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Sell the oil deposits!

A financial proposal to keep the oil underground in the Yasuni National Park, Ecuador

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Abstract: The Yasuni National Park is a protected area located in the Amazon region of Ecuador and is recognized as one of the most biodiverse regions in the world. In recent years the park has received much attention due to the media exposure of the Yasuni-ITT Initiative. This Initiative proposed a moratorium on oil activities in the Ishpingo-Timbococha-Tiputini (ITT) blocks within the Yasuni National Park, in exchange for US$3.6 billion in compensation over ten years, to be paid by the international community. In this paper we first conduct a feasibility analysis of the ITT Initiative and show that it was severely flawed from its inception. Second, we develop a financial approach for a 'New ITT Initiative'. We propose the sale or leasing of the rights of extraction of the oil deposits in the Park as a feasible strategy to keep the oil underground and consequently to protect the Yasuni National Park's ecosystem services. Our proposal is much more simplified and transparent than the original ITT Initiative and could be easily implemented through existing financial mechanisms.

Keywords: additionality, uncertainty, permanence, leakage, discount, Monte Carlo
JEL classification: Q35, Q51, Q56, Q57

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1 Introduction

The Yasuni National Park (YNP) is a protected area located in the Amazon region of Ecuador and is recognized as one of the most biodiverse regions in the world (Bass et al. 2010). In 1989 it and much of its adjacent area were designated by UNESCO as a Biosphere Reserve (UNESCO 1989). In recent years, the YNP has received much attention due to the media exposure of the Yasuni-ITT Initiative. This Initiative, announced in 2007 by the Ecuadorian government, proposed a moratorium on oil activities in the Ishpingo-Timbococha-Tiputini (ITT) blocks within the YNP, in exchange for US$3.6 billion in compensation over a period of ten years. The compensation was supposedly in recognition of the supply of environmental services generated by the YNP from which the entire planet benefited. The Initiative was initially celebrated as an innovative proposal that offered an alternative to global environmental problems as it would promote the transition from the current development model, based on oil extraction, to a new strategy based on equality and sustainability (Acosta et al. 2009; Larrea and Warnars 2009; Rival 2010; Vogel 2010).

The financial mechanism of the ITT Initiative involved contributions to the Yasuni Trust Fund, and took the form of debt-for-conservation swaps, emission permit auctions or conservation projects, and donations from governments, multilateral organizations, and non-governmental organizations, private companies, and individuals (United Nations Development Group 2010). In exchange for the contributions, the Ecuadorian government would issue Yasuni Guarantee Certificates (YGCs), which were documents with a face value equal to the contribution in US dollars. The YGCs were intended to represent ‘avoided emissions’ from keeping oil underground (measured in metric tons of CO_2e). The avoided emissions were calculated as the ratio between the contribution and the price of the European Union Allowances (EUA) from the Leipzig Carbon Market. The maximum total amount of YGCs to issue would be 407 million tons of CO_2e corresponding to the estimated emissions produced from extracting oil from the ITT field. The YGCs did not earn interest and did not have an expiration or maturity date as long as the government maintained its commitment to not exploiting the oil reserves. Any contribution below US$50,000 was considered as a donation and no YGC would be issued.

By 2013, only US$336 million had been pledged (about 9 per cent of the target compensation) and US$13.3 million actually delivered (0.37 per cent of the target compensation), leading President Correa to terminate the Initiative, arguing that the international community had failed to embrace it. The termination of the Initiative was an unpopular decision and there remains widespread concern about the preservation of the YNP since oil activities started in 2013.[1] Some authors argue that the original ITT Initiative is still a coherent and innovative proposal to address climate change (e.g. Vallejo and Friant 2015), and that the failure of the Initiative was not due to poor design but to poor implementation by the policy makers in charge (Pellegrini et al. 2014). They argue that the decisions of the Ecuadorian government to allow oil extraction underestimate the value of the YNP and disregard important aspects of the analysis such as ecosystem services and social capital (Vallejo et al. 2015). However, Finer et al. (2010) already recognized that the global economic downturn in 2008 led Ecuador to modify the Initiative as it was becoming increasingly difficult to find contributions. This revealed that the implementation of the Initiative largely depended on exogenous dynamics (e.g. oil and commodities prices) that had not been considered by its designers.

[1] In 2014, a petition for a referendum to decide on further oil exploration in the YNP was made in Ecuador. The National Electoral Council turned down this petition on the argument that a large number of the petitionary signatures were invalid (see BBC 2014).

Despite the purported advantages of the Initiative, Pellegrini et al. (2014) indicate that its demise depended to a large extent on the inability of policy makers to identify and resolve tensions between the proposal and the institutions that facilitated it. Additional tensions involved framing the proposal in a way that would be acceptable both domestically and internationally (e.g. regarding trust and cooperation between the Ecuadorian government and the global community) and the legitimacy of the ITT Initiative. Haddad (2011) argued that the Initiative took the form of a compensated moratorium, where the compensation was estimated with respect to foregone oil revenues rather than the environmental benefit accrued. Likewise, Harstad (2012a) considered that the Initiative and the oil moratorium could be viewed as the Ecuadorian government holding a hostage (the YNP) and demanding a ransom (the target compensation), so that if the ransom was not received, oil extraction would start. Therefore, the whole Initiative appeared as an arbitrary exercise of power where the stronger party (the Ecuadorian government) demanded a ransom from the rest of the world, who had no alternative but to comply (Williamson 1983).

