Summary notes on some papers about deforestation and land use change

Skand Goel

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Part I

Simple models of Leakage

1 Delacote and Angelsen [2015]

- Leakage (or synergy) from anti-deforestation policy (PES) to degredation (illegal harvesting) and vice versa, depends on whether land and labor are net complements (or substitutes).
- They model an agricultural household with a fixed amount of labor and land.
- The household chooses the amount of land to cultivate (deforest) vs leave forested, and the labor allocation to each of these activities.
- Clearing land has a cost.
- The BAU scenario is defined by

$$\max_{l,L} A(l, L) + H(l, L) - cL$$

  where

  - l are L are labor and land used in agriculture, respectively
  - $A(l, L)$ is agricultural output, $A()$ is increasing and concave in both arguments
  - $H(l, L)$ is forest output, $H()$ is decreasing and concave in both arguments
- Two kinds of policies
  - PES (for deforestation): Pay r per unit of forests conserved over BAU scenario

- Monitoring (for degredation/illegal harvesting): with α probability, $H()$ is confiscated

- The household problem with these policies is

$$\max_{l,L} A(l,L) + (1-\alpha)H(l,L) - cL + r(L^{BAU} - L)$$

- FOC

$$A_l = (1-\alpha)H_l$$
$$A_L + (1-\alpha)H_L = c + r$$

- They have two main propositions -
  - L^* is falling in r, l^* is falling in α. No direct effect of r on l (FOC 1).
  - Indirect effects: Increase in r increases (decreases) H^* if land and labor are complements (substitutes)

    $$A_{lL} + (1-\alpha)H_{lL} > (<)\, 0$$

    Similarly, increase in α increases (decreases) L^*.

- The logic is the following: When substitutes, increasing r leads to lower L, which increases l allocation to agriculture, which reduces H. When substitutes, increasing α leads to lower labor allocation to forest, increases labor allocation to agriculture, which reduces optimal land for agriculture.

- They use travel costs to motivate substitutes or complements.

$$H(l,L) = I(\bar{l} - l - kL)$$

  For k bigger than a threshold, l and L are substitutes.

- Prices fixed. No leakage through prices.

Part II

Conservation contracts

2 Harstad and Mideksa [2017]

2.1 Introduction

This article provides a flexible model of resource extraction, such as deforestation, and derives the optimal conservation contract. When property rights are "strong" and districts are in charge of extracting their own resources to get revenues, conservation in one district benefits the others since the reduced supply raises the sales price. A central authority would internalize this positive externality and thus conserve more. When property rights are instead weak and extraction is illegal or costly control, conservation in one district increases the price and thus the profit from illegally depleting the resource in the other districts. The externality from conservation is then negative, and centralization would lead to less conservation. We also derive the optimal conservation contract, and we explain when the principal, who values conservation, benefits from contracting with the districts directly even when contracting with a central authority would have led to more conservation, and vice versa.

2.2 Model

- n districts
- Each district has X_i units of resource
  - harvest x_i units of this resource (legally) for price $p(x)$
  - price depends on actions of all other districts - aggregate extraction
  - so, revenue = $x_i p(x)$
  - each district places some weight b on this revenue (this is an important parameter - paper discusses multiple interpretations - discussed later)
  - v - valuation of each unit of remaining $(X_i - x_i)$ resource conserved
- The remaining $(X_i - x_i)$ resource can be illegally harvested by loggers

- loggers also receive price $p(x)$ per unit
- each logger price taker + free entry of loggers
- District can monitor the resource unit j with expected penalty θ_j - this is set in advance before loggers or districts move
- j harvested illegally if $\theta_j \geq p$

- Monitoring is costly - constant marginal cost c, so total cost of enforcement $c\theta_j$
  - Costly enforcement $\implies$ $\theta_j = p$ or $\theta_j = 0$
  - Therefore, net benefit from each unit chosen to be conserved is $v - cp$
- Since all units of X_i are homogenous within a district (not necessarily across districts - extension in appendix), district i chooses x_i to maximize

