Incentives for Corruption

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Introduction

- Corruption though to be a serious impediment to development
  - Believed to be endemic in many countries
  - Potentially severe efficiency consequences

- Today I’ll talk about three issues in corruption
  1. Why we care: the efficiency costs of corruption
  2. The individual decision maker’s problem:
     - Do corrupt officials respond to incentives and punishments?
     - Why don’t they respond more?
  3. Market forces: The industrial organization of corruption
I’ll draw on examples from my work in Indonesia.

- I’ll draw from my work in Indonesia on:
  - Graft in road projects (Olken 2007)
  - Rice distribution for the poor (Olken 2006)
  - Bribes paid by truck drivers (Olken and Barron 2009)
  - Illegal logging (Burgess, Hansen, Olken, Potapov, and Sieber 2011)

- Will discuss 3 types of corruption:
  - Graft (theft of government funds)
  - Extortion (extracting money using threat of punishment)
  - Bribes (taking money to allow someone to ignore a government rule)

- Not meant to be an exhaustive list!
Why do we care about corruption?

- I’ll touch on three main costs:
  - As a tax on certain types of government activity
  - Distorting the efficacy of government activity
  - Limits the government’s ability to correct externalities

- Other examples as well:
  - E.g., tax on firm growth
Corruption acts like a tax on certain types of government activity.

- Example from Indonesia (Olken 2006)
  - Program distributes subsidized rice to the poor
  - Estimated graft in the program by comparing receipt of rice in household survey to administrative data on how much rice distributed
  - Estimates are that at least 18% of rice may have been lost to corruption

- What are the costs of corruption?
  - Corruption itself is not a social cost; it’s just a transfer of funds to corrupt officials
  - Costs come from redistributive effects (marginal utility for officials is lower than for the poor) and marginal cost of funds for lost revenues
  - Net result: program may have made program not worth doing, so lose benefits from redistribution
Costs of corruption can make a program not cost effective.

Table 4
Comparing costs and benefits

<table>
<thead>
<tr>
<th>Allocations:</th>
<th>Utilitarian, CRRA utility $\rho = 1$ (% of welfare maximizing utility)</th>
<th>Utilitarian, CRRA utility $\rho = 2$ (% of welfare maximizing utility)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program</td>
<td></td>
<td></td>
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<tr>
<td>Actual allocation</td>
<td>52.23</td>
<td>35.31</td>
</tr>
<tr>
<td>Actual allocation, no corruption</td>
<td>62.06</td>
<td>42.73</td>
</tr>
<tr>
<td>Official eligibility guidelines</td>
<td>60.90</td>
<td>42.10</td>
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<tr>
<td>No program</td>
<td></td>
<td></td>
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<tr>
<td>Consumption tax, MCF = 1.00</td>
<td>46.90</td>
<td>24.68</td>
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<tr>
<td>Consumption tax, MCF = 1.20</td>
<td>56.25</td>
<td>29.59</td>
</tr>
<tr>
<td>Consumption tax, MCF = 1.40</td>
<td>65.59</td>
<td>34.48</td>
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<tr>
<td>Consumption tax, MCF = 1.60</td>
<td>74.91</td>
<td>39.36</td>
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<td>Baselines</td>
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<td>Pure waste</td>
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<tr>
<td>Welfare maximizing</td>
<td>100.00</td>
<td>100.00</td>
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</table>
Corruption can distort the efficacy of government investment.

- Projects may be distorted to extract funds
- Examples from roads in Indonesia:
  - Steal by reducing bottom layer of materials because hardest to detect, so roads decay much more quickly
  - Can't complete a road because run out of funds, so road ends up being useless
A "road" in North Sumatra, Indonesia
Corruption can undermine the government’s ability to correct externalities.

- With externalities, idea of a fine/tax/etc is to equate private and social marginal cost
  - Examples: speeding tickets, etc.
- If there is corruption, the key question is how does corruption affect marginal cost
  - If you pay a bribe regardless of whether you are speeding, there can be a substantial efficiency loss, since marginal cost of speeding is now 0
  - If you pay a bribe (equal to the official fine) only if you are actually speeding, no efficiency loss
We test how corruption affects the marginal cost of driving an overweight truck.

