Deforestation and Conservation Contracts

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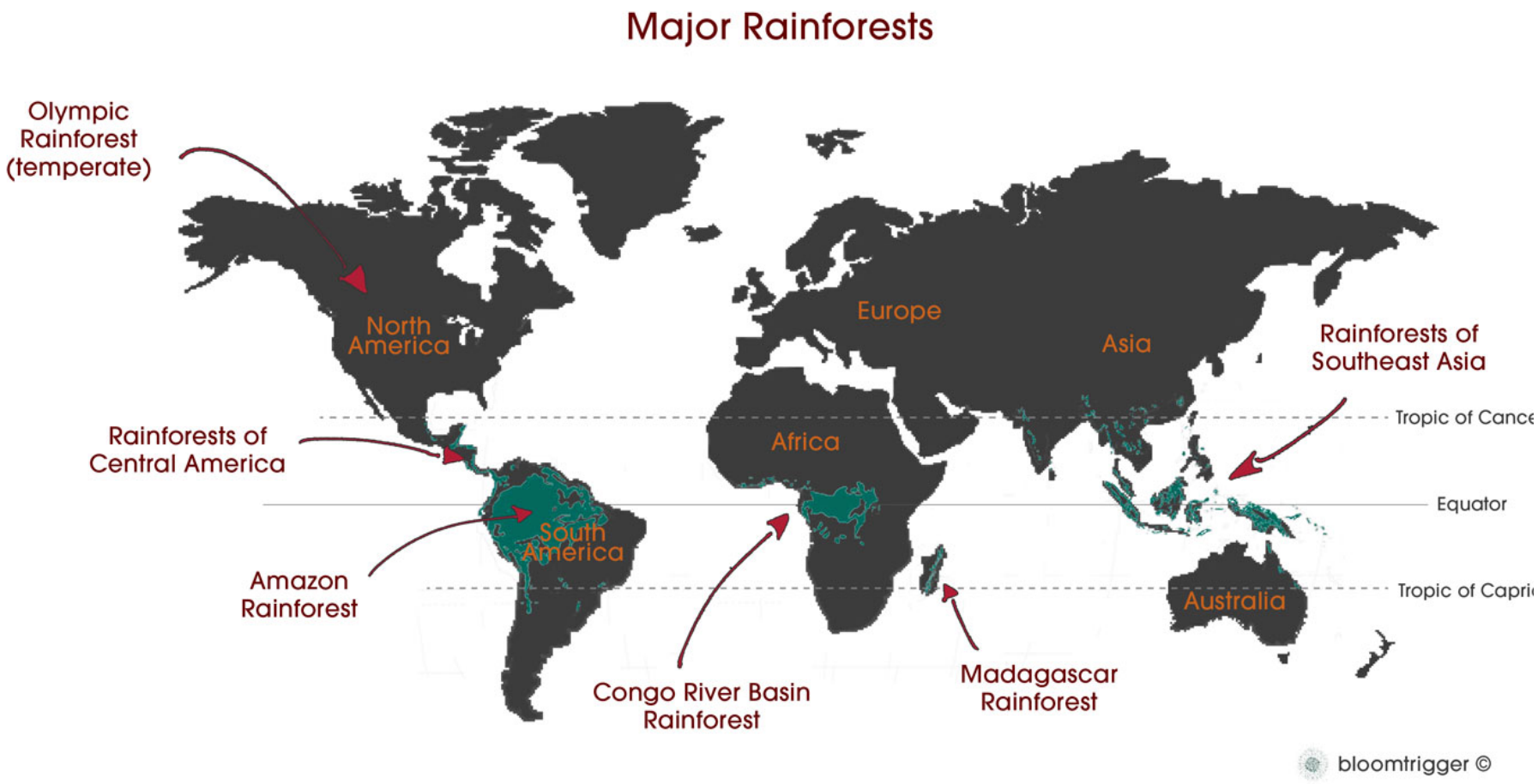
April 9, 2014

Overview

Tropical Rainforests



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   - given that deforestation may be either illegal or controlled by the local governments?
   - when there is leakage, i.e., that one country/district may log more when the neighbor log less?
4. Whenever possible, is contracting at top level better than contracting at lower hierarchies of a decentralized state?(in progress)

Definition: Conservation Contracts

The most popular contractual form is to *pay developing countries for performance* i.e. for avoided deforestation relative to the baseline or BAU deforestation.

The REDD contract is thus P pays each agent:

$$T_i = max\{t_i(\bar{x}_i - x_i), 0\} \tag{1}$$

Economic Model of Tropical Deforestation

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1. Principal (donor) from north,
2. Central/Regional governments in south (A and B or i and j),
3. Illegal loggers in south (very large in number)

Preferences

Region i's:

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$$\begin{aligned} x_i &= x_{i,s} + x_{i,n}, \\ x_s &= x_{i,s} + x_{j,s}, \\ x_n &= x_{i,n} + x_{j,n}, \\ x &= x_i + x_j = x_n + x_s. \end{aligned} \tag{3}$$

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Central government's $u_c \equiv u_i + u_j$

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Donor's utility function

$$u_D = -d\left(x_A, x_B\right) - \sum_{i \in \{A,B\}} t_i \max\left\{0, \overline{x}_i - x_i\right\}. \tag{4}$$

Market and illegal logging

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Proposition 1

Illegal logging: The amount of illegal logging in a region decreases in the region's policing, increases in the other region's policing, and decreases in both regions' sales:

$$x_{i,n} = \frac{ah - bx_s h - e_i (h + b) + be_j}{h^2 + 2bh}$$

Decentralization: Contracting with regional governments

Proposition 2

Policing: Taking sales as given, a district polices more if it sells more (since then it is more important to get a high price) and if v_i is large. The policing effort is independent of the other district's policies or v_j:

$$e_i = \frac{x_{i,s}}{2c}\frac{b}{h+2b} + \left(\frac{v_i + t_i}{2c}\right)\frac{h+b}{h(h+2b)} \tag{7}$$

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Proposition 3

Sales: Taking the other policing as given, a district sells more if it, and/or the neighbor, polices more (since the price is then higher) and if v_i is small while v_j is large:

$$x_{i,s} = \frac{a}{3b} + \frac{e_i + e_j}{3h} - \left(\frac{h+b}{3bh}\right)\left[(v_i + t_i) - (v_j + t_j)\right].$$

Subgame perfect allocations are:

$$
\begin{aligned}
p &= \frac{ah + (h+b)(v_i + t_i + v_j + t_j)}{6b - b/2h - b/2hc + 3h} \\
x &= \frac{a}{b} - \frac{1}{b}\left[\frac{ah + (h+b)(v_i + t_i + v_j + t_j)}{3h + 6b - b/4ch}\right] \\
e_i &= \frac{1}{2hc}\left[\frac{ah + (h+b)(v_i + t_i + v_j + t_j)}{3h + 6b - b/4ch}\right] \\
x_{i,n} &= \frac{(1 - 1/2hc)}{h}\left[\frac{ah + (h+b)(v_i + t_i + v_j + t_j)}{3h + 6b - b/4ch}\right] \\
x_{i,s} &= \frac{h + 2b}{bh}\left[\frac{ah + (h+b)(v_i + t_i + v_j + t_j)}{3h + 6b - b/4ch}\right] - \left(v_i + t_i\right)\frac{h+b}{bh} \\
x_i &= \left(\frac{2h + 6b - b/ch}{2bh}\right)\left[\frac{ah + (h+b)(v_i + t_i + v_j + t_j)}{3h + 6b - b/4ch}\right] - \left(v_i + t_i\right)\frac{h+b}{bh}
\end{aligned}
$$

Proposition 4

If t_i increases, x and $x_{i,s}$ decrease but $x_{j,s}$ increases. In addition, p, $x_{i,n}$, $x_{j,n}$, e_i and e_j increase in both districts. The leakage is large and $|\partial x/\partial t_i|$ is small if c is large:

$$\frac{\partial x}{\partial t_i} = -\frac{1}{b}\left[\frac{h+b}{3h+6b-b/4ch}\right]$$

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$$\begin{aligned}\frac{\partial x}{\partial t_i} &= -\frac{1}{b}\left[\frac{h+b}{3h+6b-b/4ch}\right] \\ \frac{\partial x_j}{\partial t_i} &= -\frac{2h+6b-b/ch}{2h}\frac{\partial x}{\partial t_i} > 0\end{aligned}$$

Proposition 5

Externalities:

- *Region i benefits from the neighbor's larger $x_{j,s}$ and smaller e_j if and only if*

$$v_i + t_i > \underline{V} \equiv \frac{a}{1 + 4b/h - b/4ch^2}$$

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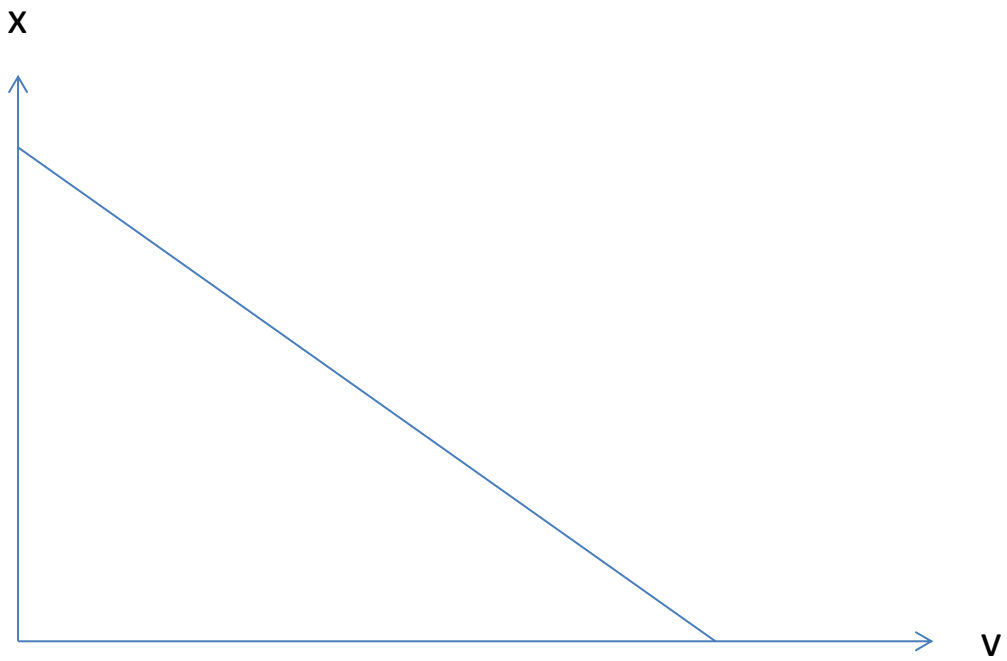
- *Region i benefits from the neighbor's larger t_j if and only if $v_i + t_i$ is small (same condition as previous proposition):*

$$v_i + t_i < \underline{V}.$$

Deforestation decreases in v



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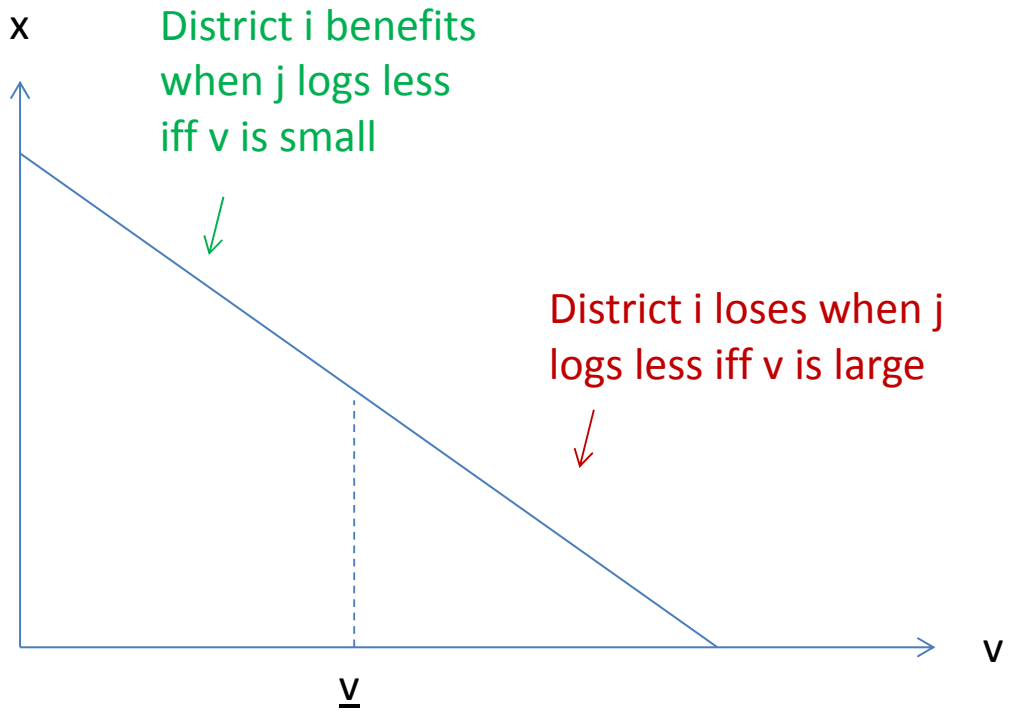

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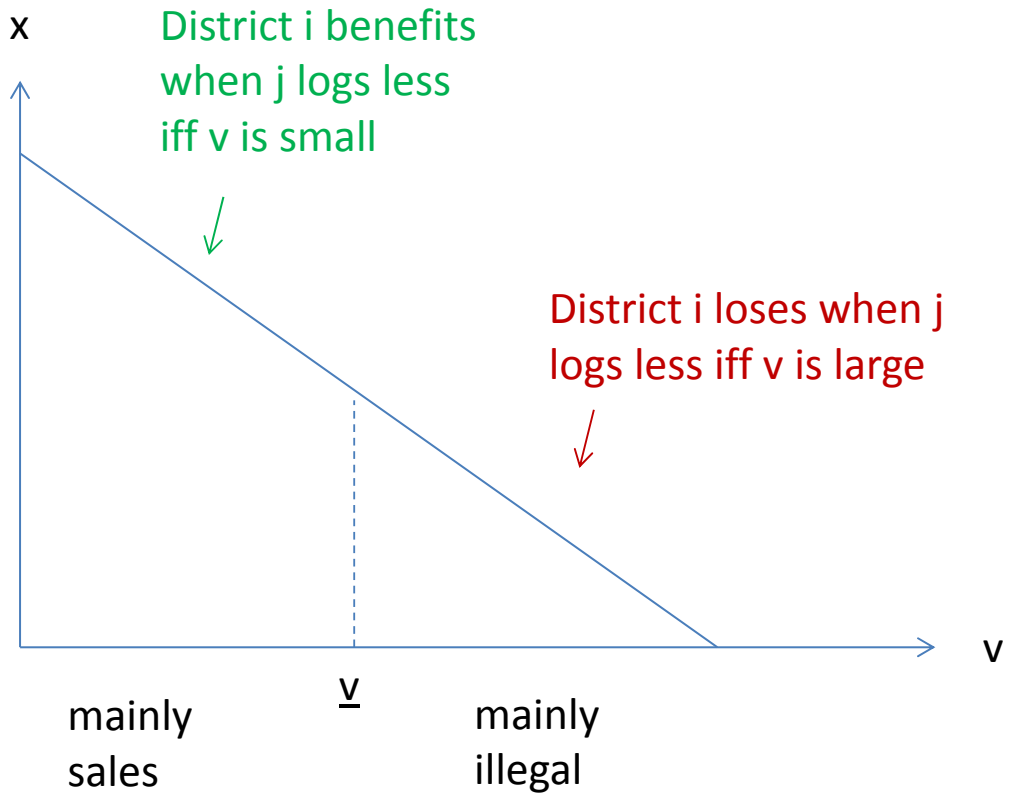
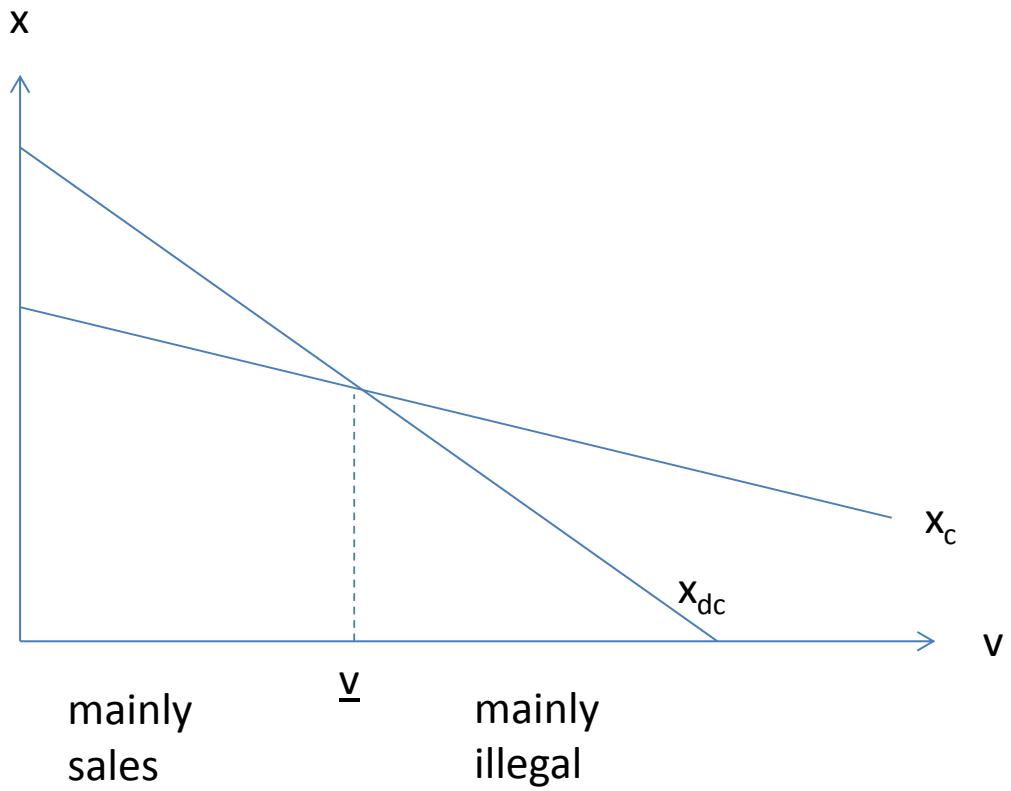