$$u(x_i, x_{-i}) = bp(x)x_i + (v - cp(x))(X_i - x_i) \tag{1}$$

- Demand: $p(x) = \bar{p} - ax$.
- **Interpretations and extensions.**
  - b can have several interpretations. The district could willingly want to harvest some forest and b could be a social welfare parameter, or it could be the tax from a logging concession (in that case x_i would be size of concession). Alternatively if all timber is protected, b could be the expected fine collected on timber caught after post harvest (in principle, b would then be a choice variable for monitoring/enforcement of timber)
  - Appendix/working paper allows for district specific v, b and c. Authors suggest does not add insight, only complexity.
  - Same model can accommodate input market competition eg price is fixed but wage is (linearly) increasing in overall extraction.
  - Can also accommodate non-pecuniary negative externalities of the form $-\tilde{v}\Sigma_{j \in N \setminus i} x_j$ in the utility function, with $\tilde{v} > 0$. Amounts to redefining existing parameters.
- The derivative of the coefficient on $p(x)$ in (1) with respect to x_i is $(b + c)$. So if x_j goes up, $i's$ utility changes by $p'(x)(b + c)x_i$. The pecuniary externality (which gives the strategic substitutes property) is scaled by $(b + c)$.

- The effect via b is the standard cournot style revenue effect.
- The effect via c is because lower price makes extraction relatively less valuable.

- If demand was flat,

$$u(x_i) = ((b+c)p - v)x_i + (v - cp)X_i$$

so whether i conserved or not (0-1) would depend on

$$(b+c)p > v$$

- Demand side policies work through both reducing legal as well as illegal harvesting revenues.

2.3 Equilibrium

- Equilibrium extraction (Proposition 1)

$$x_i^0 = \frac{b\bar{p} - v}{ab(n+1)} + c\frac{v + ab[(n+1)X_i - X]}{ab(b+c)(n+1)}$$
$$x^0 = \frac{nb\bar{p} - nv}{ab(n+1)} + c\frac{nv + abX}{ab(b+c)(n+1)}$$

where x_i^0 and x^0 are individual and aggregate equilibrium extractions.

- Total X as well as X_i are assumed to be large enough to allow for interior solutions.
- The first term in each of the above expression is the standard cournot output ($c = 0$). The second term is the additional (suboptimal) extraction because of the threat of illegal extraction.
- Comparative statics
  * x_i^0 increasing in $c$and X_i, decreasing in v - obvious
  * x_i^0 may be increasing or decreasing in b - increasing because of the standard revenue incentive. However, note that for high values of c, i is extracting too much compared to the cournot level (pure revenue

incentive) - so for such high values of c, increasing b gives the revenue motive more weight and reduces extraction.

* Increased X_j leads to high x_j^0, reducing x_i^0.

- Equilibrium externality:

$$\frac{\partial u_i(x_i^0, x_{-i}^0)}{\partial x_{-i}^0} = \frac{e}{n+1} \equiv \frac{(b+c)\bar{p} - acX - v}{n+1}$$

  – Strong property rights i.e. high b, low $c \implies e$ is high. This is the cournot externality.

  – Weak property rights i.e. low b, high $c \implies e$ is low (because we assume $p(X) < 0$). Look at the utility function. As long as x_i is interior, the effect of increasing $p(x)$ on utility is negative if $c >> b$. This is the idea that enforcement matters over "pure extraction" concerns, the externality will be weak or negative. District wants to extract more to reduce price to reduce pressure from illegal loggers.

- Externality is a sufficient statistic for several equilibrium comparative statics (Proposition 2)

  – $e < 0 \iff$ Larger districts extract larger fraction of their resources $\left(\frac{x_i}{X_i}\right)$ - Large districts affect price more. With weak property rights, the price reducing incentive comes into play to combat illegal extraction.

  – $e < 0 \iff$ centralization leads to more extraction $\left(\frac{\partial x^0}{\partial n} < 0\right)$ - Producing more reduces pressure of illegal extraction. This "positive externality" was not taken into account when districts were decentralized.

2.4 Conservation contracts

- Donor's payoff:

$$u_D = -dx - \tau(x), \qquad \tau, d > 0 \tag{2}$$

- Districts' payoffs:

$$U_i = u_i(x_i, x_{-i}) + \tau_i$$

- Two type of contracts

- take it or leave it schedule: $\{\tau_i(\mathbf{x})\}$ iff $x_i = x_i^*$, where x_i^* is specified by donor.
- linear schedule (seen more often in practice): $\tau_i = \max 0, (\bar{x}_i - x_i)t_i$, where the donor specifies $\bar{x}_i$ (baseline) and t_i.

