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Early Days in the Certification of Logging Concessions: Estimating FSC's Deforestation Impact in Peru and Cameroon

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Abstract*

Conservation and development agendas often are seen as in contradiction and, in the past, most forest policy was driven by only one such agenda. Yet leading conservation policies such as protected areas (PAs) increasingly are understood to vary in how development considerations are integrated, within PA types, given the starting point of conservation. Similarly, development policies such as logging concessions can integrate conservation. Sustainable forest management pushes integration from a starting point of development. One of the most visible initiatives of this type is the certification of logging concessions − such as by the Forest Stewardship Council (FSC) − to reduce various impacts of logging. The cost of sustainable management may lead a firm not to certify any given concession, yet the potential benefits could lead firms to voluntarily certify at least some concessions (including as perhaps firms could benefit from strategies that raise forest loss elsewhere). Our empirical analyses of two countries, Peru and Cameroon, aid in understanding what actually has happened in certified sites for the relatively 'early days' of such certifications. We control for unobserved factors' influences over space and time, without which impact − sometimes perverse − is mistakenly attributed to FSC certification (FSCC). For Peru, we see no average FSCC deforestation impact in our study area (almost all concessions). One region, Madre de Dios, has an average reduction of 0.07% per year. For Cameroon, we find a small average FSCC deforestation impact of 0.02% per year in our study area (all concessions), though in four of five regions there is no statistically significant effect. We suggest that, as available data improve, more impact may be seen in some conditions.

Keywords: certification, FSC, deforestation, concessions, Peru, Cameroon

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1. Introduction

Globally, forests face increasing pressures as the increasing human population demands not only forest products but also other outputs, including many from agriculture, that demand conversion of currently forested lands to other land uses. Clearing within tropical forests is driven by many factors including illegal logging and mining, the development of infrastructure, cattle ranching, and expansion of export-oriented industrialized agriculture (see Laurance et al., 2001; Raschio, Contreras and Schlesinger, 2014; DeFries et al., 2010; Swenson et al. 2011; and Urrunaga et al., 2012, e.g.). The consequences of deforestation include increased erosion, degradation of water resources, acceleration of species extinction (Laurance et al., 1998; Laurance, 2009; Wright and Muller-Landau, 2006) and increases in emissions of stored carbon. These have motivated a range of policy interventions to aid in developing sustainable pathways for forests and the communities linked to them − around the globe. Such actions have met with mixed success (Pfaff et al. 2012).

The leading forest conservation policy has been protected areas (PAs). PAs' impacts have varied with the many ways that PAs are employed, e.g., varied siting plus very different rules that apply within different types of PAs (see Joppa and Pfaff 2009, 2010 and Pfaff et al. 2014, 2015 a & b). Yet a government setting land aside to rule out most or all potential production is not always the preferred approach. Concerns with local compensation, for instance, have spurred an increase in payments for environmental services (PES). They are offered to landowners who choose whether to accept such contracts from the state or from other private actors, e.g., water users downstream.

Voluntary, market-based approaches also can be relevant for firms who generate forest products. Sustainable forest management (SFM) involving environmentally responsible practices could be incentivized by easing market access for and providing a price premium for 'green' forest goods. As multiple-use protected areas move towards a balance of human uses and forest conservation from a conservation default, SFM aims to do so from the production default (Auld et al., 2008). One of the most recognizable SFM programs is certification by the Forest Stewardship Council (FSC), started in 1993 for “environmentally appropriate, socially beneficial, and economically viable management of the world's forests” (FSC, 2015a). By the end of 2014, a total of 1,303 FSC certificates were active across the globe, covering 183 million ha of forest (FSC, 2014). Thus, in principle, FSCC has the potential to effect positive change in a large area of forest.

The certification premise is that third-party auditors could ensure compliance of the decisions in certified logging concessions with all the applicable national and local laws, plus FSC principles (FSC, 2015b). Companies can earn three types of FSC certificates: Forest Management, Chain of Custody and Controlled Wood (FSC, 2015). While the FSC certification of logging concessions is acknowledged by many as the “most rigorous, transparent and participatory certification” (Hale and Held, 2011), the ability of certification to produce a verifiable, beneficial impact on forests in reality has been the subject of much debate. Compliance, auditing and enforcement, and measurable outcomes surely range widely (Counsell & Loraas, 2002; Nebel et al., 2005).

Considering why certification might not occur at all or be imperfect, companies must incur costs to comply with FSC standards. Labor costs rise, as employees should be on payroll, and receive health benefits (interviewee 5, personal communication, August 2014). Companies must invest in security efforts for monitoring the concession, including creation of inventories and auditing. Additionally, consultants are hired to create High Conservation Value Forests and, generally, various costs are incurred for FSCC (interviewee 1, personal communication, August 2014).

To consider why certification might work despite all the costs, we must consider possible gains. Companies might see FSC certification as a way to increase their access to: markets prohibiting illegally sourced timber; price premia; government incentives; operational efficiencies; and NGO funding (Blackman, Raimondi, and Cubbage 2014; Breukink, Levin, and Mo 2015). The issue of legal timber sourcing is central because the United States' Lacey Act and the European Union's FLEGT Action Plan require the verification of legal origin of incoming timber (European Forest Institute, 2014; Urrunaga, Johnson, Orbegozo, & Mulligan, 2012). Thus, were the enforcement of such laws perfect, well-enforced certification that eliminated the outputs of illegal logging in principle could achieve a great deal. That said, poor law enforcement could mean that in practice companies could get the access without actually improving practices. Further, there are limits on legal enforcement, including imperfect ability to track timber origin through markets. That might allow illegal activities within certified lands or alongside even a production chain that is certified (Finer, Jenkins, Sky, & Pine, 2014; Sears & Pinedo-Vasquez, 2011; Urrunaga et al., 2012).

In sum, it seems possible that certification would, in the end, improve forest outcomes. However, it also seems possible that certification itself, and the laws that generate the gains of certification, are too hampered by limited information to have impact. Also, perversely, it even seems possible that certification could increase market access for illegal activities. For example, a company may log one concession sustainably but then also use the 'FSCC label' for lands under other practices. All these possibilities suggest the value of rigorous empirical evidence on the impacts of FSCC, noting that the appropriate spatial focus for any such evidence depends heavily on local context. For instance, if using FSCC labels in one location affects deforestation elsewhere, that is trickier to measure − one form of spatial spillover to which we want to call attention but do not measure.

Our study provides solid evidence about 'early days' in FSC certification for Peru and Cameroon. We focused only on the FSC Forest Management certificate in logging concessions. We consider separately, in each country: do FSC Forest Management certification processes effectively imply that yearly deforestation[1] rates differ, during 2000-2013, when logging concessions are certified? We use multiple approaches to quantify impacts − all results are consistent − but here focus upon panel regressions for concessions, with year effects. This is the first study of which we are aware that estimates the deforestation impacts of FSCC in Peru and Cameroon using statistical methods aiming to reduce biases in estimates if treatment was not randomly assigned over space and time.

The rest of the paper proceeds as follows. Section 2 provides background on the forestry sectors in Peru and Cameroon, the countries we study (note they are not the only countries using FSCC). Section 3 then provides information concerning the data we use and the methods we employ and next Section 4 provides our results at two levels, descriptive statistics and our panel regressions.