- **Example: weigh stations in Indonesia**
  - Engineers say damage truck does to road rises to the 4th power of truck’s weight
  - Optimal fine should be highly convex so that truckers internalize this cost
  - Actual fine schedule is highly convex (major penalties if more than 5% overweight)

- Collected data by having assistants ride in trucks and record all bribes paid

- With corruption at weigh stations...
  - All truckers pay a bribe instead of actual fine
  - Efficiency question: how convex is bribe as a function of truck weight?
Corruption flattens the marginal cost curve.

Figure 2: Payments at weigh stations

Notes: Each graph shows the results of a non-parametric Fan (1992) locally weighted regression, where the dependent variable is the amount of bribe paid at the weigh station and the independent variable is the number of tons the truck is overweight. The bandwidth is equal to one-third of the range of the independent variable. Bootstrapped 95% confidence intervals are shown in dashes, where bootstrapping is clustered by trip. When the dashed lines are not shown, it indicates that the 95% confidence interval exceeds the y axis of the graph.
Potentially corrupt decision makers balance returns from honesty and corruption.

- Basic framework (e.g., Becker and Stigler 1974)
  - Decision considers gains from being corrupt and expected value of punishments
  - Decides to be corrupt if expected return exceeds value from honesty
- Suggests several natural ways of controlling corruption
- Increase expected punishment:
  - Probability of detection
  - Punishment conditional on detection
- Increase returns from being honest:
  - Wages
  - Output based incentive
Explore the problem with a randomized experiment that changed probability of detection.

- Setting: village infrastructure program where each village was building a 1-3km road
- Experimental intervention:
  - Audits by government auditors. Standard approach, but not clear the effect if auditors are also corrupt
  - Treatment: increase probability of audit from 4 percent baseline to 100 percent
  - Villages randomized, before road was built, to either 100 percent probability or control
- Also investigated improved grass-roots monitoring – not going to discuss today
We compared actual costs to reported costs to measure corruption in roads.

- Obtained final expenditure reports from village governments as to how much they spend on road construction.
- Separate survey to estimate road costs:
  - Core samples to measure quantity of materials
  - Survey suppliers in nearby villages to obtain prices
  - Interview villagers to determine wages paid and tasks done by voluntary labor
- Build several corruption-free ‘test roads’ to account for normal losses during construction, measurement
- Answer – average of 25% of funds unaccounted for
Engineers used core samples to measure actual construction costs.
Experiment showed that audits reduce missing expenditures by about one-third.

- Moving audit probability from 0.04 to 1 reduces missing expenditures from about 27 percentage points to about 19 percentage points.

<table>
<thead>
<tr>
<th>Percent Missing</th>
<th>Control Mean (1)</th>
<th>Treatment Mean: Audits (2)</th>
<th>No Fixed Effects</th>
<th>Engineer Fixed Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major items in roads (N = 477)</td>
<td>.277 (0.033)</td>
<td>.192 (0.029)</td>
<td>-.085* (0.044)</td>
<td>-.076** (0.036)</td>
</tr>
<tr>
<td>Major items in roads and ancillary projects (N = 538)</td>
<td>.291 (0.030)</td>
<td>.199 (0.030)</td>
<td>-.091** (0.043)</td>
<td>-.086** (0.037)</td>
</tr>
<tr>
<td>Breakdown of roads:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Materials</td>
<td>.240 (0.038)</td>
<td>.162 (0.036)</td>
<td>-.078 (0.053)</td>
<td>-.063 (0.042)</td>
</tr>
<tr>
<td>Unskilled labor</td>
<td>.312 (0.080)</td>
<td>.231 (0.072)</td>
<td>-.077 (0.108)</td>
<td>-.090 (0.087)</td>
</tr>
</tbody>
</table>

Note.—Audit effect, standard errors, and p-values are computed by estimating eq. (1), a regression of the dependent variable on a dummy for audit treatment, invitations treatment, and invitations plus comment forms treatments. Robust standard errors are in parentheses, allowing for clustering by subdistrict (to account for clustering of treatment by subdistrict). Each audit effect, standard error, and accompanying p-value is taken from a separate regression. Each row shows a different dependent variable, shown at left. All dependent variables are the log of the value reported by the village less the log of the estimated actual value, which is approximately equal to the percent missing. Villages are included in each row only if there was positive reported expenditures for the dependent variable listed in that row.

* Significant at 10 percent. ** Significant at 5 percent. *** Significant at 1 percent.

TABLE 4
Audits: Main Theft Results

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Substantial correlation between auditors’ findings and independent assessment.