Deforestation decreases in v
also under centralization – but less so



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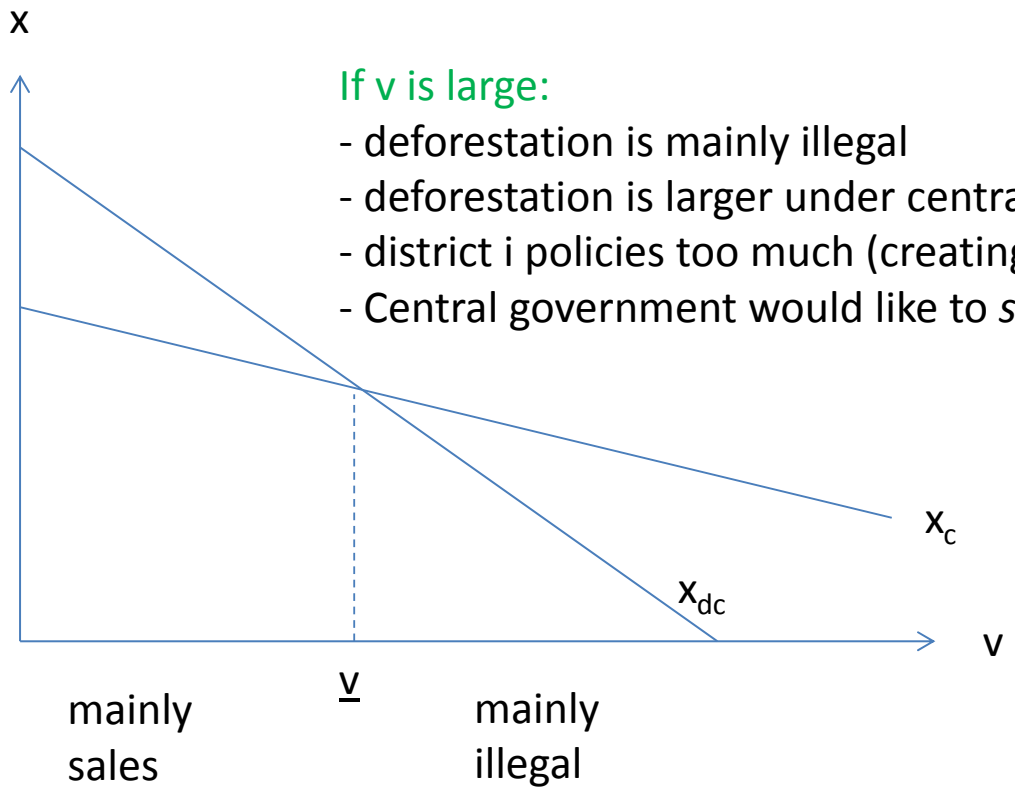
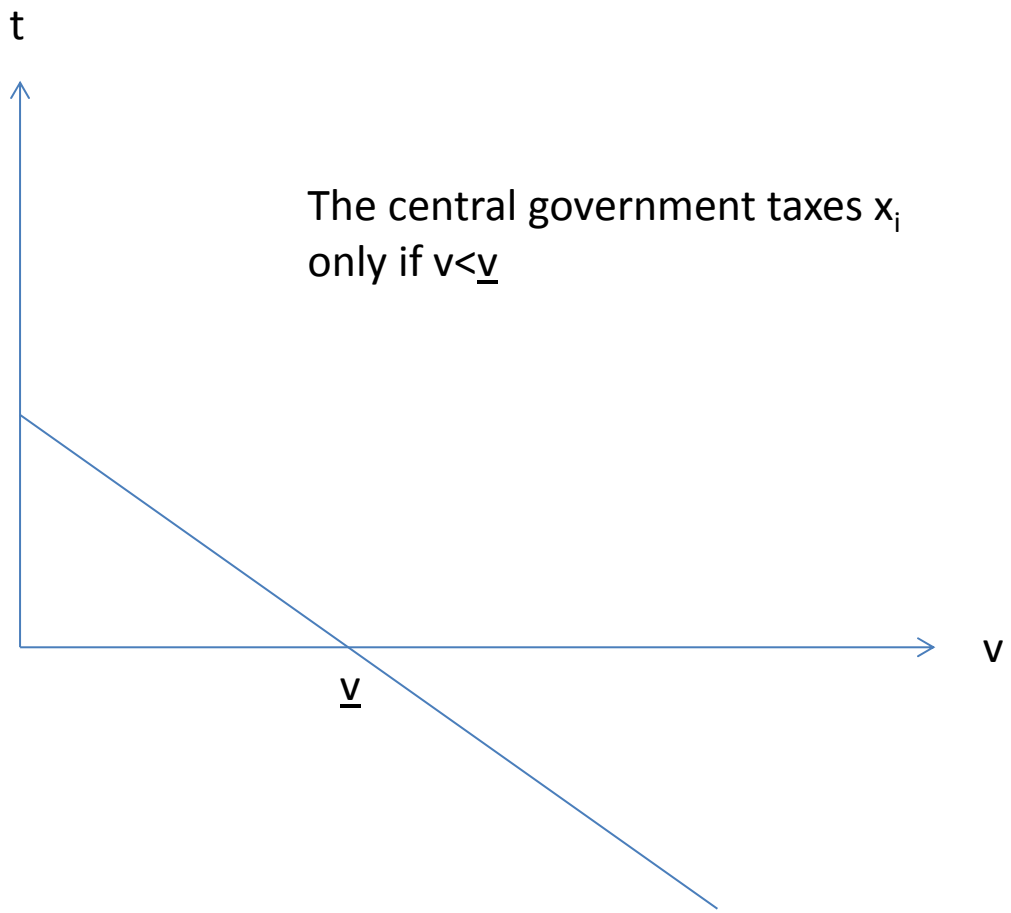


If v is large:
- deforestation is mainly illegal
- deforestation is larger under centralization
- district i policies too much (creating deforestation in j)
- Central government would like to *subsidize* x_i

C's tax on deforestation in A and B



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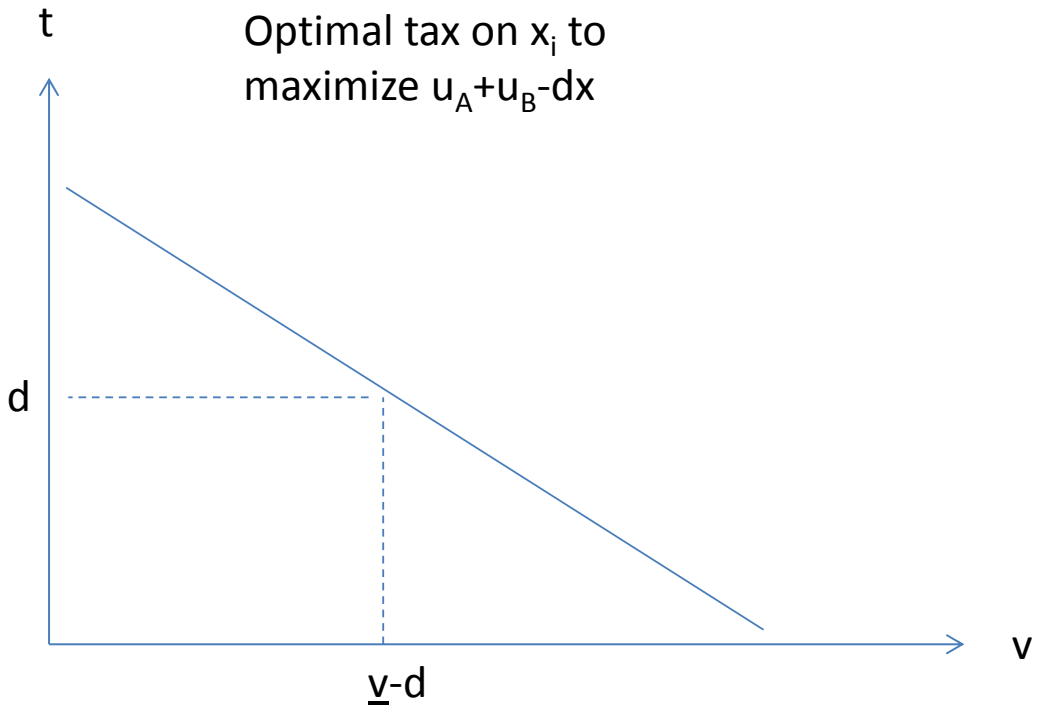