Finally, Section 5 discusses what we have found − including laying out some important caveats, concerning what can and cannot currently be learned with the available data. We believe that the approach and results we present here are contributions yet, as much as anything, set the stage for further studies of these (and other) countries that will become possible as available data improve.

[1] By deforestation, in these analyses we mean only that the forest data for a location initially show forest then, later, show non-forest. That need not imply permanent deforestation, as certainly sometimes the forest will return in a site. For instance, that is often the intention within plantations; however, the data record that standing forest disappeared. Thus, perhaps especially because we are studying logging concessions, we highlight that we are measuring current deforestation rates, not permanent, and it is very clear that during some time periods the current rate can be higher.

2. The Forestry Sector in Peru and Cameroon

2.1 Peru

Peru's area of tropical forest is the second largest in Latin America (Rainforest Alliance, 2014) and the fourth largest globally (Ministerio del Ambiente, 2014). Official 2011 data indicate that Peru has approximately 73.3 million ha of forest (Ministerio del Ambiente, 2015). The Peruvian government estimates that the Amazon forests protect 97% of the nation's freshwater supply by helping to regulate the quantity and quality of water (Ministerio del Ambiente & Ministerio de Agricultura, 2011). Forests also provide valuable timber species, such as cedar and mahogany, and multiple non-timber forest products. Peruvian Amazon forests are an important location for biodiversity conservation (Ministerio del Ambiente & Ministerio de Agricultura, 2011) and for social development. They are home to perhaps 1,262 indigenous communities and 53 different ethnic groups (Ministerio del Ambiente & Ministerio de Agricultura, 2011), described as "the poorest and most disenfranchised segment of the country's population" (Urrunaga et al., 2012).

Peru's Forestry and Wildlife Law No. 27308 enacted in 2000 emphasized forest management. It applied to the forestry sector in Peru during our study period (2000-13). It categorizes about 70% of the nation's forest patrimony (30% was uncategorized) in six groups: i) production forests, ii) future management forests, iii) forests on protected lands, iv) Natural Protected Areas, v) forests on native and peasant communities, and vi) local forests (Ministerio del Ambiente & Ministerio de Agricultura, 2011; República del Perú, 2000). We focus on permanent production forests, as they are where certified logging concessions mainly are located. Logging concessions − between 5 thousand and 40 thousand ha − are drawn up by the government and granted to concessionaires (timber companies or individuals) under 40-year contracts. A total of 7.1 million ha, or 10% of Peru's forests, are designated for forestry inside logging concessions within our study area − the regions of Madre de Dios, Loreto and Ucayali − with about 8 million ha designated nationally.

Concessionaires are required to present a general forest management plan (PGMF, in Spanish) for each concession every five years and an annual operating plan (POA, in Spanish) every year. These are planning documents that, at least in principle, contain detailed forest management information. For example, a POA might state which of the subsections of a concession are to be harvested each year, and the volumes to be extracted of each key species (Urrunaga et al., 2012). Concessionaires can only start logging if they have received the POA approval from the forest authority (Urrunaga et al., 2012). All of the wood extracted from concessions is legally required to have a "Forest Transport Permit (GTF or *Guía*), which details among other information the species and volume of the material and its place of origin" (Urrunaga et al., 2012). The regional forest authority is supposed to check these documents at different points of the transport system.

However, there is evidence suggesting different types of illegal behaviors that relate to logging concessions all along the production chain for logging output (Finer et al., 2014; Sears & Pinedo-Vasquez, 2011; Urrunaga et al., 2012). One potential behavior is that concessionaires may not be reporting true total extraction volumes. For instance, they might not report the volumes that they extracted outside the concession or extracted later (Urrunaga et al., 2012). They can also falsify the harvesting approval documents (Urrunaga et al., 2012). Other illegal activities happen when logging outputs are being transported. Even though the GTF should contain information about the authorized volume by species, the forest authority has no tool to verify the origin of wood it inspects (Sears & Pinedo-Vasquez, 2011), rendering it much less of a constraint upon illegality.

As Sears and Pinedo-Vasquez (2012) have noted: "once issued, the POA becomes a tradable document disengaged from the registered locality. Because no one is watching, it allows loggers to transport timber from anywhere in the region" (p. 621). The regulatory framework to date "focuses on monitoring the product, emphasizing species and volumes, rather than processes such as logging practices and negotiation of access to timber" (Sears & Pinedo-Vasquez, 2011).

Peru's Supervisory Body of Forest Resources & Wildlife (OSINFOR) is in charge of monitoring the logging activities within forest concessions, through ex-post field visits (República del Perú, 2013a). The supervisor visits the PCA in the year of or the year prior to verification (República del Perú, 2013a). Any supervisor could initiate an administrative process (PAU, in Spanish) to investigate any irregularities or potential violations that they suspect on this basis. This could lead to a sanction and even to the cancellation of the concession contract, depending upon the results of the PAU (República del Perú, 2013b). Finer, Jenkins, Sky, and Pine (2014) found that OSINFOR, however, had never actually supervised 36.3% of concessions − since their creation. That is especially meaningful given that OSINFOR detected irregularities in the majority of the concessions that were supervised (Finer et al., 2014). The authors found that concessions failed to comply with the PGMF in 79.4% of the violations reported during OSINFOR's supervisions, including 57.8% of violations due to extraction outside the concession limits (Finer et al., 2014).

Between 2006 and 2013, 34 logging concessions achieved FSC forest management certification in Loreto, Madre de Dios and Ucayali under this regulatory context (FSC Peru and WWF Peru). Timber companies now operate 550,516.54 certified ha of forest under FSC forest management certificates (FSC Peru, 2015). In Madre de Dios, FSC certification was mainly driven by NGO and donor technical and financial support (interviewee 6 personal communication, June 2014). The Global Forest Trade Network (GFTN), a division of the World Wildlife Fund, is active in Peru as well, in providing timber companies with technical and strategic assistance to promote their compliance with and thus achievement of FSC certification (World Wildlife Fund, 2015).

2.2 Cameroon

The Republic of Cameroon is located on the Central African coast. It borders countries including Equatorial Guinea, Gabon and Nigeria (Figure 1). The population of Cameroon is 21.7 million, with its capital of Yaoundé being home to 1,739,000 people (Central Intelligence Agency, 2014).

Timber is one of the major items among Cameroon's exported goods, in addition to crude oil and petroleum products, cocoa beans, and cotton (Central Intelligence Agency, 2014). In the coming years the government of Cameroon desires to expand the mining industry for diamonds, gold and iron (Schwartz, Hoyle & Nguiffo, 2012). The city of Douala is a major port for the exportation of many such goods. About 90% of exported wood exits the country via Douala (Eba'a Atyi, 1998).

Development has been supported by the International Monetary Fund and World Bank (World Bank, 2014). Yet the business atmosphere in Cameroon is not attractive to foreign investment, due to slow economic progress, attributed to weak governance, coupled with high corruption − now ranking 144th out of 177 countries (World Bank, 2014; Transparency International, 2013). Surely this could prove relevant for the enforcement of regulations relevant for certification.