The objective of this paper is twofold. First, we conduct a feasibility analysis of the ITT Initiative and show that it was severely flawed from its inception. We calculate the heavy discounts that would have been applied to the YGCs; for this we use the Certified Emissions of Reductions (CER) as twin securities. Then, we estimate the oil extraction revenues (to assess the plausibility of the target compensation) and the revenues that would have hypothetically occurred from the trade of YGCs. We conclude that the ITT Initiative was in fact poorly designed and was bound to fail. Second, we develop a financial approach for a 'New ITT Initiative'. We propose the sale or leasing of the rights of extraction of the oil deposits in the YNP as a feasible strategy to keep the oil underground and, consequently, to protect the YNP's ecosystem services. This financial approach is much more transparent and simplified than the ITT Initiative, and could be easily implemented through existing market mechanisms. Thus, our proposal does not require the creation of financial instruments such as the YGCs, it disregards inaccurate concepts such as 'avoided net emissions', and demonstrates the redundancy of the Initiative with respect to the Kyoto Protocol instruments. We finally emphasize that the Initiative, as it was originally designed, should be discarded and further efforts should be addressed to the adoption of our new, more useable Initiative.

The paper is structured as follows: Section 2 presents the feasibility analysis of the ITT Initiative, Section 3 contains the theoretical basis for our 'new ITT Initiative', Section 4 discusses financial issues and institutional implications of our proposal, and Section 5 concludes.

2 Feasibility analysis of the ITT Initiative

This section provides a comprehensive analysis of the flaws of the ITT Initiative as a climate change mitigation instrument and as a financial tool to raise the compensation necessary to motivate the Ecuadorian government to prioritize conservation over oil extraction.

The modelling assumptions are as follows. First, we assume YGCs are financially and operatively equivalent (i.e. fungible) to the CERs. The CERs are financial instruments associated with Clean Development Mechanism (CDM) and Reducing Emissions from Deforestation and Forest Degradation (REDD+) projects, which have a payoff structure (i.e. cash flows) similar to the YCGs. That is, CERs are the best proxy or twin security to value the YGCs. This assumption relies on paragraph 26 of the Terms of Reference (TOR) of the Yasuni-ITT Trust Fund of July 2010 (United Nations Development Group 2010), which states, '…the YGCs will also include the metric tons of CO_2 avoided according to the price, at that date, of the European Union Allowances (EUAs) in the Leipzig Carbon Market…'. Furthermore, paragraph 27 of the same document asserts that '…if in the future the world carbon market accepts the YGCs as equivalents of Emission Permits, the government will issue YGCs for sale to private and/or public entities in mitigating greenhouse gas emissions…'. These statements show a clear and explicit expectation by the Ecuadorian government that the YCGs could become equivalent to the EUAs traded in the European Union Emission Trading Scheme (EU ETS). However, as EUAs are electronic certificates distributed by European governments to firms in the industrial sector, EUAs are by definition not equivalent to those of the YGCs. Hence, we use the CERs for the purposes of our analysis. Second, we assume donors are rational utility maximizers and, given scarce financial resources, they will choose the best use of their money by evaluating all the alternatives. Donors then use the carbon market as a means to decide the scale of their donations. Third, we assume the Ecuadorian government commits to keeping the oil underground as long as the compensation is incentive-compatible, that is, if the compensation is equal to or greater than US$3.6 billion. Fourth, for the sake of conducting an analysis of the best-case scenario, we ignore the fact that YGCs represent neither a portion of the oil reserves nor avoided carbon emissions as purported but are, in practice, the representation of nothing more than a *bona fide* promise from Ecuador to refrain from exploiting the ITT block. This simplifies the analysis and allows us to approach the problem from a financial perspective and to obtain an upper bound valuation of the YGCs.

2.1 Price discounting

The ITT Initiative did not comply with any of the CDM or REDD+ criteria to be considered a viable mitigation instrument, namely, the permanence, additionality, certainty, and non-leakage criteria of the greenhouse gas (GHG) emissions. Our reasons are as follows:

Permanence: Oil exports have been Ecuador's main source of revenue for more than 40 years, and oil exploration activities continued to take place in the YNP and its buffer zone even after the implementation of the ITT Initiative (Martin 2011; Arsel and Angel 2012). However, exploration was omitted as a source of potential activities that may affect the YNP. This omission signalled a weak commitment by the Ecuadorian government to the terms of the ITT Trust (Singleton 2000). Moreover, there was always the possibility that Ecuador would need funds to face negative macroeconomic shocks or to boost economic development. Then, the goals of the (current or future) government might switch from seeking international compensation for avoided emissions to prioritizing oil export revenues as these are not bound by the tight conditions of the ITT Trust. In economic terms, the Initiative may not have been credible in the long run and its permanence may have been perceived as fragile. Though the Initiative made provisions for the reimbursement of donations if oil extraction occurred, the financial and legal mechanisms that would put this repayment process into operation were not clear. Thus, other concerns arose because of the institutional instability around the design and management of the ITT Initiative (Arsel 2012; Arsel and Angel 2012).

Additionality: The ITT Initiative did not provide any baseline or offset estimations to identify truly additional GHG emissions reductions or sequestration. This implied that the claimed equivalence between the YGCs and CERs or EUAs could not hold because credit buyers would pay only for offsets that they could claim as credit under regulatory schemes. That is, credit buyers would not wish to buy YGCs if the offsets might be disallowed because they could not be proven to be truly additional (Kim et al. 2008; Kim and McCarl 2009). Moreover, the YNP has been a protected area for more than 34 years. Consequently, no additional environmental services are produced by the YNP and, therefore, no further international funding needs to be provided to ensure biodiversity conservation or protection of the indigenous peoples living in voluntary isolation. Although this all depends on whether the legislation is adequately enforced, this is not a matter within the environmental and conservation realm.