- If x_i not chosen as per donor's wishes, donor can punish by charging f_i.

2.4.1 Under centralization

- Suppose there is only one district, C.
- Donor chooses the first best x_C^* optimally: x_C^* maximizes (2)
- For a take-it-or-leave-it contract to be implementable, it must satisfy the incentive compatibility constraint

$$u_C(x_C^*) + \tau(x_C^*) \geq \max_x u_C(x) - f_C \tag{3}$$

  - This constraint must bind with equality so we can substitute $\tau(x_C^*)$ in (2) which gives us

$$u_D = -dx_C^* + u_C(x_C^*) - \max_x u_C(x) + f_C \tag{4}$$

- Thus the donor maximizes the sum of its own and the district's payoffs to implement first best.
- Equivalent linear contract:
  - Note that the first best in (4) is equivalent to replacing v by $v + d$.
  - So a linear contract with $t_i = d$ and $\bar{x}_C$ so large that (3) holds can implement first best.
  - The baseline $\bar{x}_C$ should be set at a level below x_C^0, which is the business as usual level. This is an important point for practice. Also, we see later in the decentralized case that for the linear contract to adapt to parameter changes, most of the change must happen in the baseline level and not in t_i.
- These results summarized in Proposition 3 of the paper.

2.4.2 Under decentralization

- The donor wants to maximize

$$u_D = -d\Sigma_{i\in N}x_i^* - \Sigma_{i\in N}\tau_i(\mathbf{x}^*)$$

subject to

$$u_i(x_i^*, x_{-i}^*) + \tau(\mathbf{x}^*) \geq \max_x u_i(x_i, x_{-i}) - f_i$$

- Now, donor will no longer maximize joint surplus, because contracting with one district to reduce its output will lead to increased extraction by another. Instead, the donor will want to reduce the other districts' outside options.

- As before, the optimal contract can also be implemented by a linear schedule (given no uncertainty and concave utilities). Below are some of the intuitive results from Propositions 4 and 5.

- If the donor can contract with all n districts:

  - For a given d, the extraction reduction goes down in n. This is due to leakage: when donor pays one district to extract less, it has to pay all the others to more as their outside option becomes better.

  - The linear contract rate depends only on n and d, not on any other parameters. The baseline $\bar{\mathbf{x}}^*$ changes with other parameters. However, the baseline might need to be larger that the business as usual levels. As before, this is so because it must compensate for the high equilibrium price due to so many contracts.

  - When e is small, decentralization reduces x. While this is the same result that we had in the equilibrium without contracts, it happens here because the *negative externality is contractual* - contracting with one district leads to worse outside options for the non-contracted districts. This allows the donor to get them to reduce more extraction for the same transfer. In the model

$$\frac{\partial x}{\partial n} < 0 \iff \frac{e}{d} < -\frac{2(n-1)}{n+1}$$

  - Similarly

$$\frac{\partial u_D}{\partial n} > 0 \iff \frac{e}{d} < -\frac{(n-1)}{n+1}$$

So there is a region of $\frac{e}{d}$ where u_D is increasing in n, even though x is increasing.

  - Therefore, there is an optimal number of n for the donor given $\frac{e}{d}$.

- If the donor is restricted to contract with only $M \subset N$ districts:

  - There is a bigger problem of leakage because the response of the $N \backslash M$ districts cannot be controlled.
  - Therefore, if m increases x decreases.
  - Also, if m increases u_D increases because the donor can always choose to not contract with some districts.
  - Interestingly, the sum of welfare falls in m if property rights relative to damages are high:

$$\frac{\partial(u_D + \Sigma_{i \in N} u_i)}{\partial m} < 0 \iff \frac{e}{d} < T(n, m)$$

    where $T()$ is a threshold. This happens when d is low relative to e, so the donor ends up imposing a large contractual externality (which is negative if $e < 0$) than would be socially optimal. In other words, districts can collectively ignore the donor's contracts and be better off; however, this cannot happen in equilibrium because x_is are strategic substitutes so the equilibrium is unique (prisoners' dilemma).
  - Therefore, there is a socially optimal number of contracts.

- Conservation contracts can be socially harmful (though I don't think this particular channel has been discussed in the literature that criticizes conservation contracts) in a complete information environment. Does this result go through with imperfect information or observability?