Cameroon established a progressive forestry policy along with the creation of the new Ministry of Environment and Forests in 1992 − now the Ministry of Forests and Fauna − and the passage of the Forest Law in 1994 (Cerutti et al., 2008). The latter divided land into two broad categories, the permanent forest estate (PFE) and the non-permanent forest estate, which are further divided into numerous categories of land use and tenure (Cerutti et al., 2008). The government permits resource use within the PFE but requires that the land's natural ecosystem cover be maintained for perpetuity (WRI, 2012). The government surpassed its target for 30% of total land area to be placed under the PFE, reaching 35% of land, or 16.3 million ha of forest, in 2011 (WRI, 2012). Of this, 55% is designated production forest. The remaining 45% is protected area (WRI, 2012). Within the designated production-forest area, the areas designated for logging are 5.5 million ha found across 103 of the 114 forest management units nationally, which are in five administrative regions which make up our study area within the southern portion of the country (WRI, 2012).

While the government of Cameroon has claimed some success within the implementation of its ambitious forestry policy, unfortunately illegal logging continues in Cameroon. Illegally sourced wood has previously been estimated to account for 50% of total harvest from forests and, in fact, government has enabled harvesting at unsustainable rates without approved management plans, despite the fact that the legal framework opposes any such activity (Cerutti and Tacconi, 2006). Overall, the United Nations' Food and Agriculture Organization (FAO, 2010) estimated the loss of forest in Cameroon to be increasing to an annual loss rate of 1.07% in the 2005-2010 period.

In light of this, major timber importers created regulations to limit their imports of illegal timber. Following the incentives that such regulations generate, logging companies pursue certification to satisfy both the United States Lacey Act (Rainforest Alliance, 2015) and the European Union Timber Regulations (European Forest Institute, 2014). This led Cameroon to create a Voluntary Partnership Agreement with the European Union in 2010. Now in the implementation phase of FLEGT, it will soon begin issuing such licenses (European Forest Institute, 2014). Other entities that provide certification of the legal harvesting of wood are the Bureau Veritas and the Société Générale de Surveillance (Eba'a-Atyi, 2009). After establishing the legality of its operation, any logging company may choose to pursue a responsible forest management certification from FSC.

Cameroon became involved with FSC in 1998, via the Cameroon Forest Certification Initiative (FSC-Cameroon, 2010). The country's first forest management certificate was awarded in 2005 to the company Wijma (FSC, 2014). More certifications were awarded in 2007, 2008 and 2010, and the certificates issued in 2013 brought Cameroon's total certified area above 1 million ha (Global Forest Trade Network, 2014). In total, 940,000 ha were operated under FSC certificates as of 2014 (Cerutti et al., 2014). As in Peru, GFTN is also active in Cameroon, with an estimated 20-25% of Cameroon's logging area, including both the FSC-certified and the uncertified areas, managed with assistance from GFTN (interviewee 7, personal communication, June 11, 2014).

As mentioned previously, the government of Cameroon intends to expand the mining industry for the purposes of economic growth. That has led to emerging issues in land tenure, as a result of overlaps in permits between forest management units and mining zones (Schwartz, Hoyle and Nguiffo, 2012). At present, there are no legal provisions permitting areas of mixed land use, thus the onus falls on the companies in question to work out agreements of facilities, transportation, and land management (interviewee 8, personal communication, February 16, 2015). Similarly, FSC currently lacks provisions for incorporating mining exploration projects into its auditing. Therefore, FSC-auditing companies in Cameroon must develop their own methods for taking into account the mining activities (interviewee 8, personal communication, February 16 2015).

3. Data and Methods

3.1 Data

We study 2000-2013 for both Peru and Cameroon with logging concessions as units of analysis.[2] We analyzed 525 concessions located in the departments of Madre de Dios, Ucayali, and Loreto in the Peruvian Amazon, where certified concessions are found (and also where, as noted above, the great majority of all the logging concessions are located). We also analyzed Cameroon's 114 concessions that lie in five administrative regions: South, Southwest, Littoral, East, and Center.

Using ArcMap 10.2.2, we compiled a concession-level panel data set, including forest area lost from the *Global Forest Change* data (Hansen et al., 2013), as well as concession characteristics from various sources (Table 1). Following emerging convention, we defined "forest" as a stand with 30% or more tree cover (for Peru, 50% makes no difference). We have one observation per year per concession, and thus 6,825 observations in Peru, with 1,482 observations in Cameroon.

3.2 Methods

FSC forest-management certification was not randomly assigned. We want to use observed site characteristics to reduce potential biases due to where and when the FSC certification occurred. Observables that vary across space are distances to roads, cities and processing plants (the latter only in Cameroon) and rivers (only in Peru). We also use concession fixed effects for removing all fixed site differences and year effects for removing time trends. We utilized data for relevant biophysical characteristics (rain, soil) but they vary so little in our study area that we drop them.

Equation 1 is our concession panel specification with concession fixed effects, plus year effects. We estimate the following regression for the whole study area, by country, as well as separately for each of the five regions in Cameroon and each of the three regions in the Peruvian Amazon:

$$L_{it} = \beta_0 + \beta_1 F_{it} + \beta_2 C_{it} + \alpha_i + \lambda_t + \varepsilon_{it} \qquad (1)$$

where L_{it} = the % of forest area lost in concession i in year t; F_{it} = 1 if concession i had an active FSC certificate in year t; C_{it} = 1 if concession i active in year t; α_i = concession fixed effects; λ_t = year effects; and ε_{it} is a random error. We clustered standard errors at the concession level.

An issue for concession data (but not pixel data) is that these units can be of very different sizes. That raises a new question about what we want to learn: the results for the average concession or, instead, for the average hectare in concessions? Those are the same for identical concessions but can vary greatly if, for instance, data for many small concessions support one conclusion yet the data for a single enormous concession supports another inference. What dominates in any single coefficient is a function of the weighting: if weighting by area, that single concession dominates. We have chosen to present the unweighted regressions because we believe that decisions about certification and its implementation are taken at the concession level. Thus, we want to give the choices at each concession equal weight. That said, such weighting does not change our results.

[2] To check robustness, we also generated a large sample of forested pixels across the country, i.e., in concessions as well as outside. These sometimes feature significant variation in site characteristics across pixels in one concession and we utilize matching to choose a subset of uncertified pixels with characteristics most like the certified pixels. In survival analysis, we use a variety of forms of control for time's effects. Our patterns of results are robust to all that.

4. Results

4.1 Deforestation Rates Inside Versus Outside Concessions (& thus considering property rights)

Table 2 provides a few, simple descriptive statistics about deforestation within the two countries. These are only descriptive − because we do not control for locations' characteristics or for time − yet nonetheless they generate interesting questions about what might be driving these outcomes. Table 2 shows that in both countries, the land inside logging concessions had less deforestation than the land outside logging concessions. Depending on one's view, that may be a big surprise.

One reasonable prior for some settings, for instance, may be that the majority of tree cutting in a country occurs in logging concessions. Table 2's observations, in contrast, could sugest that who has the rights and responsibility for land and natural resources influences what happens to them. From that perspective, maybe we are not surprised that, in a world of limited enforcement, areas where private companies are present, and have a stake in local resources, could be 'invaded' less than, for instance, public lands suffering illegal deforestation where lands are converted to crops.