Leakage: The avoidance of emissions from the combustion of the oil that would be preserved underground was not a sensible aim of the Initiative. Ecuador does not have any control over oil markets, thus its oil is easily substituted in the short term by purchases in other countries or extraction from other fields in Ecuador itself.

Uncertainty: Haddad (2011) argued that the Initiative took the form of a compensated moratorium where the compensation was estimated with respect to the value of foregone oil revenue rather than the environmental benefit accrued. In addition to the unavailability of baseline data and data of impacts on ecosystem services from oil extraction, potential credit buyers, donors, and investors could not make decisions regarding compliance with regulatory limits for emissions. Hence, no clear rationale existed of how the compensation requested by the Ecuadorian government was related to offset levels, or whether it was merely an arbitrary calculation.

The ITT Initiative was plagued with contradictions and logical flaws. The two most important are as follows: 1) the YGCs were not recognized under the Kyoto Protocol mechanisms and no formal procedures were specified to operationalize the equivalence with CERs and EUAs, and 2) although the Initiative predicted that the YGCs would be recognized by the US government as a pilot study for carbon offsets (Larrea and Warnars 2009), the transaction costs were too large to make this a reasonable goal.

However, we follow the reasoning of the TOR and assume that any non-compliance with CDM or REDD+ criteria is partially resolved through discounts to the price of the YGCs if they had been freely traded in the EU ETS market. Following Murray et al. (2004), Kim et al. (2008), and Kim and McCarl (2009), Equation 1 sets up a price discounting scheme as follows:

$$Discount = \frac{\sum_{t=0}^{T}\left(B_t(1+g)^t + \left(\frac{M_t}{P_0}\right)\right)(1+r)^{-t}}{\sum_{t=0}^{T} Q_t(1+g)^t(1+r)^{-t}} + (1-PA) + (1-PL) + z_\alpha * CV \tag{1}$$

The first term corresponds to the permanence discount, which is also dependent on the project's time horizon (*T*). Q_t stands for carbon offsets per hectare per year, B_t is the buyback price per reverted offset, P_0 is the initial price, and M_t are maintenance costs for the ITT Initiative to exist. Carbon price changes at the rate g and the time discount rate is r. The second and third terms capture additionality and non-leakage, where PA and PL denote the proportion of additionality and non-leakage, respectively. The last term captures the effect of uncertainty, where $z_\alpha * CV$ represents the uncertainty discount, z_α is the value from a normal distribution that reflects a confidence interval set with probability α, and CV is the coefficient of variation of offsets generated by the ITT Initiative in year t.

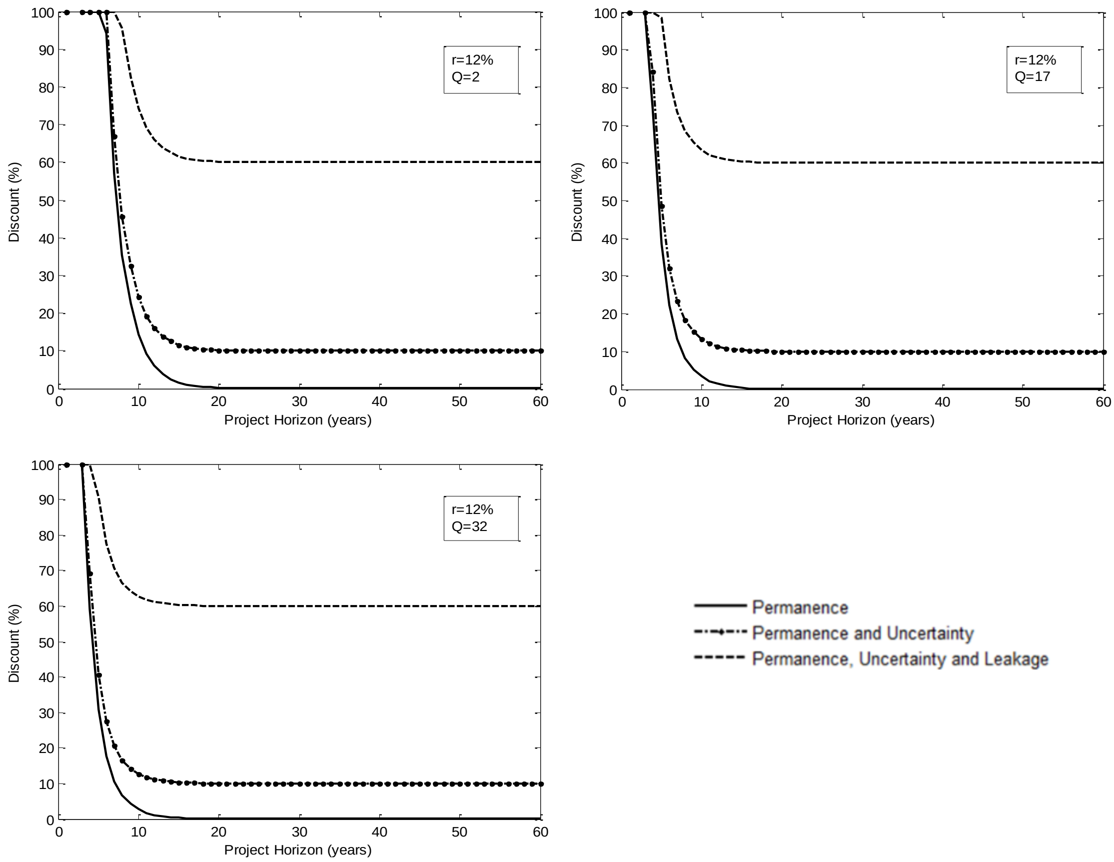
Q_t is assumed to be constant; an innocuous assumption because of the maturity and saturation of the YNP. We simulate price discounts for 2 tCO_2e, which is the carbon offset assumed for the ITT Initiative (Larrea and Warnars 2009), 17 and 32 tCO_2e per hectare per year. B_t is equal to the P_0 and is paid one period after the reversion of the contract terms. We use a 2009 average CER price of US$16 per tCO2e, which would proxy the initial conditions had the ITT Initiative become fully functional. As it was not possible to estimate a sensible rate of growth for carbon prices, and for simplicity, we assume that g is equal to 0 per cent, and r is equal to 12 per cent (as in Larrea 2010). Furthermore, as no changes to agricultural or forestry practices were required to be funded, we assume that M_t is equal to zero.