Part III

Dynamic Landuse models

3 Based on Scott [2014]

3.1 Optimal stopping model

- Data on municipality level deforestation rates and some measure of returns to deforestation
- Plot i in municipality m
- Period payoffs
  - With standing forest:
  $$\pi_{0imt} = \epsilon_{0,it}$$
  - In deforestation period:
  $$\pi_{1imt} = \alpha_R R_{mt} - \alpha_R C + \xi_{mt} + \epsilon_{1,it}$$
  where α_R is the inverse of the standard deviation of $\epsilon_{1,it}$
  - Thereafter:
  $$\alpha_R R_{it} + \xi_{mt}$$
- Value of plot of standing forest
$$V^f_{mt} = \max\left(\pi_{1imt} + \beta E_t\left[V^{df}_{m,t+1}\right], \pi_{0imt} + \beta E_t\left[V^f_{m,t+1}\right]\right)$$
- Value of deforested plot is just PDV of exogenous future payoff stream as deforestation is irreversible.
- Assuming conditionally independent logit shocks, Hotz-Miller inversion implies
$$\ln\frac{d_t}{1-d_t} = \left(\alpha_R R_{mt} - \alpha_R C + \xi_{mt} + \beta E_t\left[V^{df}_{m,t+1}\right]\right) - \left(\beta E_t\left[V^f_{m,t+1}\right]\right) \tag{5}$$

- Also

$$V_t^f = \gamma + \ln\left[\exp\left(\alpha_R R_{mt} - \alpha_R C + \xi_{mt} + \beta E_t\left[V_{m,t+1}^{df}\right]\right) + \exp\left(\beta E_t\left[V_{m,t+1}^{f}\right]\right)\right]$$

  - Add and subtracr $\left(\alpha_R R_{mt} - \alpha_R C + \xi_{mt} + \beta E_t\left[V_{m,t+1}^{df}\right]\right)$
  - and logit choice probabilities (Hotz-Miller again)

$$d_t = \frac{\exp\left(\alpha_R R_{mt} - \alpha_R C + \xi_{mt} + \beta E_t\left[V_{m,t+1}^{df}\right]\right)}{\exp\left(\alpha_R R_{mt} - \alpha_R C + \xi_{mt} + \beta E_t\left[V_{m,t+1}^{df}\right]\right) + \exp\left(\beta E_t\left[V_{m,t+1}^{f}\right]\right)}$$

  imply

$$V^f = \gamma - \ln d_t + \alpha_R R_{mt} - \alpha_R C + \xi_{mt} + \beta E_t\left[V_{m,t+1}^{df}\right] \tag{6}$$

- Combining (5) and (5) and simplifying gives

$$\ln \frac{d_t}{1-d_t} - \beta \ln d_{t+1} = -(1-\beta)\alpha_R C + \alpha_R C + \xi_{mt} + \eta_t$$

  where η_t is an expectational error (for $\ln d_{t+1}$).

- Depending on assumption on ξ_{mt}, can do OLS or IV.

3.2 Model with renewal actions

- Two actions - crops and others
- Cropping in renewal action.
  - Field state $k_t = 0$ if field was cropped in period $t-1$.
  - Else, $k_t = \max\left(\text{number of periods the field was under other}, \bar{k}\right)$.
- Payoff from action j for plot i currently under state k

$$\pi(j,k,\omega_t,\nu_{it}) = \underbrace{\alpha_0(j,k) + \alpha_R R_j(\omega_t) + \xi_{jk}(\omega_t)}_{=\bar{\pi}_t(j,k)} + \nu_{jit}$$

  - $\alpha_0(j,k)$: switching cost
  - aggregate variable ω_t can affect payoffs (implicit in model in previous section)

- ν : conditionally independent logit shock

- Define conditional value function from action j

$$v(j,k) = \alpha_0(j,k) + \alpha_R R_j(\omega_t) + \xi_{jk}(\omega_t) + \beta E_t V(k^+)$$

where evolution of k^+ depends on j and k as described above.