Such thinking seems relevant to PA types as well (though they are outside our empirical scope). Albers (2010) suggests that having individuals with incentives to conserve resources in protected areas can contribute significantly to improving the enforcement within some PA settings. While conservation organizations doubtless will not soon promote logging concessions to save forests, as trying balance using PA types seems safer for conservation, still the enforcement perspective alongside observations such as those in Table 2 at least highlights tradeoffs within policy types.

All that said, these statistics could represent other things, including simply a lack of information. For instance, Table 2 considers lands as in or out of concessions for this full period (2000-2013) though, in fact, many concessions were active for only some of the years during this time period. Further, perhaps the kinds of lands that were placed in concessions differ from the lands outside. Outside logging concessions, there are different types of forested lands, not only in different PA types but also even uncategorized forests (for Peru). We want more controls for space and time.

4.2 Bringing In Observations Over Time (lands that were at some point in a logging concession)

Next we make use of the fact that our data include observations for each year, across this period, to consider whether it actually matters when a concession was active. At the same time, we will distinguish concessions by whether they were ever FSC certified. That too requires information across time, since even while a concession is active, its certification could be active or inactive.

Consider, for example, the initial entries in Table 3, in the upper left for non-FSCC concessions and in particular for Madre de Dios. They might look more like what one would have expected, since the deforestation when the concession is active is greater than before the concession starts (this holds for Loreto and Ucayali as well). On the other hand, it might appear as though having functioned as a concession kicks off higher deforestation rates, since after the concession is no longer active, the deforestation rates in all regions are higher than before the concession started. For Madre de Dios, the deforestation is much higher even than when the concession was active.

However, stepping back, we actually need even more information about time to understand this. For instance, it is quite possible that deforestation rates are trending up over time across all Peru.

Should that be the case, the higher deforestation after a concession ends could reflect that rise in pressure more than any temporal spillover of a concession. Thus, we will need to control further.

Looking at Table 4's analogous entries highlights that the relevant dynamics differ across region. In Cameroon, while deforestation in Littoral and Center is higher for the active concession years than before the concession was active, in Southwest the opposite is true and for East − easily the region with the most concessions − there is no difference in deforestation across the two stages. Here there are no post-concession observations but, again, controls for time trends will matter.

4.3 <u>Now Adding Certification Over Time (lands that were at some point in a logging concession)</u>

Turning back to Table 3 but bringing in its right half, we can compare to the FSCC concessions. Once again, as noted, it matters whether the concession itself was active and if certification was. For instance, the Ucayali region shows a range of different deforestation rates across the period. That said, it is worth emphasizing that these are fractions of a percentage point. So, for instance, the difference between the highest and lowest rates for Ucayali is only about a third of a percent.

One interesting comparison across the "Never FSCC" and "Ever FSCC" subsets of concessions is what occurred before the concessions and FSCC. At that stage, FSCC and not-FSCC lands show essentially no difference − for Peru, in Table 3, and for Cameroon, in Table 4. While we will still want to use controls for differences in locations' characteristics when inferring impacts of FSCC, this comparison suggests there might not be large differences between certified and other sites.

Another similarity in Peru between FSCC and non-FSCC is higher deforestation as concessions are active. Again that may fit the typical view of the point, and impact, of any forest concession. Yet more surprising perhaps is that looking ahead one more step in time, to when the concession is still active and certification also has become active, the deforestation rates can be even higher. Just as for impacts of concession status above, here we wonder if FSCC is raising deforestation. Certainly that is not FSCC's intention, all else equal. Yet, again, maybe this is just time trends − which may be supported by the fact that, post-FSCC, deforestation during concessions is above the pre-FSCC deforestation during concessions. At least a reasonable conjecture is time effects.

Further, comparing the right and left halves of Table 3 suggests the opposite impact from FSCC. Deforestation of active concessions when they are pre-FSCC is lower than it is for the non-FSCC concessions. Perhaps even signaling a future certification may have impacts. For Madre de Dios, deforestation is still lower when FSCC is active, given that this did not raise deforestation rates, although the opposite is true for Ucayali. Perhaps FSCC's impacts are heterogeneous by region.

Turning back to Table 4 and bringing in its right half as well, Cameroon shows at least one very similar story, in that FSCC becoming active seems at a glance to be raising the deforestation rate. Once again, we will need to control for time (we have fewer post-concession information data to spur further conjectures about time trends). This result differs across Cameroon's regions as well, with the largest region in terms of concessions, East, not rising in deforestation for active FSCC.

Finally, for conjectures about FSCC, we should compare the right and left halves of Table 4 too. For the first four regions listed in the table, the pre-FSCC deforestation in the active concessions clearly is lower for the Ever FSCC (that is despite the pre-active-concession rates being similar). Yet for the largest region, East, there is no deforestation difference for just having a concession.

4.4 Panel Regressions (concession fixed effects for spatial biases & year effects for time biases)

Given the clear indications from the tables above that we will need to control for trends in time, in Table 5 (for Peru) and Table 6 (for Cameroon) we present panel regressions that consider the outcomes for each of the years during the time period we study. One excellent feature of a panel approach is inclusion of fixed effect for each unit, i.e., each concession's propensity for clearing. This captures the effects of any fixed characteristic − those we observe and others, unobserved − then we use changes over time in the concessions' FSCC status to estimate the effects of FSCC.

As noted above, though, outcomes change over time not only due to changes over time in FSCC but also due to changes over time in unobserved factors (analogous to the unobserved differences across land units for a landscape, but in time). We want to remove all time trends from estimates. Thus, in our panels we include not only concessions' fixed effects but also an effect for each year (as Tables 5 and 6 include the concession and year effects, they are our preferred specifications). This last inclusion turns out to be critical in avoiding assignments of perverse impacts to FSCC.

As Tables 5 and 6 both show, later years have higher deforestation rates in both of the countries. Since years in which FSCC was active for a concession tended to come later in this time period, there is a significant risk that inadequate controls for the rising time trend in deforestation could accidentally make it appear as though the advent of active FSC certification raises deforestation (our Appendices document that without time controls FSCC is more likely to be seen as hurting).

Considering Peru in Table 5, we see that there is no significant average impact from certification. The same is quite robustly true for Loreto. Ucayali also is not significant (coefficient is positive). There is negative average effect for Madre de Dios. Its magnitude is under a tenth of one percent: we see a statistically significant reduction of 0.07% in the yearly deforestation rate due to FSCC.

For Cameroon in Table 6, the average impact upon all the concessions is statistically significant, although for four out of the five regions we considered there is no statistically significant impact. The East region is the only one showing any impact, a statistically significant reduction of 0.02% (note that as East by far has the most concessions, it leads the overall coefficient to be the same). That equals a fiftieth of one percent. As that is a reduction in yearly rate, it adds up across years, although for now with certification still being new that still implies limited impacts for the costs, at least when looking across the 2000-2013 period at the concession level using these forest data.