We assume that PL ranges between 0 per cent and 50 per cent and that the uncertainty discount ranges between 0 per cent and 10 per cent. The latter figure is consistent with Marland, Fruit et al. (2001); Marland, McCarl et al. (2001); Murray et al. (2004); and Kurkalova (2005). To estimate additionality, we require reliable information about the emissions baseline and additions. But, apart from data unavailability, the YNP is a saturated ecosystem that may have already reached maturity, so that its ecosystem services remain constant regardless of the implementation of the ITT Initiative. Thus, it could be argued that only because of non-additionality, the total price discount would be close to 100 per cent. However, we do not include these aspects in the analysis in order to observe the behaviour of the other types of price discounting.

Figure 1 shows the results of the price discounting simulations. We first consider permanence before successively introducing the uncertainty and leakage discounts. Additionality is analysed separately. By assumption, the uncertainty discount ranges between 0 per cent and 10 per cent regardless of the time horizon. The same applies to the leakage discount, which is assumed to range between 0 per cent and 50 per cent. For the permanence discount only, when carbon sequestration is 2 tCO_2e per hectare per year, the price discount for the YGCs is equal to 100 per cent if the time horizon is shorter than seven years. For longer horizons, this discount decreases until it reaches 0 per cent at around 20 years and over. For offsets of 17 tCO_2e per hectare per year, the permanence discount is equal to 100 per cent if the horizon is shorter than four years. The discount decreases to zero and is less than 10 per cent for horizons longer than eight years. For offsets of 32 tCO_2e per hectare per year, the permanence discount is less than 10 per cent for projects longer than seven years and becomes insignificant for horizons of over 15 years.

For offsets of 2 tCO_2e and with permanence and uncertainty discounts combined, the price discount remains at 100 per cent for eight years and then decreases until it reaches 10 per cent from year 16 and beyond. With the introduction of leakage, the combined discount is equal to 100 per cent until year nine and then decreases to 60 per cent by year 16. For offsets of 17 tCO_2e, and when uncertainty is introduced, the discount curve shifts right and after year 14 the discount is never lower than 10 per cent, where the permanence discount vanishes and only uncertainty prevails. However, with leakage and even for a long-horizon project, after year 14 the combined discount is never below 60 per cent. Finally, for offsets of 32 tCO_2e and with uncertainty, discounts are between 3 per cent and 100 per cent for projects shorter than 10 years but are never lower than 10 per cent after year 16. With leakage, the discount is total for projects shorter than six years and never falls below 60 per cent afterwards.

Figure 1: Price discounts (%) on YGCs due to permanence, uncertainty, and leakage



Source: Authors' calculations.

From the simulations, we conclude that the longer the time horizon, the lower the price discounts from permanence and uncertainty; but long time horizons have a minimal effect on the heavy discounts related to leakage. In the context of the Initiative, however, it seems fair to emphasize short-run effects. Considering the often volatile political environment in Ecuador, it was not clear whether the government following President Correa would maintain the promise of not extracting oil. Further, the Ecuadorian constitution allows Correa to remain in office only until 2017 (ten years from the beginning of the Initiative), so donors/investors would probably have looked at this time horizon when evaluating the Initiative. Hence, price discounting is relevant for the evaluation of the ITT Initiative for the following reasons: 1) the unclear and possibly short time horizon of the Initiative, which makes its permanence questionable; 2) the degree of uncertainty concerning the overall design of the ITT Trust and its implementation; and 3) the significant leakage in the short-run.

2.2 Financial valuation of the ITT Initiative

In this section we evaluate whether the ITT Initiative was an incentive-compatible contract for the Ecuadorian government using as a focal date 13 August 2013 (i.e. when the Initiative was terminated). The target compensation expected by the Ecuadorian government was US$3.6 billion, a figure that, according to the Initiative's designers, was equal to half the foregone oil revenues from the ITT block. Thus, if oil revenues accruing to the government were estimated to be higher than US$3.6 billion, the Ecuadorian government would not have had any incentive to keep the oil underground, resulting in a breach of the ITT commitments. Also, we estimate the revenues that would have been raised from the YGCs trade in the best-case scenario. For this we employ Monte Carlo simulations that incorporate the price discounts calculated in Section 2.1.