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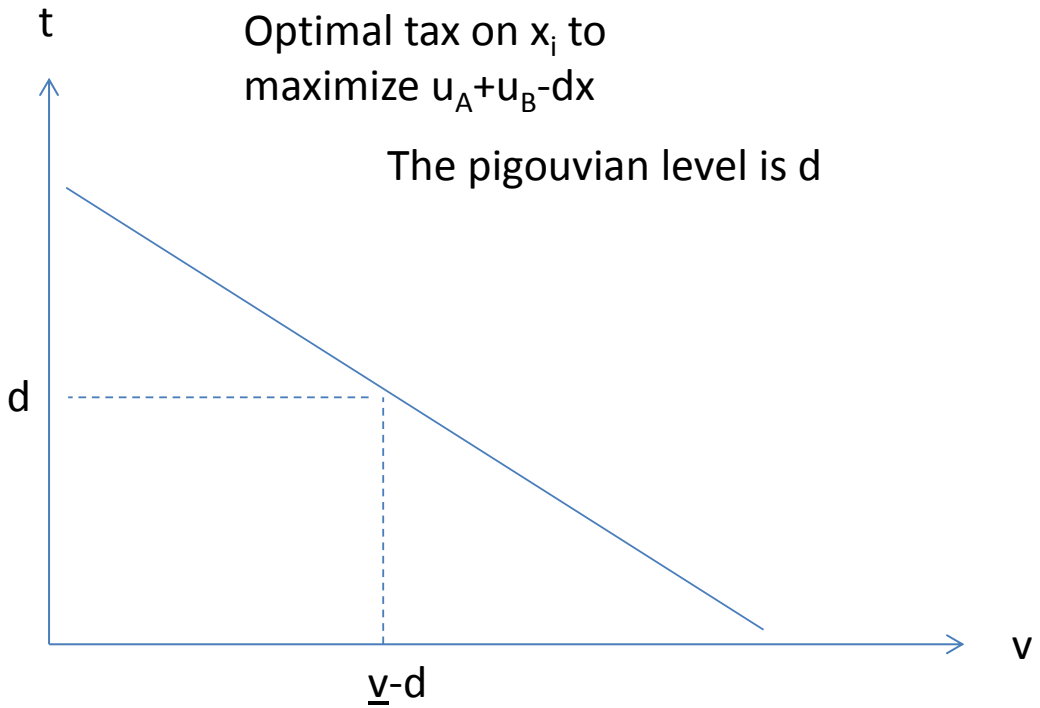

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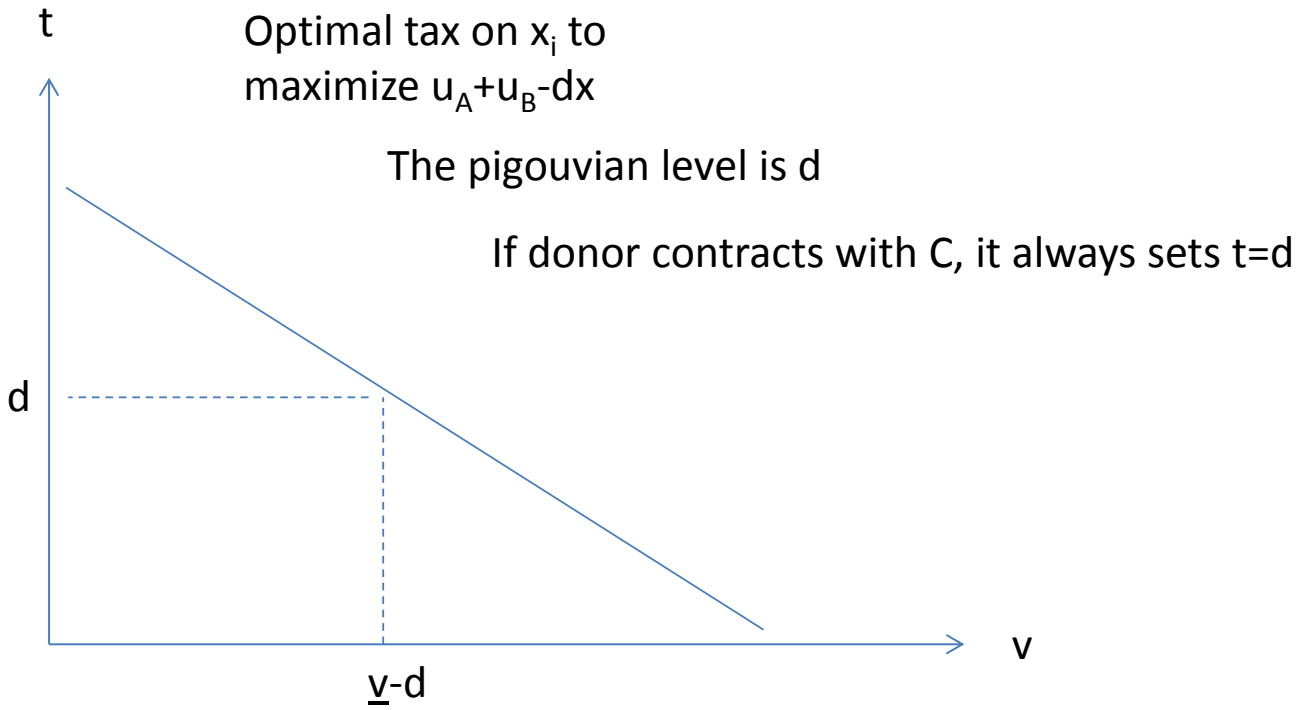

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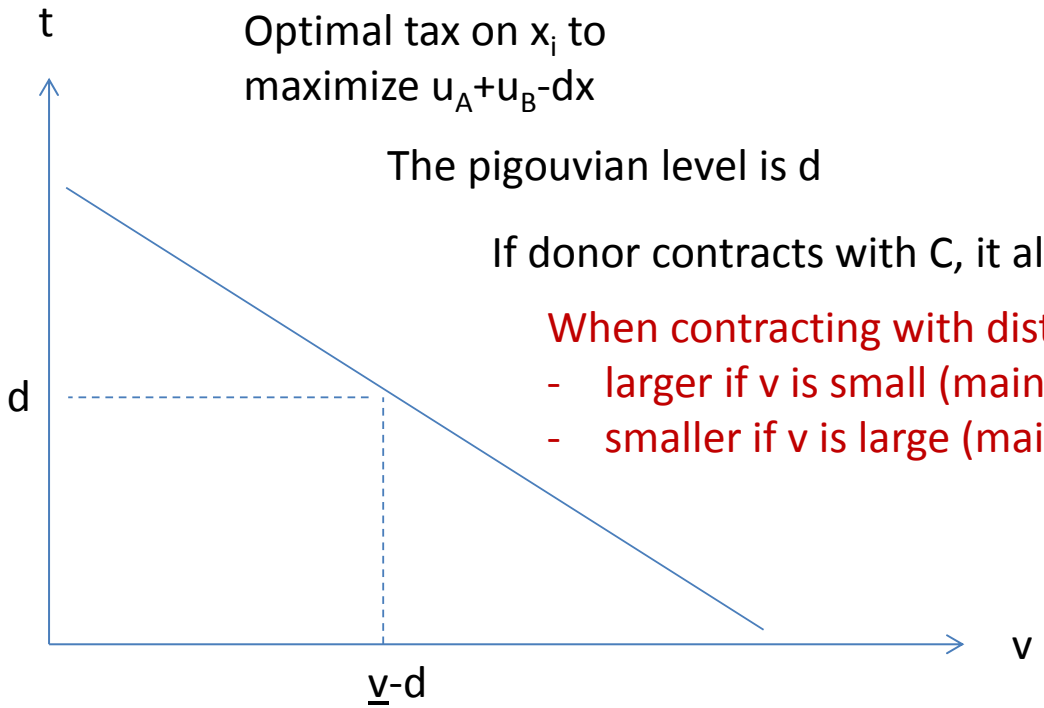


Optimal tax on x_i to maximize u_A+u_B-dx

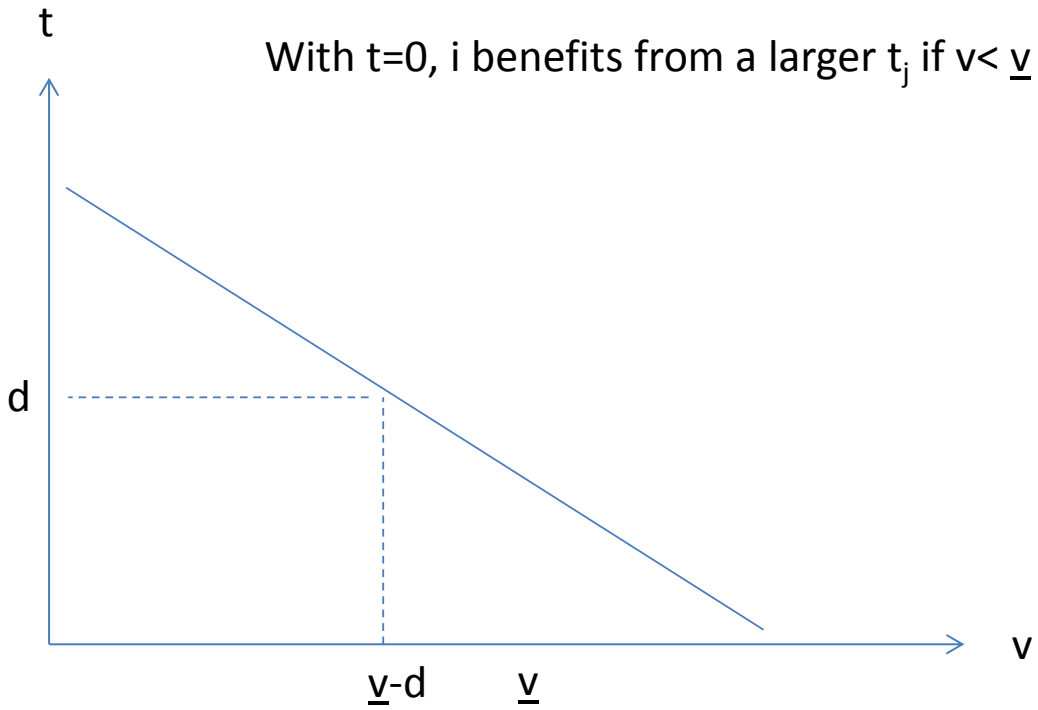
The pigouvian level is d

If donor contracts with C, it always sets t=d

When contracting with districts, optimal tax is:

- larger if v is small (mainly sales);
- smaller if v is large (mainly illegal logging).