5. Discussion

We presented statistics and panel regressions using concession-level data to conclude that, at the least for these data and this time period, we find very little deforestation impacts of certification. This conclusion is quite robust, including for instance to weighting by the size of the concession. We have also noted that the results from analyses of a large pixel sample, including matching for spatial similarity and survival analysis for temporal study, are supportive of the conclusions here.

We believe that for these data, and this time period, these are good estimates. However, another question is whether they are highly informative about all certification effects, past and future. Before speculating about how other data and settings might sometimes yield different results, first we would say that even for other data and settings, we think our approaches are sensible. Thus, we hope similar focus on isolating treatment effects will continue within this literature. Here, without attention to removing time trends, FSCC would be 'seen' to raise deforestation.

Time trends also constitute a likely shift in setting that might also shift impact from certification. Our results documented an increase in deforestation pressure over time, though that was on a low base level of pressure (for instance 2000-2013 deforestation in concessions is under one percent). While certification is far from guaranteed to effectively constrain deforestation, it will have more potential for impacts if pressures rise over time, so that there is more deforestation to be avoided.

Shifts in impact across space also are possible. That may be suggested by the difference in effect between two regions within Peru, Madre de Dios and Ucayali. Depending upon exactly how one controls for time's impacts, FSC certification in Ucayali can be seen as increasing deforestation. Controlling for time in other ways, FSCC in Madre de Dios could be seen to lower deforestation. Yet for any of our forms of time controls, the estimated FSCC effects differ across these regions. Thus, we might ask whether there are known differences across regions which could explain this. One speculation, based on discussions with those more expert than us in certification, is that the Madre de Dios area received more international attention, with greater donor and NGO support. Should that be the case, then, like types of PAs, we might think of FSCC implementation levels.

Shifts in the available data certainly seem possible and we hope are likely. For instance in stories of how FSCC functions, it seems clear that different companies might employ FSCC differently. A large multinational corporation that does most of its business across international borders and thus could be monitored and constrained by import restrictions but yet knows that monitoring is imperfect might use one FSCC strategy, while a largely domestic small firm might use another. FSC could collect such characteristics of FSCC settings, along with the kind of data potentially in forest management plans such as harvest technique, volume harvested and species harvested. Unfortunately for our study, to date for these countries any such records were quite incomplete.

Changes in forest data seem likely and would be welcome. The data we utilized are well known, including in that they are limited, even to the level of confusing plantations with forest (Tropek et al. 2013). Yet while data investments ideally will improve available data, consistent mapping and monitoring of detailed forest changes across large regions will remain challenging. Thus, a complementary change, alongside more precise data sets, could be more focus on impact areas. For instance, likely the largest effects of better forest management will be along logging roads.

Even what is measured in the forest seems likely to change. The effects of selective logging, and thus very likely of FSC certification, may take the form of changes in level of forest degradation. That is a more subtle change than deforestation, yet can be absolutely critical to the provision of ecosystem services including carbon storage and species habitat. Processes of forest degradation may be detected using particular remote-sensing data techniques, complemented by field-based investigations. However, at this time such tested, high-resolution data sets are not available for these countries and generating them is well outside the (expense and time) scope of this study.

Finally, based on our descriptive statistics we speculate further on context for considering FSCC. It is perhaps common to imagine rampant tree cutting in concessions but pristine PAs. However, we saw in these countries that there was lower deforestation inside the concessions than outside. While too simple an observation to permit conclusions, this suggested consideration of the roles of property rights, private incentives, and enforcement presence for outcomes on forest frontiers. In the extreme, one might imagine that illegal logging in a poorly enforced PA, without any local incentivized presence, could be higher than at least sustainably managed logging in a concession. In the big picture, such juxtapositions suggest a consideration of variations on any type of policy.

References

Albers, H.J. (2010). Spatial modeling of extraction and enforcement in developing country protected areas. *Resource and Energy Economics* 32, 165–179.

Auld, G., Gulbrandsen, L.H. & McDermott, C.L. (2008). Certification schemes and the impacts on forests and forestry. Annual Review of Environment and Resources 33, 187-211

Blackman, A., Raimondi, A., & Cubbage, F. (2014). Does Forest Certification in Developing Countries Have Environmental Benefits? Insights from Mexican Corrective Action Requests, (March).

Breukink, G., Levin, J., & Mo, K. (2015). Profitability and Sustainability in Responsible Forestry. Economic impacts of FSC certification on forest operators. Retrieved from http://d2ouvy59p0dg6k.cloudfront.net/downloads/profitability_and_sustainability_in_responsible_forestry_main_report_final.pdf

Central Intelligence Agency. (2014). The World Factbook 2014. Washington, DC. Retrieved from https://www.cia.gov/library/publications/the-world-factbook/index.html.

Cerutti, P. O., Lescuyer, G., Tsanga, R., Kassa, S. N., Mapangou, P. R., Mendoula, E. E., ... & Yembe, R. Y. (2014). Social impacts of the Forest Stewardship Council certification: An assessment in the Congo basin (No. CIFOR Occasional Paper no. 103, p. 74). Center for International Forestry Research (CIFOR), Bogor, Indonesia.

Cerutti, P. O., Nasi, R., & Tacconi, L. (2008). Sustainable Forest Management in Cameroon Needs More than Approved Forest Management Plans. Ecology and Society, 13(2), 36.

Cerutti, P. O., & Tacconi, L. (2006). Forests, Illegality, and Livelihoods in Cameroon (No. 35) (p. 41). Bogor.

Counsell, S., & Loraas, K. T. (2002). Trading in credibility: the myth and reality of the Forest Stewardship Council. (Retrieved online from http://globalforestcoalition.org/wp-content/uploads/2010/12/Trading-in-Credibility1.pdf)

DeFries, R.S., Rudel, T., Uriarte, M., & Hansen, M. (2010). Deforestation driven by urban population growth and agricultural trade in the twenty-first century. Nature Geoscience 3: 178-181.

Eba'a-Atyi, R. (1998). Cameroon's Logging Industry: Structure, Economic Importance and Effects of Devaluation. CIFOR. (Retrieved online from http://www.cifor.org/publications/pdf_files/OccPapers/OP-14.pdf)

Eba'a-Atyi, R. (2009). Study on Development and Progress in Timber Procurement Policies: Country Case Study: Cameroon. International Tropical Timber Organization (ITTO), (August), 33.

ESRI. (2014). ArcGIS 10.2.2 for Desktop. Redlands, CA: Envir. Systems Research Institute.

European Forest Institute. (2014). Cameroon. Retrieved from http://www.euflegt.efi.int/cameroon.

Food and Agriculture Organization (FAO). (2010). Global Forests Resources Assessment-Main Report. Rome. Retrieved from http://www.fao.org/docrep/013/i1757e/i1757e.pdf

Finer, M., Jenkins, C. N., Sky, M. A. B., & Pine, J. (2014). Logging Concessions Enable Illegal Logging Crisis in the Peruvian Amazon. Scientific Reports, 4719(4), 1-6.

FSC-Cameroon. (2010). FSC Standard for Community Forests and SLIMFs in Cameroon. Retrieved from https://ic.fsc.org/cameroon.259.htm.

Forest Stewardship Council (FSC). (2015a). Our vision and mission. Retrieved from https://ic.fsc.org/vision-mission.12.htm.