Valuation of oil extraction in the ITT block

The ITT Initiative was drafted under the assumption that the Net Present Value (NPV) of the oil revenues from the exploitation of the ITT block would be around US$7.2 billion, from which the Ecuadorian government would receive 50 per cent. Consequently, if oil revenues exceeded US$3.6 billion, there would no longer be any incentive to comply with the agreements set in the Initiative. The Initiative's designers argued that this compensation value was incentive-compatible, and that the Ecuadorian government would easily be able to comply with it. This conclusion was derived from the following assumptions (Acosta 2007): 1) an expected production of 900 million barrels in total (on average 36 million barrels per year); 2) an average oil price received by Ecuador of US$32 per barrel; 3) a production period of 25 years; 4) production costs of US$12 per barrel; 5) a discount rate of 9 per cent—the official rate of discount of the Ecuadorian government (Ministerio Coordinador de Política Económica 2013); and 6) no initial investment.[2] However, many of these assumptions were wrong or unrealistic. For instance, WTI oil prices were in fact around US$72 per barrel in 2007, and averaged US$80 in 2008 and 2009.[3] Thus, the assumption of an average oil price received by Ecuador of US$32 per barrel was pessimistic and, in fact, actual oil price behaviour during this period changes the government's incentives. High oil prices can be considered as one of the main factors for the termination of the Initiative in 2013.

It is then necessary to determine a more accurate valuation of the revenues of the ITT block through the use of a more realistic and updated set of assumptions. We use as a focal date 13 August 2013 (i.e. when the Initiative was terminated). We use the official assumptions provided by Petroamazonas (2010), Larrea (2010), and Ministerio Coordinador de Política Económica (2013) as follows: 1) an expected oil production of 846 million barrels; 2) operation and transportation costs of the oil drilling operation of US$15 per barrel; 3) a production period of 23 years; 4) an initial investment of US$5.5 billion; and 5) a participation in the profits of 47 per cent for the Ecuadorian government. For the average oil price during the life of the project we use three scenarios: US$70 per barrel (pessimistic), US$80 per barrel (most likely), and US$91.70 per barrel (optimistic). We use three different discount rates: 9 per cent, used by the Ecuadorian government (Ministerio Coordinador de Política Económica 2013), and 6 per cent, and 12 per cent, used by Larrea (2010). Table 1 presents the NPV of oil revenues under these parameters. The results show that there is no case where the ITT Initiative is incentive-compatible (NPV less than US$3.6 billion). In all cases, the compensation would never have been high enough to enable the government to meet its pledge to keep the oil underground indefinitely.

[2] For a summary of these assumptions and a transcript of a speech by the then Minister of Energy, Alberto Acosta, promoting the ITT Initiative, see: http://sef.umd.edu/sef2007.html (accessed September 2014).

[3] For its 2007 budget, the Ecuadorian government set a price of US$35 per barrel of oil, which would seem consistent with the price used in the Initiative. However, by mid-2007, when the Initiative was launched, the price was already edging over US$60 per barrel (see Figure 4).

Table 1: NPV of oil revenues from exploitation of the ITT block (billions of US$)

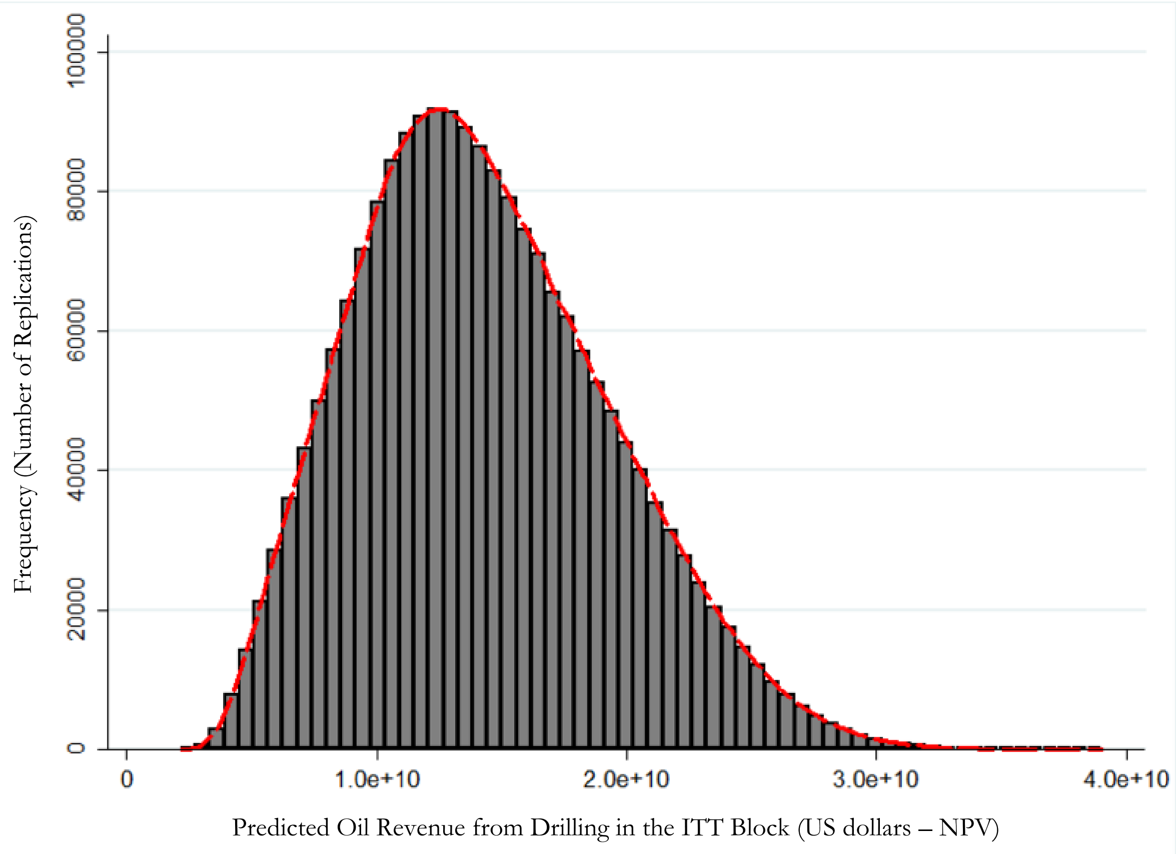
Discount rate (%)	Average price of oil (US$ per barrel)		
	70	80	91.7
6	11.2	13.4	16.1
9	8.7	10.5	12.6
12	6.9	8.3	10.1

Source: Authors' calculations.