- Now, Hotz-Miller tells us

$$\ln\left(\frac{p_t(j,k)}{p_t(j',k)}\right) = v_t(j,k) - v_t(j',k)$$

or

$$\bar{\pi}_t(j,k) - \bar{\pi}_t(j',k) - \ln\left(\frac{p_t(j,k)}{p_t(j',k)}\right) = \beta E_t\left[V_{t+1}(j,k) - V_{t+1}(j',k)\right]$$

- Replace expectation with realization plus prediction error:

$$\bar{\pi}_t(j,k) - \bar{\pi}_t(j',k) - \ln\left(\frac{p_t(j,k)}{p_t(j',k)}\right) = \beta\left[V_{t+1}(j,k) - V_{t+1}(j',k)\right] + \epsilon_t^V(j,k) - \epsilon_t^V(j',k) \tag{7}$$

- Arcidiacono Miller: for all j

$$V_t(k) = v_t(j,k) - \ln p_t(j,k) + \gamma \tag{8}$$

- Plug (8) in (7) with $j = j^{re}$, which here is crop.

Part IV

Reviews of REDD/PES schemes

4 Fortmannm et al. [2014]

This is a paper about how to design contracts for REDD. The asymmetric information problem is the following: "Carbon storage levels are not costlessly, or even easily observable; the level of carbon storage on the landscape is heterogeneous; and carbon storage depends on biological growth processes that vary from year-to-year." These are further complicated by implementation and monitoring issues in developing countries.

It also gives some overview of REDD as well.

- It all started in 1992 and now it is a mix of private, public and ngo work.
- CDM only accounts for afforestation/reforestation - not for reducing deforestation - though there is some talk of including ILUC in CDM!
- Warsaw Framework for REDD+ (2013 - 19th COP): Backed by $280 million financing from US, UK and Norway.
- World Bank Forest Carbon Partnership Facility is WB's scheme to help implement REDD. Funding comes from national and private sources. A part of it is to help countries prepare "Readiness plans". Then, these plans are submitted to WB for review and application for grants to implement them. But countries have been vague on the specifics - especially what kind of contracts between national governments and land owners, and also how to make ground level monitoring incentive compatible and prevent mistreporting.
- Reducing deforestation may be less expensive than many other options for reducing carbon dioxide emissions worldwide, it can still be costly. Kindermann et al. (2008) find that the marginal costs of reducing deforestation by 10% globally is about $3 per ton CO2, but the marginal costs of a 50% reduction in deforestation is about $15 per ton CO2. How are these marginal costs estimated?
- Funding is uncertain. Country proposed estimated way higher than available funding already. There is no existing agreement to fund this, such as a global cap and trade for REDD, and this may be unlikely. There are many small different types of voluntary markets, however.
- I think there is an issue of verifying carbon credits from REDD activities (there is something called Verified Carbon Standard), which impedes the working of even the California ARB program.
  - California ARB allow offsets from improved forest management and avoided conversion only for projects located within the United States. However, plans for incorporating international markets are underway (Diaz et al. 2011).

- EU emission trading scheme will not discuss REDD until 2020.

- Developing countries:
  - Indonesia: Most REDD readiness projects here (Wertz-Kanounnikoff et al, 2009). 98% forest land is controlled by government so most projects are concession based, where property rights over forests/land are given to a private company. This excludes locals and despite private tenure can lead to ineffectiveness (also + activities). This is so even though "literature hypothesizes that REDD activities will follow the model of PES programs with small-scale resource managers providing the service". See Madiera (2009)
  - China: First forest project under CDM (it might be useful to look at/study forest projects under CDM) . World bank main buyer of carbon credits - private forest company sign secondary contracts with local villagers/communities and smaller companies.
  - Brazil and Peruvian Amazon: Several projects now. See references in paper.

- Issues in implementing REDD:
  - Baseline establishment & Additionality: Several methods exist but have to be collectively agreed upon by nations.
  - When thinking about funding REDD via selling carbon credits (credits/offsets are sold by people who plant trees), there is the issue of permanence (this is beyond the physical issue of permanence whereby stored carbon is released into the atmosphere). While some benefits from having a forest are direct or implied, one source of income for someone planting a forest is selling carbon offsets. A firm in the US is willing to pay much less for a forest offset in Indonesia (say, relative to a wind farm) because it is possible that this forest is cut down and the offset no longer remains - it is a risky asset for a firm to have. Moreover, these risks are likely to be fat tailed (low probability of forest fire, but large swathes of forests destroyed if any occurs), or when many low probability deforestation risks are bundled together, the risk on the bundled security is higher. There is a suggestion, however, that pricing carbon leads to incentives to manage forests better and mitigate such risks. As of now, California ARB requires forest offsets to be at least for 100 years, so if a forest gets cut down before that you lose your money. Of course, there

is scope for having insurance, but such arrangements are way more difficult in developing countries.