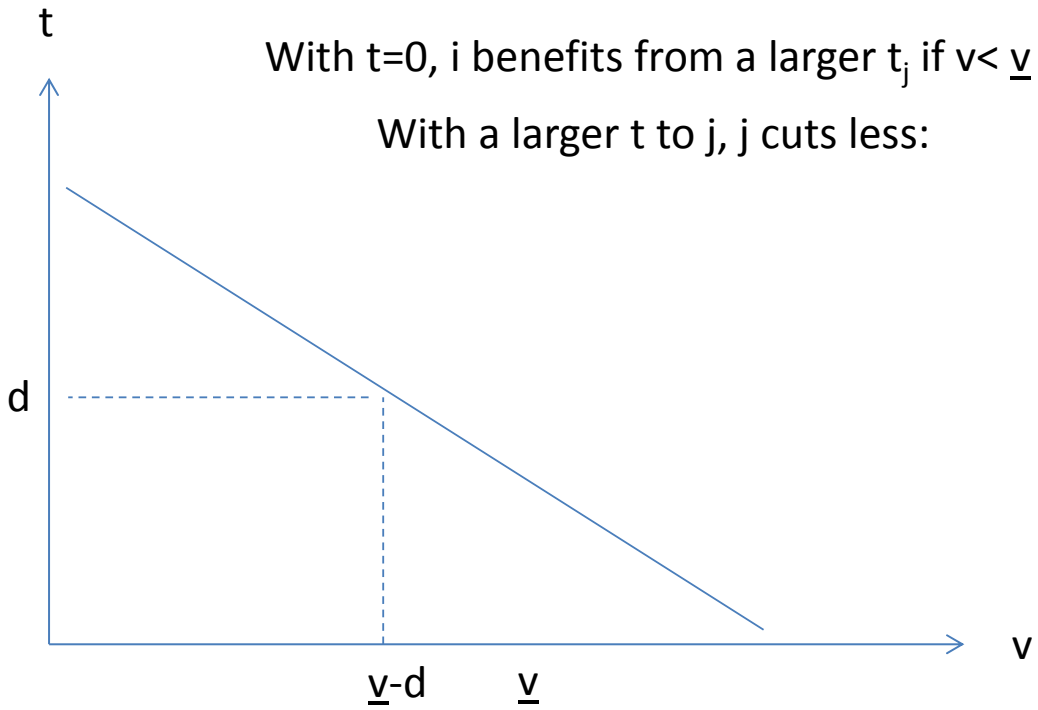
Equilibrium t



Equilibrium t

With t=0, i benefits from a larger t_j if $v < \underline{v}$

With a larger t to j, j cuts less:



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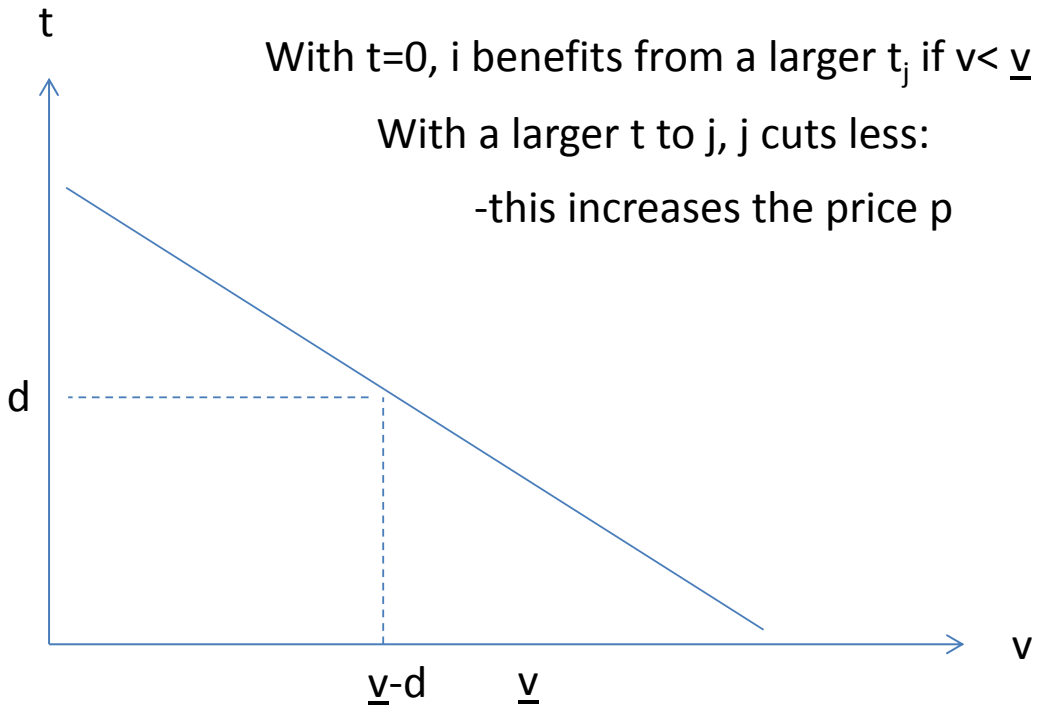

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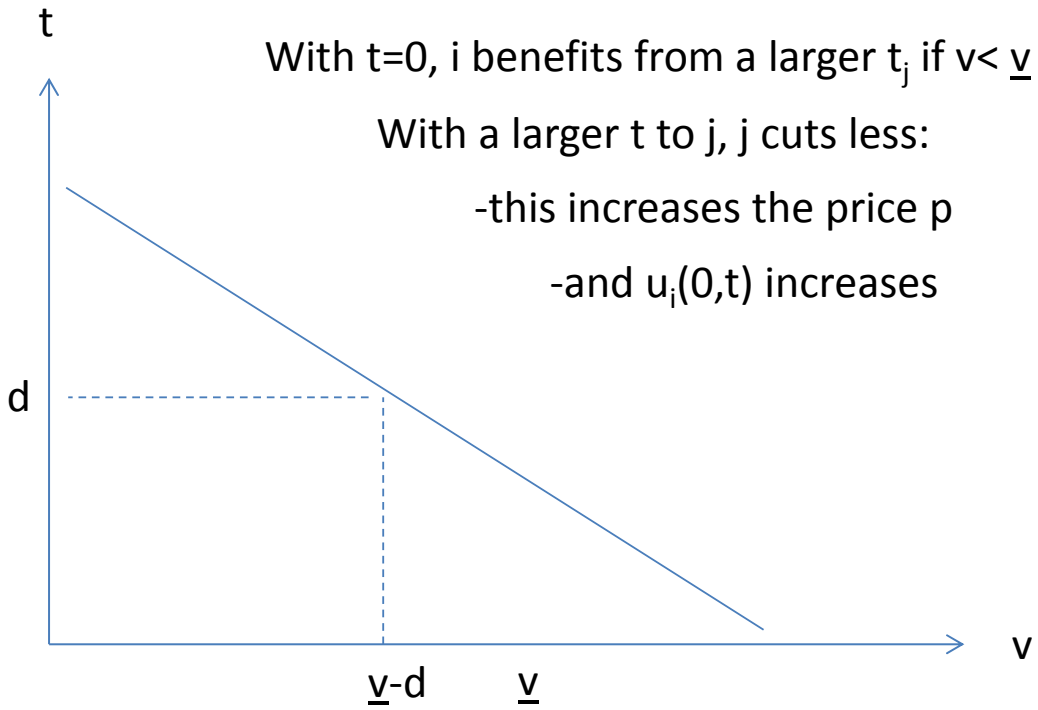

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With a larger t to j, j cuts less:

-this increases the price p

-and $u_i(0,t)$ increases

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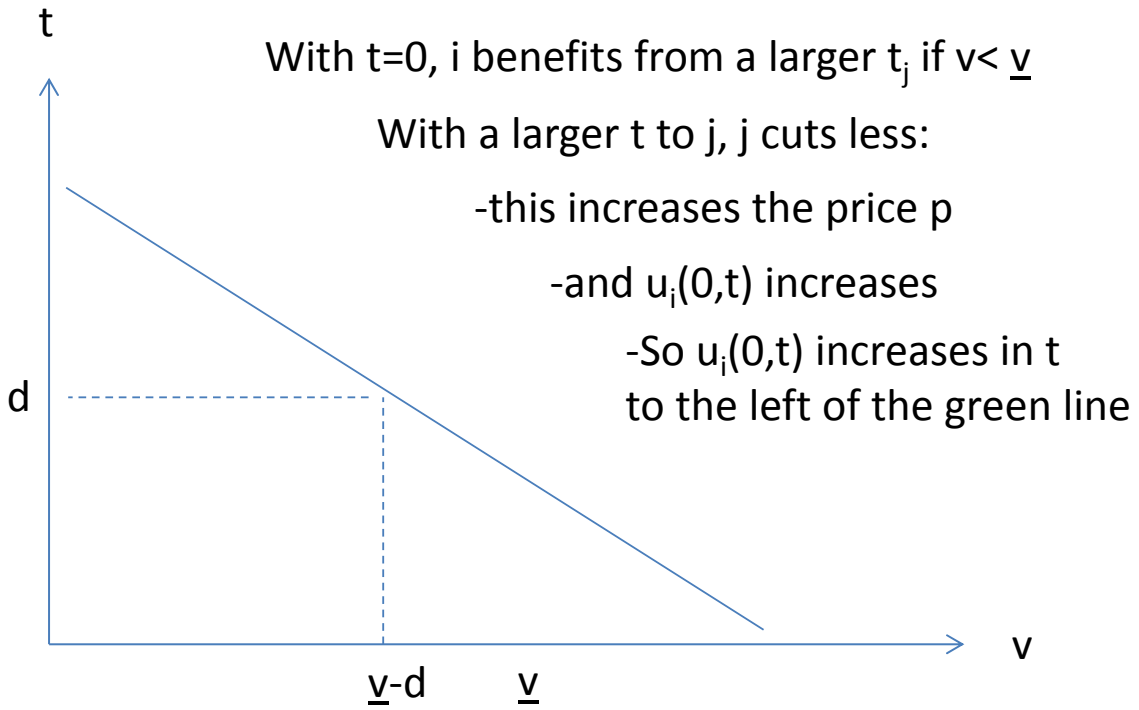