- Why don’t audits have a larger impact?
- It is not that auditors don’t detect corruption: there is a positive correlation between problems on auditors’ ‘administrative checklists’ and missing expenditures.

### Table 6
**Relationship between Auditor Findings and Survey Team Findings**

<table>
<thead>
<tr>
<th></th>
<th>Engineering Team Physical Score (1)</th>
<th>Engineering Team Administrative Score (2)</th>
<th>Percent Missing in Road Project (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditor physical score</td>
<td>.109**</td>
<td>-.067</td>
<td>.024</td>
</tr>
<tr>
<td></td>
<td>(.043)</td>
<td>(.071)</td>
<td>(.033)</td>
</tr>
<tr>
<td>Auditor administrative score</td>
<td>.007</td>
<td>.272**</td>
<td>-.055**</td>
</tr>
<tr>
<td></td>
<td>(.049)</td>
<td>(.133)</td>
<td>(.027)</td>
</tr>
<tr>
<td>Subdistrict fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>248</td>
<td>249</td>
<td>212</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.83</td>
<td>.78</td>
<td>.46</td>
</tr>
</tbody>
</table>
Auditors’ findings insufficient to impose substantial punishments.

- Auditors rarely catch people ‘red-handed’
  - Most problems are procedural in nature
  - E.g., no receipts, tendering process not documented
- Suggests that audits may need to be complemented with higher punishments conditional on concrete evidence

### TABLE 7
**Audit Findings**

<table>
<thead>
<tr>
<th>Finding</th>
<th>Percentage of Villages with Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any finding by BPKP auditors</td>
<td>90%</td>
</tr>
<tr>
<td>Any finding involving physical construction</td>
<td>58%</td>
</tr>
<tr>
<td>Any finding involving administration</td>
<td>80%</td>
</tr>
<tr>
<td>Daily expenditure ledger not in accordance with procedures</td>
<td>50%</td>
</tr>
<tr>
<td>Procurement/tendering procedures not followed properly</td>
<td>38%</td>
</tr>
<tr>
<td>Insufficient documentation of receipt of materials</td>
<td>28%</td>
</tr>
<tr>
<td>Insufficient receipts for expenditures</td>
<td>17%</td>
</tr>
<tr>
<td>Receipts improperly archived</td>
<td>17%</td>
</tr>
<tr>
<td>Insufficient documentation of labor payments</td>
<td>4%</td>
</tr>
</tbody>
</table>

Note.—Tabulations from BPKP final report submitted to the Government of Indonesia’s KDP management team and to the World Bank on December 22, 2004. This report included all findings from the 283 villages that were audited as part of phase II of the audits. The percentage reported is the percentage of the 283 audited village for which BPKP reported finding the listed problem.
Ongoing work explores improving the return to honest behavior.

- Randomized experiment on property tax in Pakistan
- Tax inspectors (teams of 3) will be randomized into four treatments:
  - Wages: Wages will be tripled
  - Incentives: An average of 30% of revenues above historical baseline will be paid to the team of 3 inspectors (so 10% each)
  - Wages + Audits: independent audit survey to assess accuracy of assessments, with forfeit of wage bonus and reassignment to lowest performing inspector
  - Incentives + Audits: independent audit survey, with forfeit of incentives and reassignment to lowest performing inspector
- Tests 3 theories:
  - Efficiency wages (e.g., Becker and Stigler)
  - Honesty as a "normal good"
  - Output based incentives
- Main experiment starts in July, results in 1-2 years
Opportunities for corruption may also be determined by market forces.

- When we examined the individual corrupt decision maker, opportunities for corruption were treated as exogenous.

- But, they may be determined by market forces (e.g. Shleifer & Vishny 1993)

- Examples:
  - If you need to get multiple permits, double marginalization may mean you pay higher total bribes than if corruption was centralized, since each bribe taker doesn’t fully internalize effect of their bribes on total demand
  - Conversely, if you can choose where to get a permit, competition among officials may increase quantities and drive bribes down

- Does this happen?
First example: Trucking in Aceh.

- Setting: the two main roads in Aceh, one to Meulaboh and one to Banda Aceh
Two main trucking routes in Aceh.
We test for double-marginalization in bribes at checkpoints.