  - Measuring and monitoring D&D is costly, and can be a substantial fraction of a REDD program.

- There are some similarities with PES.

- Examples of types of considerations when thinking about contracts:

  - Focusing on the activity vs focusing on the amount of carbon sequestered
  - Sandker et al. (2010) find that for a 20 year contract in Ghana offered to potential cocoa farmers, the farmers would renege after 4 years. They suggest increasing the length of the contract beyond 20 years.
  - There are a host of issues about social norms, local politics, incentive compatibility in monitoring and who holds de facto vs de jure property rights to the land.
  - The paper then reviews some of the literature on contracts under asymmetric information. These include Ferraro (2008), Mason and Plantinga (2010) and subsequent literature. Might be useful to review if the eventual question is how to design a PES contract. These papers have the theory, they have some parameters to inform that theory.

5 Ezzine-de Blas et al. [2016]

They do a meta-analysis of 55 PES schemes around the globe. Public sector schemes bigger and more expensive than private sector scheme. Schemes perform better when they do greater spatial targeting, pay conditionally and use differentiated payments or differentiated contracts. However, policy makers might not like this hyper calibration and discrimination. Refer to three big national level schemes - Costa Rica, China (SLCP) and CRP.

6 Baylis et al. [2008]

They compare EU and US AEPs (not strictly PES schemes under the CIFOR definition). They suggest that these came about as politically motivated payments to farmers in lieu of environmental protection activities (such as endangered species act in the US) and cross compliance (in EU). While they are similar in motivation, there are some differences.

	US	EU
View of externalities	Cultivating land leads to environmental losses. Pay to prevent negative externalities.	Land's best use is (sustainable) agriculture. Also pay to maintain agricultural landscape ie positive externalities.
Targeting	Targeted, depending on land value type etc	Different types of land paid same just for committing to good practices
Targeting	The externality (a measure of it, such as nitrogen fixation) is rewarded	Often, inputs are rewarded rather than outcomes. This can sometimes generate a greater variety of environmental services.
Selection	CRP selects based on auction - some provision for heterogenous opportunity cost	Flat rates determined by country, some bonus but no heterogeneity
Additionality	More targeted so geared towards getting additionality	Suggest that additionality is lot lower as they dont worry about baseline
Leakage	Targeted to more vulnerable lands so (price) leakage if any occurs on resilient soils	Broad based so less leakage, but extensification of agriculture not necessary better policy
Leakage: Control	CRP federal program - can coordinate across states	Different member states have different regulations/benchmarks - potential for leakage?
Driver of policy	U.S. agri-environmental programs are designed for the benefit of either the farmer or the environment, but not for either the consumer or the non-farming taxpayer.	In contrast, their econometric analysis shows that many EU programs are responding to 'green' demand.

Exception in the US is the Farm and Ranch Lands Protection Program (FRLP), which was previously known as the Farmland Protection Program, renamed in the 2002

Farm Bill. The FRLP provides matching funds to State, tribal and local governments and nongovernment organizations for the purchase of conservation easements, with the aim of helping farmers and ranchers to keep their land in agriculture. The worry is that this land will be developed. In Europe, the worry is land will revert to scrub.

References

Kathy Baylis, Stephen Peplow, Gordon Rausser, and Leo Simon. Payment for environmental services: a comparison of us and eu agrienvironmental policies. *Ecological Economics*, 65(4):753–64, 2008.

Philippe Delacote and Arild Angelsen. Reducing deforestation and forest degradation: leakage or synergy? *Land Economics*, 91(3):501–515, 2015.

Driss Ezzine-de Blas, Sven Wunder, Manuel Ruiz-Pérez, and Rocio del Pilar Moreno-Sanchez. Global patterns in the implementation of payments for environmental services. *PloS one*, 11(3):e0149847, 2016.

Lea Fortmannm, Paula Cordero Salas, Brent Sohngen, and Brian Roe. *Incentive contracts for environmental services and their potential in REDD*. The World Bank, 2014.

Bård Harstad and Torben K Mideksa. Conservation contracts and political regimes. *The Review of Economic Studies*, 84(4):1708–1734, 2017.

Paul Scott. Dynamic discrete choice estimation of agricultural land use. 2014.