For the Monte Carlo simulations of the valuation of oil extraction revenues we introduce some additional assumptions as follows: 1) the total amount of oil reserves is uncertain, so we use the range of reserves from Petroamazonas (2010), namely 412 million barrels of proven, 846 million barrels of probable, and 1,531 million barrels of possible reserves; 2) as the bargaining power and contract conditions for oil exploitation are not certain, we assume that participation in the profits for the Ecuadorian government ranges between 40 per cent and 50 per cent; 3) the production and transportation costs range between US$11 and US$19 per barrel; 4) the discount rate ranges between 6 per cent and 12 per cent; and, 5) annual average oil prices for the period 2007–12 are derived from the WTI oil price series observed in the NYMEX market, for 2013–17 from the NYMEX WTI oil forecast, and for 2018 and beyond the price assumptions of Larrea (2010) and Ministerio Coordinador de Política Económica (2013); that is, a range between US$70 and US$91.70 per barrel, for which we apply a discount of 5 per cent.

Simulation results in Figure 2 show that the probability of the ITT Initiative being incentive-compatible (i.e. oil revenue less than US$3.6 billion) is 0.044 per cent. This confirms our claim that the designers of the ITT Initiative greatly underestimated the potential oil revenues of the ITT block and, as a result, claimed a low level of compensation relative to the true opportunity cost of keeping the oil underground. This originated contradictions and conflicts in the management of the ITT Initiative and offered no long-term security about its permanence either from a financial perspective or in political terms.

Figure 2: Density distribution of the NVP of the expected oil revenue from the ITT block



Note: The density distribution is the result of one million replications.

Source: Authors' calculations.

Valuation of the YGCs revenue

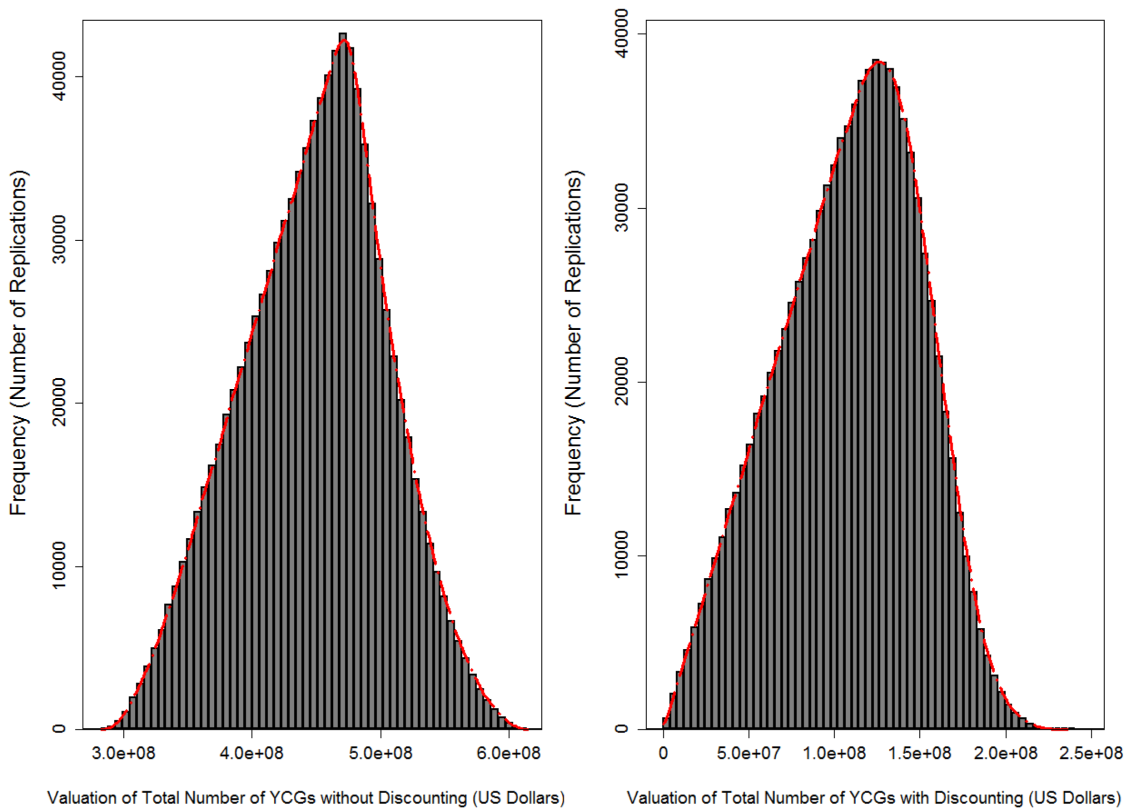
The other component required to examine the financial feasibility of the ITT Initiative is the valuation of the YGCs. We use as a proxy the market conditions (observed and predicted) for CERs in the EU ETS market. We explore two scenarios, the first where no price discount occurs and the second where we apply the discounts from Section 2.1. The assumptions used in this section are as follows: 1) the period of YGCs emission or fund collection is 13 years; 2) the maximum number of YGCs issued by the government is 407 million; 3) the sales success rate is 100 per cent (i.e. all the YGCs are sold and traded); and 4) the price of the YGCs is equal to the price of CERs in the EU ETS market. For the last assumption we use the historical prices of the instrument from 2007–13 and for the period 2014–20, the forecast price provided by Thomson-Reuters.

