
min0							0.002	0.006
							(1.13)	(0.63)
min0*corrupt								-0.005
								(-0.42)
N	98	98	90	90	90	44	44	44
R^2	0.342	0.378	0.327	0.366	0.377	0.411	0.435	0.439

t statistics in parentheses

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

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