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-So $u_i(0,t)$ increases in t to the left of the green line

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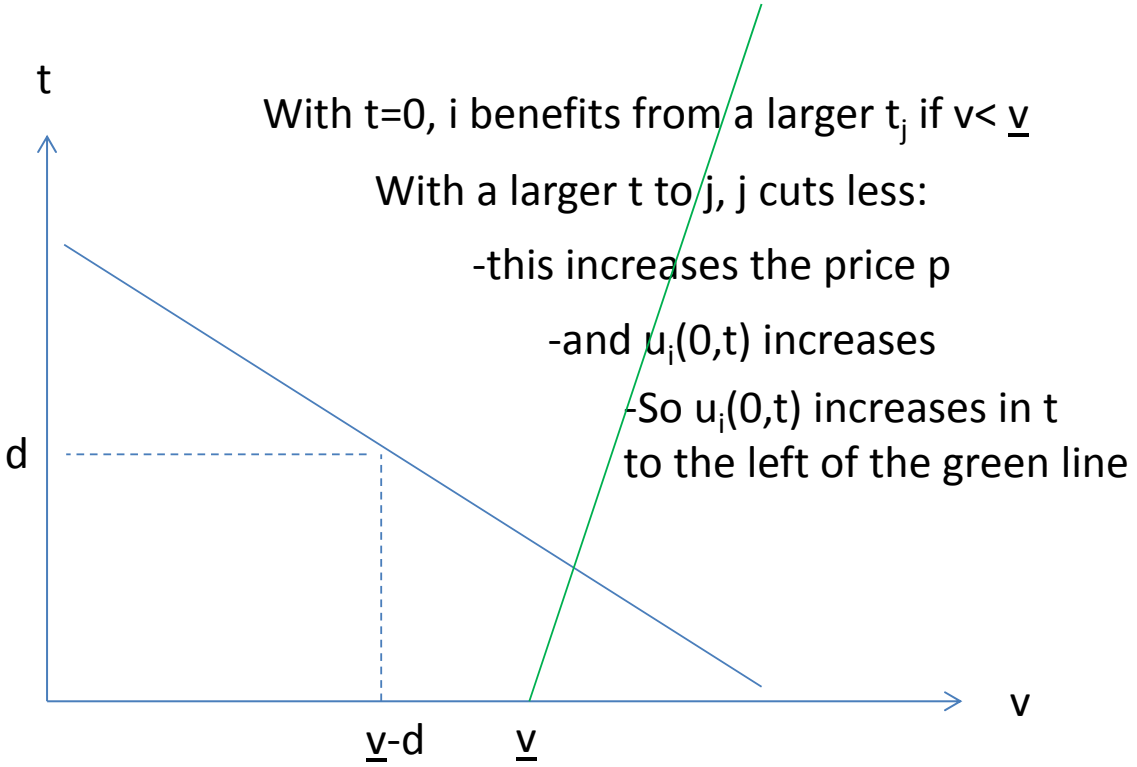

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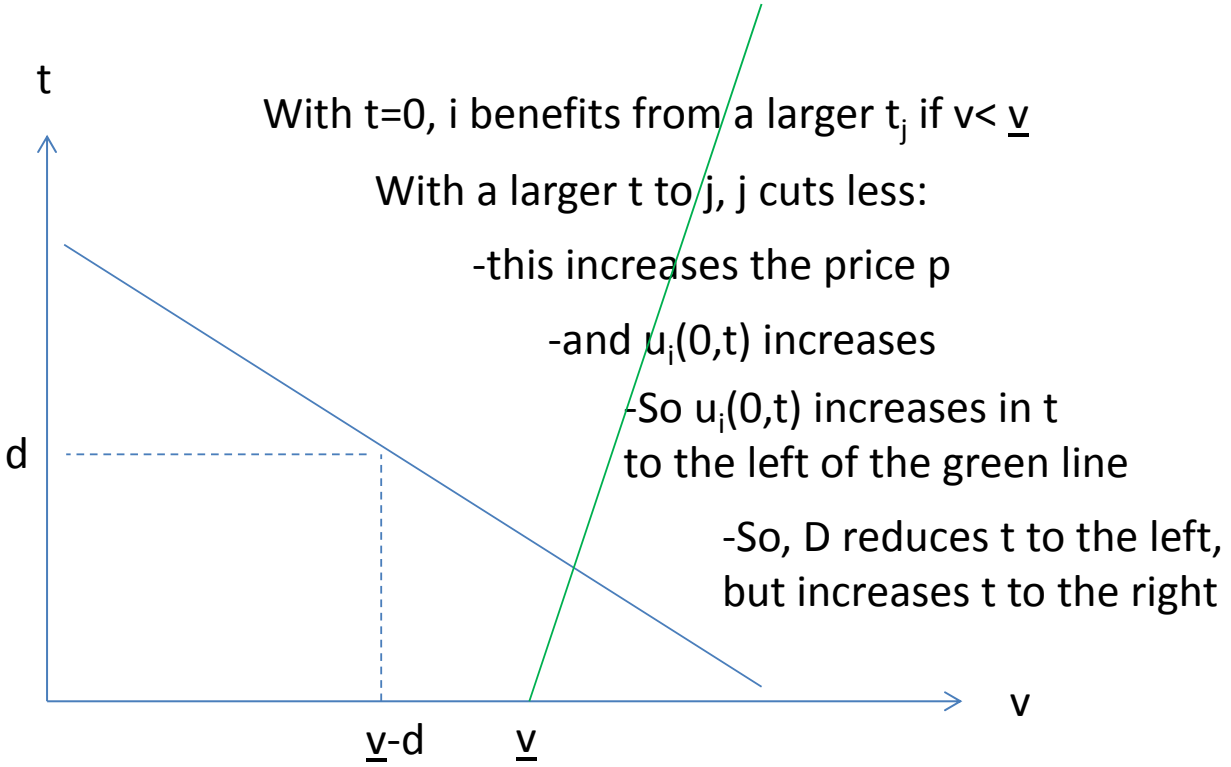

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-So, D reduces t to the left, but increases t to the right

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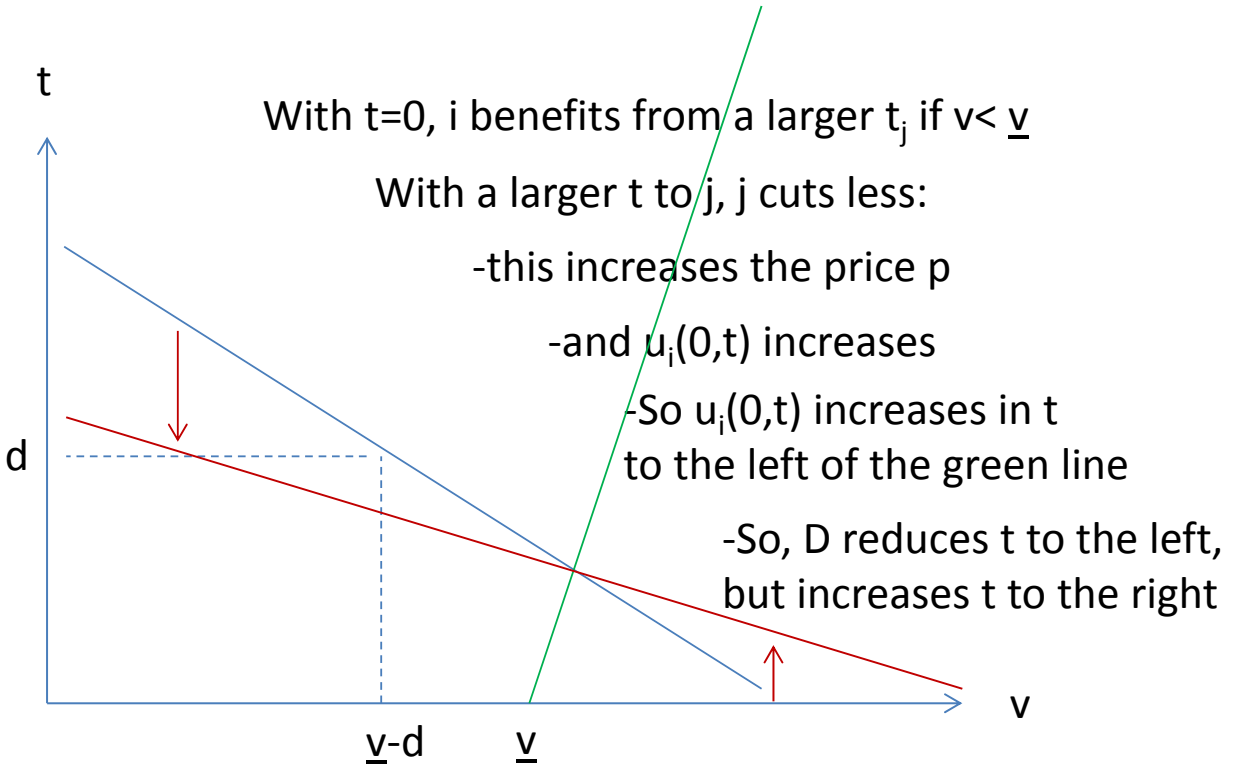