Forest Stewardship Council (FSC). (2015b). Internally generated data. Retrieved from https://ic.fsc.org/internally-generated-data.183.htm.

FSC. (2015c). Types of FSC Certificates. Retrieved from https://ic.fsc.org/types-of-certification.35.htm

Forest Stewardship Council (FSC). (2014). Global FSC Certificates: type and distribution, November 2014. Retrieved from https://ic.fsc.org/resources.10.htm.

FSC Peru. (2015). Iniciativas de certificación forestal voluntaria Perú julio 2015. Retrieved from https://pe.fsc.org/preview.mes-julio-2015.a-86.pdf

Global Forest and Trade Network. (2014). Annual Report 2014. Retrieved from http://d2ouvy59p0dg6k.cloudfront.net/downloads/gftn_fy14_annual_report.pdf.

Hale, T. & Held, D. *Handbook of Transnational Governance.* Cambridge: Polity Press, 2011.

Hansen, M. C., Potapov, P. V., Moore, R., Hancher, R., Turubanova, S. A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R., Kommareddy, A., Egorov, A., Chini, L., Justice, C.O., & Townshend, J.R.G. (2013). High-Resolution Global Maps of 21st-Century Forest Cover Change. Science 342 (15 November): 850–53. Data available on-line from: http://earthenginepartners.appspot.com/science-2013-global-forest.

Joppa, L. N., & Pfaff, A. (2011). Global protected area impacts. Proceedings. Biological Sciences / The Royal Society, 278(1712), 1633–8.

Laurance, W.F. (2009). Reflections on the tropical deforestation crisis. Bio.Cons. 9: 109-117.

Laurance, W.F., Cochrane, M.A., Bergen, S., Fearnside, P.M., Delamonica, P., Barber, C., D'Angelo, S., & Fernandes, T. (2001). The future of the Brazilian Amazon: Development trends and deforestation. Science 291: 438–439.

Laurance, W.F., Ferreira, L.V., Rankin-de Merona, J.M., & Laurance, S.G.. (1998). Rain forest fragmentation and the dynamics of Amazonian tree communities. Ecology, 79(6), 2032-2040.

Ministerio del Ambiente. (2014). El Perú, cuarto país con más bosques tropicales. Conservación de bosques para la mitigación del cambio climático. Retrieved September 26, 2014, from http://www.minam.gob.pe/programa-bosques/el-peru-cuarto-pais-con-mas-bosques-tropicales/

Ministerio del Ambiente. (2015). Los Bosques en cifras. Retrieved August 13, 2015, from http://www.minam.gob.pe/bosques/los-bosques-en-cifras/

Ministerio del Ambiente, & Ministerio de Agricultura. (2011). El Peru de los Bosques. Lima, Perú.

Nebel, G., Quevedo, L., Jacobsen, J.B., & Helles, F. (2005). Development and economic significance of forest certification: the case of FSC in Bolivia. Forest Policy and Economics, 7(2), 175-186.

Pfaff, A., Amacher, G. S., & Sills, E. O. (2013). Realistic REDD : Improving the Forest Impacts of Domestic Policies in Different Settings. *Review of Environmental Economics and Policy*, *7*(1), 114–135. http://doi.org/10.1093/reep/res023

Pfaff, A., Rica, C., Rica, C., & Herrera, L. D. (2014). Governance, Location and Avoided Deforestation from Protected Areas : Greater Restrictions Can Have Lower Impact , Due to Differences in Location. *World Development*, *55*, 7–20.

Pfaff, A., Robalino, J., Herrera, D., & Sandoval, C. (2015). Protected Areas ' Impacts on Brazilian Amazon Deforestation : Examining Conservation – Development Interactions to Inform Planning. *PLoS ONE*, 1–17. http://doi.org/10.1371/journal.pone.0129460

Pfaff, A., Robalino, J., Sandoval, C., & Herrera, D. (2015). Protected Area Types, Strategies, and Impacts in Brazil's Amazon: public PA strategies do not yield a consistent ranking of PA types by impact. 2nd revision submitted to Philosophical Transactions B.

Rainforest Alliance. (2014). Community Forestry in Peru. Retrieved May 28, 2014, from http://www.rainforest-alliance.org/work/community-forestry/regions/peru

Rainforest Alliance. (2015). Timber Legality Verification. Retrieved from http://www.rainforest-alliance.org/forestry/verification/legal.

Raschio, G., Contreras, C., & Schlesinguer, P. 2014. Análisis de agentes y causas De La deforestación y degradación forestal para la región de Madre de Dios, Peru. Report to World Wildlife Fund/Peru. April 2014.

República del Perú. Ley Forestal y Fauna Silvestre (Ley No 27308) (2000).

República del Perú. Resolución Presidencial N.006-2013-OSINFOR (2013).

República del Perú. Resolución Presidencial N.007-2013-OSINFOR (2013).

Schwartz, B., Hoyle, D. & Nguiffo, S. (2012). Emerging Trends in Land-Use Conflicts in Cameroon: Overlapping Natural Resource Permits Threaten Protected Areas and Foreign Direct Investment. Yaoundé, Cameroon: WWF/CED/RELUFA.

Sears, R. R., & Pinedo-Vasquez, M. (2011). Forest Policy Reform and the Organization of Logging in Peruvian Amazonia. Development and Change, 42(2), 609-631.

StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP.

Swenson, JJ., Carter, C.E., Domec, J.C., & Delgado, C.I. (2011). Gold Mining in the Peruvian Amazon: Global Prices, Deforestation, and Mercury Imports. PloSONE. doi:10.1371/journal.pone.0018875

Transparency International. (2013). Corruption Perceptions Index 2013. Retrieved from https://www.transparency.org/cpi2013/results.

Tropek, R., Sedláček, O., Beck, J., Keil, P., Musilová, Z., Šímová, I., & Storch, D. (2014). Comment on "High-resolution global maps of 21st-century forest cover change". Science 344(6187) 6187: 981.

Urrunaga, J.M., Johnson, A., Orbegozo, I.D., & Mulligan, F. (Environmental Investigation Agency). (2012). The Laundering Machine: How Fraud and Corruption in Peru's Concession System are Destroying the Future of its Forests. Retrieved from http://eia-global.org/news-media/the-laundering-machine

Wright, S.J. & Muller-Landau, H.C. (2006). The Future of Tropical Forest Species. Biotropica 38(3): 287-301.

The World Bank. (2014). Cameroon Country Overview. Retrieved from http://www.worldbank.org/en/country/cameroon/overview.

World Resources Institute (WRI). (2013). [Geospatial data of the Interactive Forest Atlas of Cameroon]. Available from World Resources Institute Web site: http://www.wri.org/our-work/project/congo-basin-forests/cameroon#project-tabs

World Resources Institute (WRI). (2012). Interactive Forest Atlas of Cameroon, Version 3.0.

World Wildlife Fund. (2015). GFTN-Peru. Retrieved from http://gftn.panda.org/gftn_worldwide/latin_america/peru/

World Wildlife Fund – Peru. (2014). Geospatial data for Peru's administrative regions and logging concessions. Unpublished raw data.