- To test for endogenous bribes:
  - Look what happened when 30,000 police and military were withdrawn in 4 phases from Aceh province, from September 2005 to January 2006
  - Our data is from November 2005 - June 2006
  - (includes 3rd and 4th phases of withdrawals, plus post period)

- Empirical strategy:
  - During out period, withdrawals only affected Meulaboh road
  - Withdrawals did not affect portion of road in North Sumatra
  - Therefore, can use changes in prices charged at checkpoints in North Sumatra to identify how prices respond, using Banda Aceh road as a control
Decentralized price setting predicts elasticity between 0 and 1.

- Estimation: Checkpoint level, with all checkpoints on Meulaboh - Medan road *in North Sumatra province*

\[ \text{LOGPRICE}_{ci} = \alpha_c + X'_i \gamma + \beta \text{LOGEXPECTEDPOSTS}_i + \epsilon_{ci} \]

- Predictions
  - If pricing is exogenous, *cost per checkpoint* does not change \((\beta = 0)\)
  - If pricing is centralized, *total cost* of passing through the road does not change \((\beta = -1)\)
  - If pricing is decentralized, change is somewhere in between \((-1 < \beta < 0)\)
Evidence shows endogenous price response.
Earnings Costs Incentives Market forces

Trucking Forestry

Evidence shows endogenous price response.

TABLE 2

<table>
<thead>
<tr>
<th>Impact of Number of Checkpoints in Aceh on Bribes in North Sumatra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meulaboh OLS (1)</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>A. Log Payment at Checkpoint</td>
</tr>
<tr>
<td>Log expected checkpoints on route</td>
</tr>
<tr>
<td>Truck controls</td>
</tr>
<tr>
<td>Common time effects</td>
</tr>
<tr>
<td>Observations</td>
</tr>
<tr>
<td>Test elasticity = 0</td>
</tr>
<tr>
<td>Test elasticity = −1</td>
</tr>
</tbody>
</table>

Note.—Panel A presents the results from estimating eq. (5), where each observation is a payment at a checkpoint, the dependent variable is the log payment at the checkpoint, the sample is limited to North Sumatra province only, all specifications include checkpoint direction of travel fixed effects, and robust standard errors are in parentheses, adjusted simultaneously for clustering at the checkpoint and trip levels. Panel B presents the results from estimating eq. (6), where each observation is a trip, the dependent variable is log total payments in North Sumatra province, and robust Newey-West standard errors allowing for up to 10 lags are included in parentheses. In both specifications, truck controls are dummies for six types of contents, log driver's monthly salary, truck age and truck age squared, and number of tons truck is overweight; these characteristics are examined in more detail in table 6. The instrument in col. 4 is the log number of troops remaining in Aceh in the districts covered by the Meulaboh route; the first-stage F-statistic for the excluded instruments based on the panel B specification is 43.11. Log expected checkpoints uses only variation from Aceh province; the details of how this variable is constructed are in the text. Columns 5 and 6 are the difference-in-difference specifications, including both routes and a common cubic in time (col. 5) or common month fixed effects (col. 6). Note that cols. 5 and 6 of panel B also includes a route dummy.

* Significant at 10 percent.
** Significant at 5 percent.
*** Significant at 1 percent.

If we estimate the first stage with one observation per trip (equivalent to panel B), the F-statistic on the excluded instruments is 43.11. This suggests that weak instruments are not a problem in this context (Staiger and Stock 1997).
Does competition between jurisdictions increase quantities?

- With Cournot competition, as you increase the number of firms, quantities increase and prices decrease.
- Example from forestry:
  - Each district head can allow illegal logging in return for a bribe
  - As we increase the number of districts, total logging should increase and prices should fall
- Empirical setting:
  - In Indonesia, number of districts almost doubled between 2000 and 2008, with districts splits occurring asynchronously
  - We examine the impact of increasing number of districts in a market over time
- Tests:
  - Show impact on quantity using satellite data
  - Demonstrate impact on prices from official production data
- Can rule out various alternative explanations (impacts on legal production, changes in enforcement, differential time trends)
We track illegal logging using satellite imagery.