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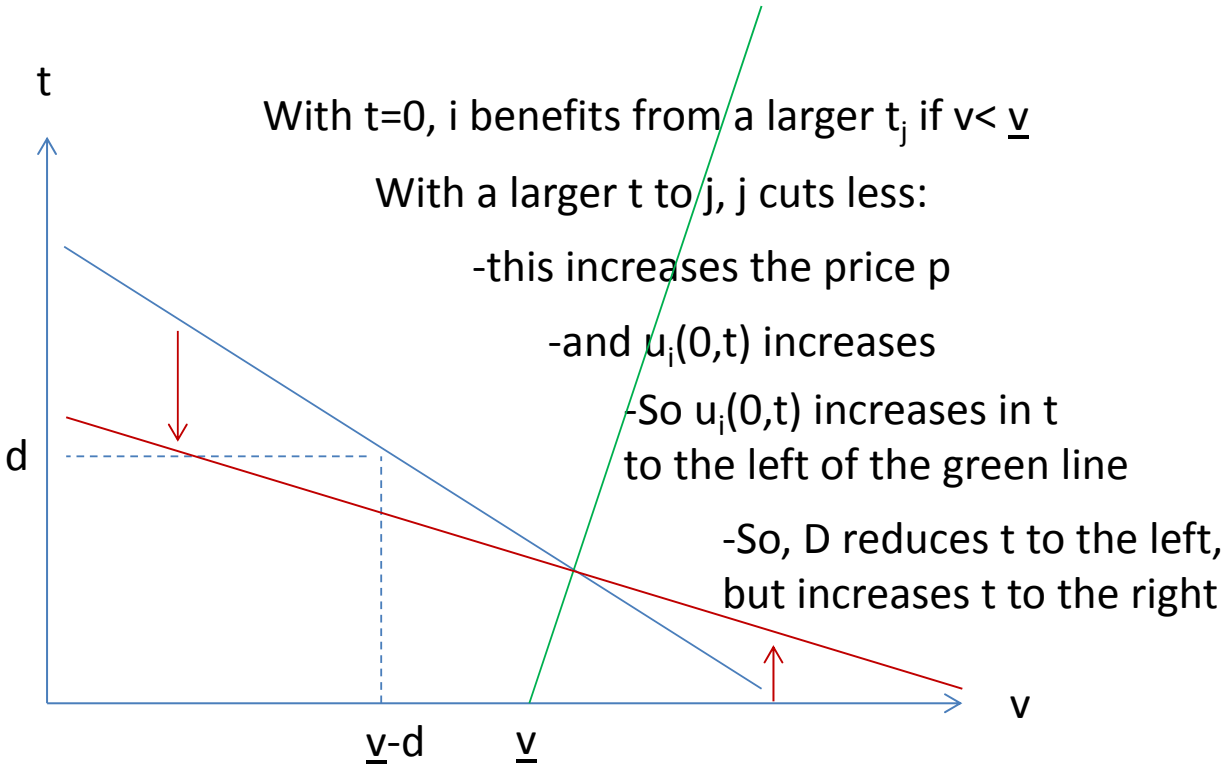
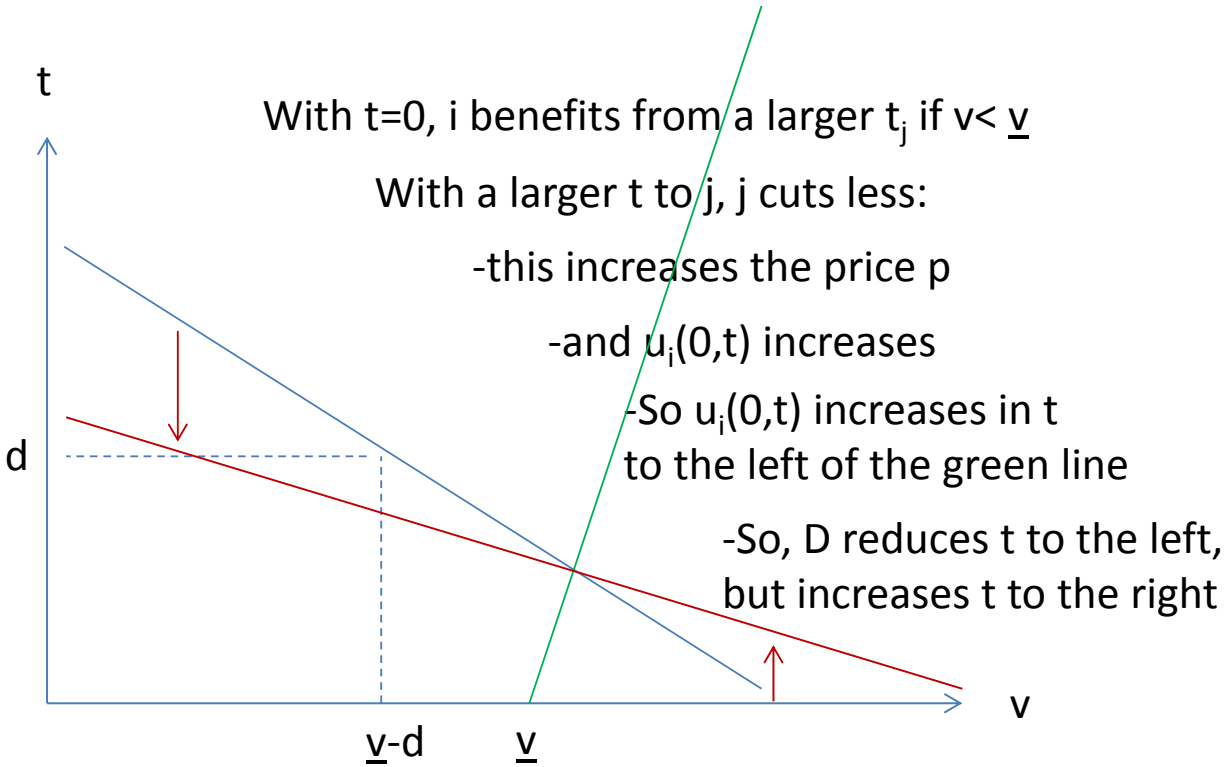