Figure 3 shows the density distribution of the NPV of the expected YGCs revenue. The left panel shows results when no price discount is applied to the YGCs, while the right panel shows results for price discounts between 60 per cent and 100 per cent. Under the no price discount scenario and for a discount rate of 9 per cent, the NPV of YGCs revenue is US$544 million. For discount rates of 6 per cent and 12 per cent, the NPV is US$616 and US$484 million, respectively. That is, even without any price discount, the funds that could have been raised using carbon market mechanisms are much lower than the target compensation of US$3.6 billion. To analyse the impact of the price discounts on the YGCs valuation, we further assume that the sales success rate varies between 70 per cent and 100 per cent, and that the discount rate ranges between 6 per cent and 12 per cent. The probability of the Ecuadorian government raising US$3.6 billion through the Initiative is zero, regardless of the YGCs price discounting (i.e. using either CER as the twin security of the YGCs).

The most likely amount of funds that could have been raised is US$449 million with no discount on YGCs prices, and US$109 million with price discounts. An interesting result is that the value actually pledged to the Yasuni Trust Fund (US$336 million) was within the range of our valuation of the YGCs (US$109–449 million). In addition, with YGCs price discounting, the probability that the YGCs would be valued at US$336 million is 0 per cent, indicating that international donors discounted the YGCs at a lower rate than we have considered appropriate in this paper (i.e. between 60 per cent and 100 per cent). Specifically, donors discounted the price of YGC bonds at 40 per cent approximately. This shows that the willingness of the international community to contribute to the Initiative was mainly for altruistic reasons.

The introduction of additionality to the valuation would render the ITT Initiative completely valueless. This further reinforces our findings and conclusion that donors contributed more than could have been expected according to a rational-economic perspective. The altruistic behaviour of international investors is clear because worldwide there were different donation opportunities available, most of which offered higher returns and lower risk.

Figure 3: Density distribution of the NPV of the expected YGCs revenue



Note: Each density distribution used one million replications.

Source: Authors' calculations.

3 A new Yasuni-ITT Initiative

Following the termination of the ITT Initiative, considerable public debate continues and concern for the preservation of the YNP remains an important issue. There is still a strong public feeling that oil extraction should be stopped and that the original Initiative should be restored. However, we argue that no practical implementation steps exist that guarantee the success of the original Initiative. Hence, we propose the adoption of a new ITT initiative, as outlined below.

3.1 The model

We use the static framework of Harstad (2012b), which entails a coalition of (Kyoto Protocol Annex-I) countries purchasing or leasing the rights to exploit the fossil-fuel deposits in non-coalition countries. That is, the property rights to the oil deposits are transferred to the coalition, which prefers not to extract oil in order to prevent leakage effects when non-coalition countries free ride on the environmental policies of the coalition.

Consider a cost function $C_i(x_i)$ of producing or extracting x_i units of oil, and a benefit function $B_i(y_i)$ of consuming y_i units of oil, for all i countries. $C_i(x_i)$ is an increasing strictly convex function, while $B_i(y_i)$ is an increasing and concave function. $C_i(x_i)$ orders a country's deposits according to their extraction costs. This ordering is natural as a country that is extracting x_i units would prefer to first extract the deposits that have the lowest extraction costs. M denotes the coalition countries, which are assumed to act as a single agent, and N represents the set of non-coalition countries. The maximization problems for $i \in N$ (e.g. Ecuador) and M are, respectively:

$$\max_{x_i, y_i} B_i(y_i) - C_i(x_i) - p(y_i - x_i), \quad \forall i \in N$$

$$\max_{p, x_M} B_M(y_M) - C_M(x_M) - p(x_M - y_M) - H\big(x_M + S(p)\big)$$

where the harm, $H(\cdot)$, experienced by M, is a strictly increasing and convex function. Similar to Harstad (2012b), for simplicity we assume that only M takes the environmental harm into account in the objective function. Equilibrium conditions in the oil market lead the equilibrium price, p, to equal the marginal benefit of consumption and the marginal cost of extraction such that $B_i'(y_i) = p \to y_i = D_i(p) \equiv B_i'^{-1}(p)$, and $p \in C_i'(x_i) \to x_i = S_i(p) \equiv C_i'^{-1}(p)\ \forall i \in N$. These conditions imply that $y_M = x_M + S(p) - D(p)$ where $S(p) \equiv \sum_N S_i(p)$ and $D(p) \equiv \sum_N D_i(p)$.

Let a deposit ordered between, say, x_i' and x_i'', be characterized by its size or fossil-fuel content, $\Delta \equiv x_i''$-x_i', and by a marginal extraction cost $c \equiv [C_i(x_i'') - C_i(x_i')]/\Delta$. At this stage, while $C_i'(\cdot)$ describes i's marginal extraction cost, given a set of deposits, c represents the actual extraction cost for a specific but small (marginal) deposit. Different marginal deposits have different c's, and when ordering country i's deposits according to costs, the cost correspondence is given by $C_i'(\cdot)$, whereas $C_i'(x_i)$ is the actual marginal cost when x_i units are extracted. The deposit is owned by $i \in N$, and if the marginal exploitation cost is such that $c < p$, then $i \in N$ would prefer to exploit the deposit.