- MODIS satellite gives daily images of world at 250m resolution
- We use MODIS to construct annual change layers for forests for all Indonesia
  - Aggregate daily images to monthly level to get clearest cloud-free image for each pixel
  - Use 7 MODIS bands at monthly level + 8-day MODIS land surface temperature product \(\rightarrow\) over 130 images for each pixel
  - Use Landsat training data to predict deforestation
  - Once coded as deforested, coded as deforested forever

- Since we have pixel level data, we can overlay with GIS information on the four (fixed) forest zones – production, conversion, conservation, protection \(\Rightarrow\) enables us to look directly at illegal logging
Example
Example
Example

Figure 1: Forest cover change in the province of Riau, 2001-2008
Example
Example

Figure 1: Forest cover change in the province of Riau, 2001-2008

2001
2008
2007
2006
2005
2004
2003
2002

Forest loss
Non-Forest
Forest

INDONESIA

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Incentives for Corruption
Example

Figure 1: Forest cover change in the province of Riau, 2001-2008

2001
2008
2007
2006
2005
2004
2003
2002

Forest loss
Non-Forest
Forest

INDONESIA

2006
Example
Example
Logging increases as number of jurisdictions increase.

- Estimate fixed-effects Poisson Quasi-Maximum Likelihood count model:

\[
\mathbb{E}(\text{deforest}_{pit}) = \mu_{pi} \exp(\beta \text{NumDistrictsInProv}_{pit} + \eta_{it})
\]

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<thead>
<tr>
<th>VARIABLES</th>
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<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
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<tbody>
<tr>
<td></td>
<td>All Forest</td>
<td>Production/Conversion</td>
<td>Conservation/Protection</td>
<td>Conversion</td>
<td>Production</td>
<td>Conservation</td>
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<td>NumDistricts in province</td>
<td>0.0361**</td>
<td>0.0424**</td>
<td>0.0391</td>
<td>0.0283</td>
<td>0.0533***</td>
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<td>(0.0333)</td>
<td>(0.0199)</td>
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<td>Observations</td>
<td>672</td>
<td>336</td>
<td>336</td>
<td>128</td>
<td>168</td>
<td>144</td>
<td>168</td>
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<tr>
<td>NumDistricts in province</td>
<td>0.0370</td>
<td>0.0435</td>
<td>0.0833***</td>
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<td>0.0959**</td>
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<td>Lag 1</td>
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<td>0.0434</td>
<td>-0.129**</td>
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<td>Lag 2</td>
<td>-0.0717***</td>
<td>-0.0740***</td>
<td>0.0186</td>
<td>-0.0883**</td>
<td>-0.0625**</td>
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<td>(0.0346)</td>
<td>(0.0257)</td>
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<td>(0.0679)</td>
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<tr>
<td>Lag 3</td>
<td>0.0731*</td>
<td>0.0654</td>
<td>0.117*</td>
<td>0.107</td>
<td>0.0476</td>
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<td>336</td>
<td>128</td>
<td>168</td>
<td>144</td>
<td>168</td>
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<tr>
<td>Joint p</td>
<td>4.75e-06</td>
<td>6.95e-08</td>
<td>0.0235</td>
<td>0.0428</td>
<td>0.000923</td>
<td>0.0486</td>
<td>0.0665</td>
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<tr>
<td>Sum of lags</td>
<td>0.0789***</td>
<td>0.0783***</td>
<td>0.0900**</td>
<td>0.0712</td>
<td>0.0793***</td>
<td>0.125**</td>
<td>0.0484</td>
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<tr>
<td></td>
<td>(0.0200)</td>
<td>(0.0190)</td>
<td>(0.0400)</td>
<td>(0.0616)</td>
<td>(0.0214)</td>
<td>(0.0611)</td>
<td>(0.0357)</td>
</tr>
</tbody>
</table>

Notes: The forest dataset has been constructed from MODIS satellite images, as described in Section 2.2.1. It counts the total number of forest cells by year and forest zone. Note that 1000HA = 10 square kilometres.
Prices for wood fall as number of jurisdictions increase.