x is too large if v is small, while x is too small if v is large

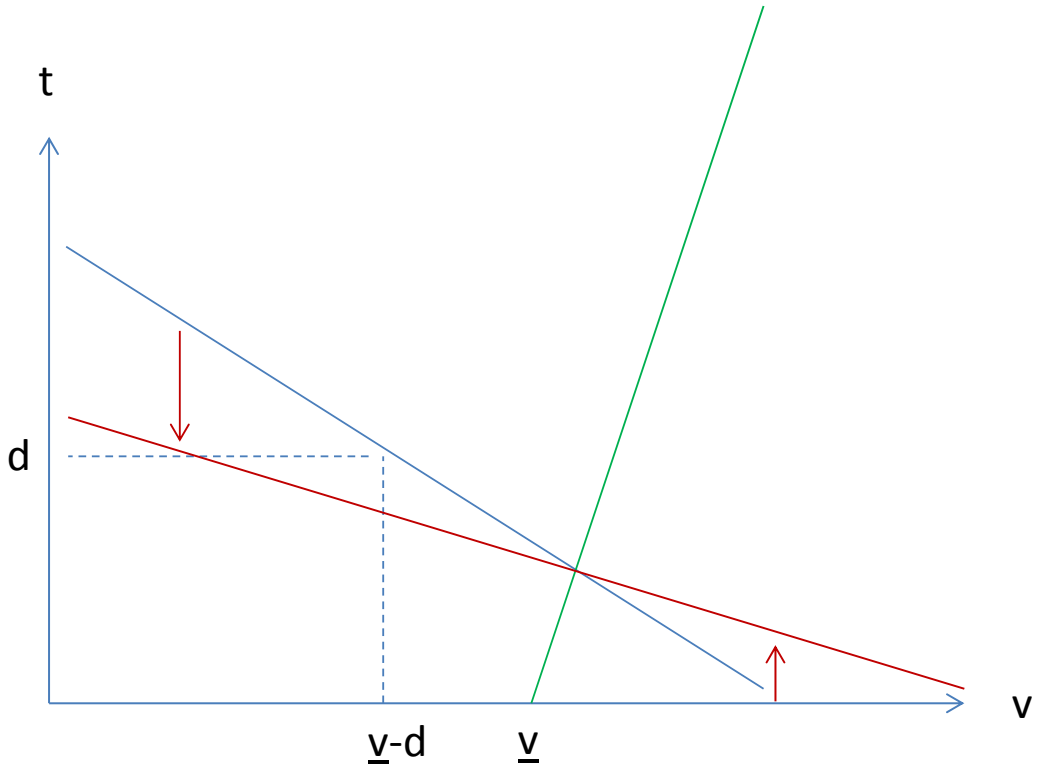
Equilibrium t



x is too large if v is small, while x is too small if v is large

x is too large if d is large, while x is too small if d is small

Equilibrium t



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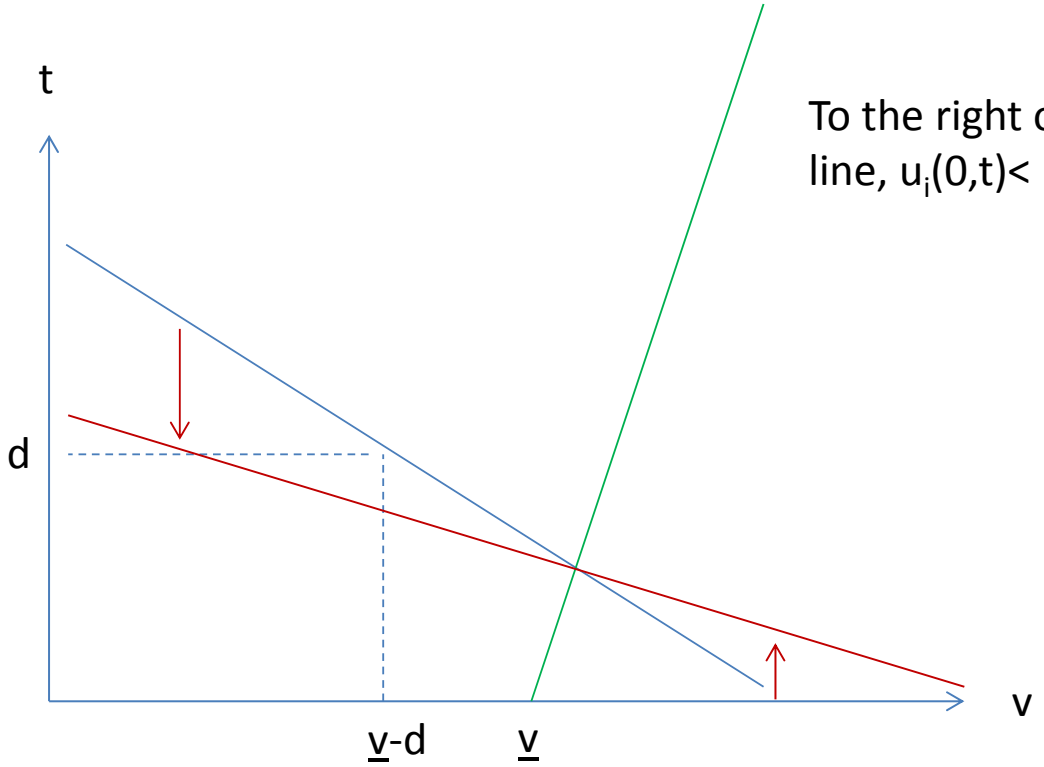
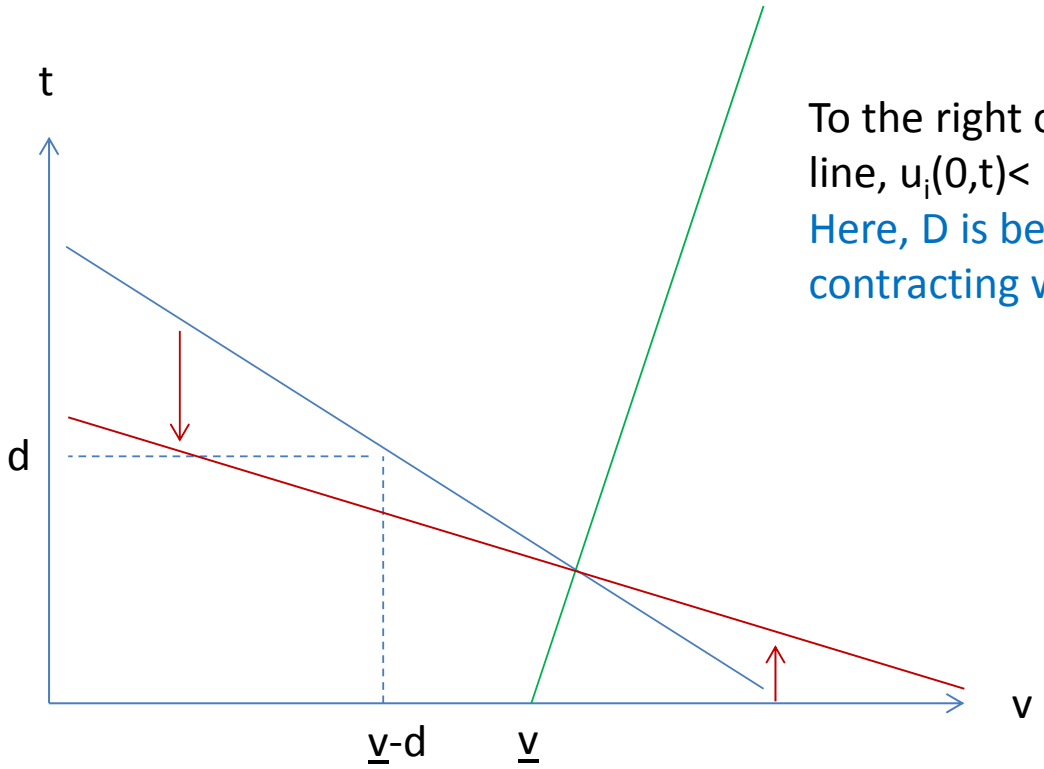


To the right of the green line, $u_i(0,t) < u_i(0,0)$

Equilibrium t



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Here, D is better off contracting with districts

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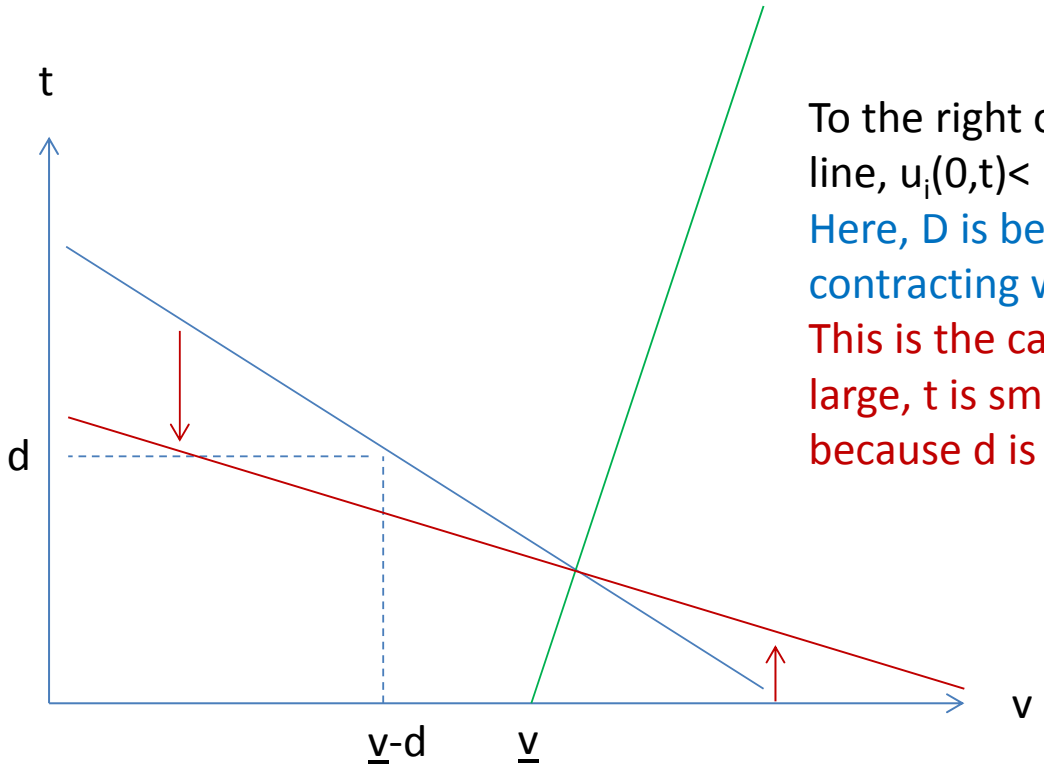

To the right of the green line, $u_i(0,t) < u_i(0,0)$

Here, D is better off contracting with districts

This is the case when v is large, t is small (e.g. because d is small)

Conclusions

We present a model of deforestation where sales of logging concession interact with illegal logging

If a district sells less, illegal logging increases in both districts

With «mainly» (il)legal logging, A benefits (loses) if B logs/signs REDD

With mainly (il)legal logging, centralization reduces (increases) deforestation

If a donor contracts with C, the contract is Pigouvian

If a donor contracts with districts:

- the optimal t is larger (smaller) with mainly (il)legal logging
- deforestation is too large (small) when (un)important

The donor is better off contracting with districts if logging is mainly illegal