Table 1. Description of variables used in panel data analysis

	Unit	Source
Outcome: % forest area lost in year t	%	Hansen et al. (2013) *Global Forest Change* data
Treated: FSC = 1 if active in year t	0,1	FSC Peru, WWF Peru, MINAG, FSC
Concession = 1 if active in year t	0,1	WRI, MINAM, MINAG, OSINFOR, WWF Peru
Distance to nearest city	km	MINAM, WRI
Distance to nearest road	km	MINAM, WRI
Distance to nearest river	km	MINAM
Distance to processing plant	km	WRI

Notes: These concession-average distances are fixed. They enter panel analyses only if not using concession fixed effects. MINAG= *Ministerio de Agricultura*, MINAM= *Ministerio del Ambiente*, OSINFOR= *Organismo de Supervisión de los Recursos Forestales y de Fauna Silvestre*, WRI= World Resources Institute, and WWF= World Wildlife Fund.

Table 2. Percentage of forest loss, for Peru and Cameroon, during the period 2000-2013, for land always outside vs. at some point inside of logging concessions in the study areas

Country	Inside logging concessions	Outside logging concessions
Peru	0.68%	1.55%
Cameroon	0.34%	1.92%

Note: We used pixels for these calculations.

Table 3. Average percentage of forest loss per year in Peru during the period 2001-2013 within concessions always uncertified vs. at some point FSC certified (accounting for active statuses)

	Never FSC				Ever FSC					
	Pre concession	Active concession	Post concession		Pre concession & pre FSC	Active concession & pre FSC	Active concession & active FSC	Active concession & post FSC		
Region	%	%	%	N	%	%	%	%	N	Total N
Madre de Dios	0.01%	0.07%	0.19%	923	0.01%	0.03%	0.03%	0.04%	260	1,183
Loreto	0.01%	0.04%	0.03%	3,237	0.00%	0.02%	0.06%	-	78	3,315
Ucayali	0.02%	0.10%	0.06%	2,223	0.02%	0.07%	0.38%	0.14%	104	2,327
All	0.01%	0.07%	0.06%	6,383	0.01%	0.04%	0.09%	0.07%	442	6,825

Notes: These statistics were calculated with a panel of 525 concessions for the period 2001-2013. Therefore, there are a total of 6,825 observations. N shows the number of observations. The number of years within each category varies and the proportions shown in this table were not weighted by those years. We found almost the same results when we excluded 19 concessions from the analysis that were cancelled during the period and did not have end dates (only a 0.01 increase in the percentage of forest loss in the never FSC concessions in Ucayali while concessions were active). We defined forests as more than 30% tree cover.

Table 4. Average percentage of forest loss per year in Cameroon during 2001-2013 within concessions always uncertified vs. at some point FSC certified (accounting for active statuses)

	Never FSC			Ever FSC					
	Pre concession	Active concession		Pre concession & pre FSC	Active concession & pre FSC	Active concession & active FSC	Active concession & post FSC		
Region	%	%	N	%	%	%	%	N	Total N
Southwest	0.13%	0.08%	91	0.01%	0.01%	0.04%	-	13	104
Littoral	0.07%	0.21%	26	-	-	-	-	0	26
Center	0.01%	0.04%	143	0.02%	0.00%	0.00%	0.00%	13	156
South	0.03%	0.04%	247	0.02%	0.01%	0.05%	-	130	377
East	0.02%	0.02%	637	0.01%	0.02%	0.02%	0.02%	182	819
All	0.04%	0.03%	1,144	0.02%	0.02%	0.03%	0.02%	338	1,482

Note: These statistics were calculated with a panel of 114 concessions for the period 2001-2013. Therefore, there are a total of 1,482 observations. N shows the number of observations under each status. We excluded 8 concessions (104 observations) from the analysis that do not have a concession start date. N shows the number of observations. The number of years within each category varies and the proportions shown in this table were not weighted by those years. We defined forests as more than 30% tree cover.

Table 5. Panel data model explaining the percentage of forest loss per year during 2001-2013 inside logging concessions in Peru (overall for our study area (most concessions) & by region)

Percentage of forest loss	All	Madre de Dios	Loreto	Ucayali
FSC (1 if active in year t)	0.0000	-0.0007	0.0000	0.0015
	(0.0006)	(0.0003)*	(0.0003)	(0.0027)
Concession (1 if active in year t)	0.0001	-0.0004	0.0001	0.0006
	(0.0001)	(0.0005)	(0.0001)	(0.0002)*
Year 2002 (1,0)	-0.0000	0.0003	-0.0000	-0.0004
	(0.0000)	(0.0003)	(0.0000)	(0.0001)*
Year 2003 (1,0)	-0.0000	0.0006	-0.0001	-0.0006
	(0.0001)	(0.0005)	(0.0000)*	(0.0002)**
Year 2004 (1,0)	0.0001	0.0007	0.0000	-0.0005
	(0.0001)	(0.0005)	(0.0001)	(0.0002)*
Year 2005 (1,0)	0.0001	0.0005	0.0000	-0.0004
	(0.0001)	(0.0005)	(0.0001)	(0.0002)
Year 2006 (1,0)	0.0000	0.0006	-0.0001	-0.0006
	(0.0001)	(0.0005)	(0.0001)	(0.0002)*
Year 2007 (1,0)	0.0001	0.0008	-0.0000	-0.0005
	(0.0001)	(0.0005)	(0.0001)	(0.0002)*
Year 2008 (1,0)	0.0003	0.0011	0.0002	-0.0001
	(0.0001)**	(0.0006)	(0.0001)	(0.0002)
Year 2009 (1,0)	0.0006	0.0008	0.0004	0.0007
	(0.0001)**	(0.0006)	(0.0001)**	(0.0003)**
Year 2010 (1,0)	0.0005	0.0014	0.0002	0.0004
	(0.0001)**	(0.0006)*	(0.0001)**	(0.0002)
Year 2011 (1,0)	0.0006	0.0014	0.0001	0.0007
	(0.0001)**	(0.0006)*	(0.0000)*	(0.0002)**
Year 2012 (1,0)	0.0010	0.0021	0.0005	0.0011
	(0.0002)**	(0.0008)**	(0.0001)**	(0.0003)**
Year 2013 (1,0)	0.0013	0.0015	0.0005	0.0022
	(0.0002)**	(0.0006)*	(0.0001)**	(0.0005)**
Constant	0.0002	0.0002	0.0001	0.0003
	(0.0001)*	(0.0002)	(0.0001)	(0.0002)
Concession fixed effects	Yes	Yes	Yes	Yes
R^2	0.05	0.07	0.04	0.09
N	6,825	1,183	3,315	2,327

Notes: Standard errors in parentheses. * $p<0.05$; ** $p<0.01$. We used a panel of 525 concessions for the period 2001-2013. Therefore, we had a total of 6,825 observations. We clustered the standard errors by concession. We defined forests as more than 30% tree cover. We found almost the same results when we excluded 19 concessions from the analysis that were cancelled during the period and did not have end dates. There was only a +/-0.01 change in some coefficients, but the main conclusions do not change.