Estimate:

\[
\log (y_{wipt}) = \beta \text{NumDistrictsInProv}_{pit} + \mu_{wpi} + \eta_{wit} + \epsilon_{wipt},
\]

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>NumDistricts in province</td>
<td>-0.017* (0.009)</td>
<td>-0.019* (0.010)</td>
<td>-0.023** (0.009)</td>
<td>0.081*** (0.016)</td>
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<tr>
<td>Observations</td>
<td>1003</td>
<td>532</td>
<td>2355</td>
<td>2355</td>
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Panel B: Lags

<table>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lag 1</td>
<td>0.010** (0.008)</td>
<td>-0.041 (0.036)</td>
<td>0.012 (0.045)</td>
<td>-0.035 (0.021)</td>
<td>-0.015* (0.004)</td>
<td>0.029 (0.008)</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.044)</td>
<td>(0.007)</td>
<td>(0.040)</td>
<td>(0.008)</td>
<td>(0.037)</td>
</tr>
<tr>
<td>Lag 2</td>
<td>-0.001 (0.008)</td>
<td>0.041 (0.045)</td>
<td>-0.017** (0.006)</td>
<td>0.018 (0.007)</td>
<td>-0.015* (0.004)</td>
<td>0.029 (0.008)</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.044)</td>
<td>(0.007)</td>
<td>(0.040)</td>
<td>(0.008)</td>
<td>(0.037)</td>
</tr>
<tr>
<td>Lag 3</td>
<td>-0.017** (0.006)</td>
<td>0.033 (0.044)</td>
<td>-0.017** (0.007)</td>
<td>0.043 (0.040)</td>
<td>-0.015* (0.004)</td>
<td>0.029 (0.008)</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.044)</td>
<td>(0.007)</td>
<td>(0.040)</td>
<td>(0.008)</td>
<td>(0.037)</td>
</tr>
<tr>
<td>Observations</td>
<td>1003</td>
<td>532</td>
<td>2355</td>
<td>2355</td>
<td>1960</td>
<td>1960</td>
</tr>
<tr>
<td>Joint p</td>
<td>0.00271</td>
<td>0.000533</td>
<td>0.00756</td>
<td>0.000583</td>
<td>0.000199</td>
<td>0.00645</td>
</tr>
<tr>
<td>Sum of lags</td>
<td>-0.0329*** (0.0103)</td>
<td>0.131** (0.0527)</td>
<td>-0.0361** (0.0116)</td>
<td>0.153** (0.0505)</td>
<td>-0.0339*** (0.0131)</td>
<td>0.117*** (0.0363)</td>
</tr>
</tbody>
</table>

Notes: The log price and log quantity data has been compiled from the `Statistics of Forest and Concession Estate'. The number of districts in province variable counts the number of kabupaten and kota within each province. The regression also includes wood-type-by-province and wood-type-by-island-by-year fixed effects and are weighted by the first volume reported by wood type and province. The robust standard errors are clustered at the 1990 province boundaries and reported in parentheses. *** 0.01, ** 0.05, * 0.1
Magnitudes are consistent with benchmark Cournot model.

- Benchmark Cournot model:

\[
\max_{q_i} q_i p \left( \sum q \right) - c q_i
\]

- Taking derivatives and rewriting yields:

\[
\frac{(p - c)}{p} = \frac{1}{n \varepsilon}
\]

where \( n \) is number of jurisdictions and \( \varepsilon \) is elasticity of demand.

- If we assume \( p = \frac{a}{Q^\lambda} \), so we have constant elasticity of demand \( \varepsilon = \frac{1}{\lambda} \), we can derive a formula for semi-elasticity of extraction with respect to \( n \) (which is what we estimate), i.e.

\[
\frac{1}{Q} \frac{dQ}{dn} = \frac{1}{n^2 - n\lambda}
\]
Magnitudes are results consistent with benchmark Cournot model.

- Does this match the data?
- With $n = 5.5$ and $\varepsilon = 2.1$, formula implies $\frac{1}{Q} \frac{dQ}{dn} = \frac{1}{n^2 - n\lambda}$, which is about 0.035
- We estimate $\frac{1}{Q} \frac{dQ}{dn}$ to be between 0.036 in short run and 0.079 in long run – so in the right order of magnitude
Concluding thoughts

- Efficiency costs can be severe, particularly if they undo government’s ability to correct externalities or distort investment decisions.
- Corrupt officials do respond to monitoring and punishments, but there may be limits:
  - What if the auditors are corrupt? Then it depends on whether the amount you have to bribe the auditors depends on how corrupt you are.
  - Evidence of substitution to other margins: in road example, nepotism increased in response to audits.
- Market forces can affect bribe levels in equilibrium:
  - Whether competition is good or bad depends on whether increasing quantities is socially good or bad.
  - In forestry, it led to more illegal logging.
  - In other cases (getting an ID card) it could lead to lower bribes.
  - Not clear how this interacts with case when government also trying to correct externalities (e.g., getting a driver’s license).