Table 6. Panel data model explaining the percentage of forest loss per year during 2001-2013 inside logging concessions in Cameroon (overall for our study area (all concessions) & by region)

Percentage of forest loss	All	Southwest	Center	South	East
FSC (1 if active in year t)	-0.0002	-0.0013	-0.0001	-0.0001	-0.0002
	(0.0001)*	(0.0013)	(0.0001)	(0.0001)	(0.0001)*
Concession (1 if active in year t)	-0.0001	-0.0016	-0.0001	-0.0000	-0.0001
	(0.0001)	(0.0018)	(0.0002)	(0.0001)	(0.0001)
Year 2002 (1,0)	0.0001	0.0004	0.0000	-0.0000	0.0001
	(0.0000)	(0.0001)*	(0.0002)	(0.0001)	(0.0000)
Year 2003 (1,0)	-0.0001	-0.0002	-0.0001	-0.0001	-0.0000
	(0.0000)**	(0.0001)	(0.0001)	(0.0001)*	(0.0000)
Year 2004 (1,0)	-0.0001	-0.0004	0.0001	-0.0001	-0.0000
	(0.0000)	(0.0004)	(0.0003)	(0.0000)	(0.0000)
Year 2005 (1,0)	0.0000	-0.0001	-0.0000	-0.0000	0.0000
	(0.0000)	(0.0002)	(0.0002)	(0.0000)	(0.0000)
Year 2006 (1,0)	0.0001	0.0018	0.0001	-0.0000	-0.0000
	(0.0001)	(0.0019)	(0.0003)	(0.0001)	(0.0000)
Year 2007 (1,0)	0.0001	0.0003	0.0004	0.0000	0.0001
	(0.0000)	(0.0006)	(0.0005)	(0.0001)	(0.0000)*
Year 2008 (1,0)	0.0001	0.0013	-0.0001	0.0001	-0.0000
	(0.0001)	(0.0015)	(0.0001)	(0.0001)	(0.0000)
Year 2009 (1,0)	0.0005	0.0009	0.0001	0.0001	0.0008
	(0.0002)**	(0.0011)	(0.0003)	(0.0001)	(0.0003)**
Year 2010 (1,0)	0.0004	0.0049	0.0007	0.0000	0.0001
	(0.0003)	(0.0044)	(0.0008)	(0.0001)	(0.0000)*
Year 2011 (1,0)	0.0001	0.0017	-0.0001	0.0002	-0.0000
	(0.0001)	(0.0018)	(0.0001)	(0.0001)	(0.0000)
Year 2012 (1,0)	0.0001	0.0017	0.0002	0.0001	0.0001
	(0.0001)*	(0.0018)	(0.0002)	(0.0001)	(0.0001)
Year 2013 (1,0)	0.0006	0.0035	0.0003	0.0007	0.0004
	(0.0001)**	(0.0030)	(0.0002)	(0.0001)**	(0.0001)**
Constant	0.0003	0.0005	0.0003	0.0002	0.0002
	(0.0000)**	(0.0005)	(0.0001)*	(0.0000)**	(0.0000)**
Concession fixed effects	Yes	Yes	Yes	Yes	Yes
R^2	0.06	0.23	0.12	0.32	0.14
N	1,378	91	130	338	793

Notes: Standard errors in parentheses. * *p*<0.05; ** *p*<0.01. We used a panel of 114 concessions for the period 2001-2013. Therefore, we had a total of 1,482 observations. We clustered the standard errors by concession. We did not include 8 concessions (104 observations) that do not have concession start date.

Peru Appendix − Redoing Table 5 Without Year Effects

	All	Madre de Dios	Loreto	Ucayali
FSC (1 if active in year t)	0.0007	0.0001	0.0003	0.0029
	(0.0002)**	(0.0003)	(0.0003)	(0.0007)**
Concession (1 if active in year t)	0.0000	-0.0001	0.0001	-0.0001
	(0.0001)	(0.0002)	(0.0000)**	(0.0001)
Year 2002 (1,0)	---	---	---	---
	---	---	---	---
Year 2003 (1,0)	---	---	---	---
	---	---	---	---
Year 2004 (1,0)	---	---	---	---
	---	---	---	---
Year 2005 (1,0)	---	---	---	---
	---	---	---	---
Year 2006 (1,0)	---	---	---	---
	---	---	---	---
Year 2007 (1,0)	---	---	---	---
	---	---	---	---
Year 2008 (1,0)	---	---	---	---
	---	---	---	---
Year 2009 (1,0)	---	---	---	---
	---	---	---	---
Year 2010 (1,0)	---	---	---	---
	---	---	---	---
Year 2011 (1,0)	---	---	---	---
	---	---	---	---
Year 2012 (1,0)	---	---	---	---
	---	---	---	---
Year 2013 (1,0)	---	---	---	---
Constant	0.0005	0.0008	0.0002	0.0009
	(0.0000)**	(0.0002)**	(0.0000)**	(0.0001)**
Fixed effects (concession)	Yes	Yes	Yes	Yes
N	6,825	1,183	3,315	2,327
R^2	0.0017	0.0007	0.0030	0.0086

Notes: Standard errors in parentheses. * $p<0.05$; ** $p<0.01$. We used a panel of 525 concessions for the period 2001-2013. Therefore, we had a total of 6,825 observations. We clustered the standard errors by concession for all specifications except for column 3. Distances to roads, rivers, and capital do not change over time. We included concession fixed effects in specifications 3 and 4. We defined forests as more than 30% tree cover.

Cameroon Appendix − Redoing Table 6 Without Year Effects

	Southwest	Center	South	East
FSC (1 if active in year t)	0.0001	-0.0001	0.0001	-0.0000
	(0.0016)	(0.0004)	(0.0001)	(0.0001)
Concession (1 if active in year t)	0.0002	0.0001	0.0001	-0.0000
	(0.0006)	(0.0002)	(0.0001)*	(0.0001)
Year 2002 (1,0)	---	---	---	---
	---	---	---	---
Year 2003 (1,0)	---	---	---	---
	---	---	---	---
Year 2004 (1,0)	---	---	---	---
	---	---	---	---
Year 2005 (1,0)	---	---	---	---
	---	---	---	---
Year 2006 (1,0)	---	---	---	---
	---	---	---	---
Year 2007 (1,0)	---	---	---	---
	---	---	---	---
Year 2008 (1,0)	---	---	---	---
	---	---	---	---
Year 2009 (1,0)	---	---	---	---
	---	---	---	---
Year 2010 (1,0)	---	---	---	---
	---	---	---	---
Year 2011 (1,0)	---	---	---	---
	---	---	---	---
Year 2012 (1,0)	---	---	---	---
	---	---	---	---
Year 2013 (1,0)	---	---	---	---
Constant	0.0009	0.0003	0.0001	0.0002
	(0.0004)*	(0.0002)	(0.0001)**	(0.0000)**
Fixed effects (concession)	Yes	Yes	Yes	Yes
N	91	130	338	793
R^2	0.0019	0.0008	0.0257	0.0001

Notes: Standard errors in parentheses. * p<0.05; ** p<0.01. We used a panel of 525 concessions for the period 2001-2013. Therefore, we had a total of 6,825 observations. We clustered the standard errors by concession for all specifications except for column 3. Distances to roads, rivers, and capital do not change over time. We included concession fixed effects in specifications 3 and 4. We defined forests as more than 30% tree cover.