Coalition $M's$ equilibrium policy means that $B_M'(y_M) - H' \in C_M'(x_M)$, implying that M would prefer to exploit the deposit if and only if $B_M'(y_M) - H' \geq c$. If $c + H' < B'(y_M)$, the deposit will be exploited, whether owned by i or M. If the right to exploit the deposit is transferred from

i to M, i saves the extraction cost but loses some profit. Thus, for a given p, the utility of $i \in N$ becomes:

$$U_i = \max_{x_i, y_i} B_i(y_i) - C_i(x_i) - p(y_i - x_i) - (p - c)\Delta, \quad (2)$$

We use the envelope theorem to differentiate (2), such that

$$\frac{dU_i}{d\Delta} = c - p - (y_i - x_i)\frac{dp}{d\Delta} \quad (3)$$

Similarly, $M's$ utility becomes

$$U_M = \max_{p, x_M} B_M(y_M) - C_M(x_M) - p(x_M - y_M) - H\big(x_M + S(p)\big) + (p - c)\Delta \quad (4)$$

We differentiate (4) with respect to Δ, and through the envelope theorem, such that

$$\frac{dU_M}{d\Delta} = p - c \quad (5)$$

Thus, the transaction of the deposit increases $U_M + U_i$ if $(x_i - y_i\ )dp/d\Delta > 0$ when $c + H' < B'(y_M)$.

If $c \in [B'_M(y_M) - H', p]$, i would exploit the deposit, but M would not. If the deposit is transferred from i to M, $i's$ payoff changes in line with (3). For a given p, the non-coalition's total supply changes from $S(p)$ to $S(p) - \Delta$. Thus, $M's$ utility can be written as:

$$U_M = \max_{p, x_M} B_M(y_M) - C_M(x_M) - H(x_M + [S(p) - \Delta]) + p(D(p) - [S(p) - \Delta]) \quad (6)$$

We use the envelope theorem and differentiate (6) to get

$$\frac{dU_M}{d\Delta} = -B'_M(y_M) + H' + p \quad (7)$$

Hence, the transaction of the deposit increases $U_M + U_i$ if $c - B'_M(y_M) + H' - (y_i - x_i\ )dp/d\Delta > 0$ when $c + H' \geq B'(y_M)$. For a third country, the transaction between M and i generates the additional benefit $(x_i - y_i\ )dp/d\Delta,\ j \in N\backslash i$, where $dp/d\Delta > 0$.

In summary, if $i \in N$ transfers the deposit to M, then

a) $U_M + U_i$ increases if and only if

$$\max\{0, c + H' - B'_M(y_M)\} + (x_i - y_i)\frac{\partial p}{\partial \Delta} > 0$$

b) $\sum_{M \cup N} U_i$ increases if and only if

$$\max\{0, c + H' - B'_M(y_M)\} + \sum_{N}(x_i - y_i)\frac{\partial p}{\partial \Delta} > 0$$

3.2 The YNP in the market of deposits

We propose that the YNP (and, consequently, its oil deposits) can be analysed within the framework of Section 3.1.

The public debate is divided between the preservation of the YNP and Ecuador's need for the foregone oil revenues. This debate is resolved through the sale or leasing of the rights of extraction to a coalition that may be interested in keeping the oil underground. The revenue raised through this transaction may be taken as a form of compensation for the ecosystem services provided by the YNP. To estimate the price for the transaction of the oil deposit, we rely on Pethig and Eichner (2015). Suppose that the deposit price is p_z. If $p_z = p$, then all non-coalition countries offer for sale all deposits with extraction costs $c \leq p$ because the revenues from selling those deposits are higher than the profit in the absence of deposit trading (i.e. no leasing or sale of oil extraction rights). Thus, the oil price p is an upper bound for the deposit price p_z. If $p_z > p$ the coalition will not accept this price since it can purchase non-coalition countries' profitable deposits at $p_z = p$. Finally, if $p_z = 0$, no country gives away for free any deposit with extraction costs $c < p$, because the extraction of those deposits generates a profit. Hence, $p_z \in [0, p]$, that is, the transaction is linked only to the dynamics of the oil prices. Then, the revenue from the trade of the deposit would need to be negotiated and agreed between the parties on, say, a yearly-basis, for which financial instruments (e.g. futures) may be used to facilitate the transaction. The revenues from the transaction of the extraction rights are thus variable but their calculation is more transparent than the claimed compensation in the original ITT Initiative (i.e. US$3.6 billion).

The cost function $C_i(x_i)$ orders the deposits according to the costs of extraction, and those deposits with high extraction costs are preserved because of their unprofitability. For the YNP we do not know exact extraction costs, but it is reasonable to assume these are not negligible, given the remote location of the deposit. Moreover, given the fragility of the YNP's ecosystem and the risk of significant environmental harm, $c \in (B'_M(y_M) - H', p)$ still holds as long as the coalition internalizes the harm independently of the oil price.

Finally, we may further assume that the size of the deposit is not large enough to affect oil prices, so that $\partial p/\partial \Delta = 0$. For Ecuador and the coalition to benefit from the transaction of the deposit, $c \in (B'_M(y_M) - H', p)$. Thus, the coalition will keep the oil underground since the revenues gained by exploiting it are less than the costs to offset/mitigate the environmental harm from its extraction.

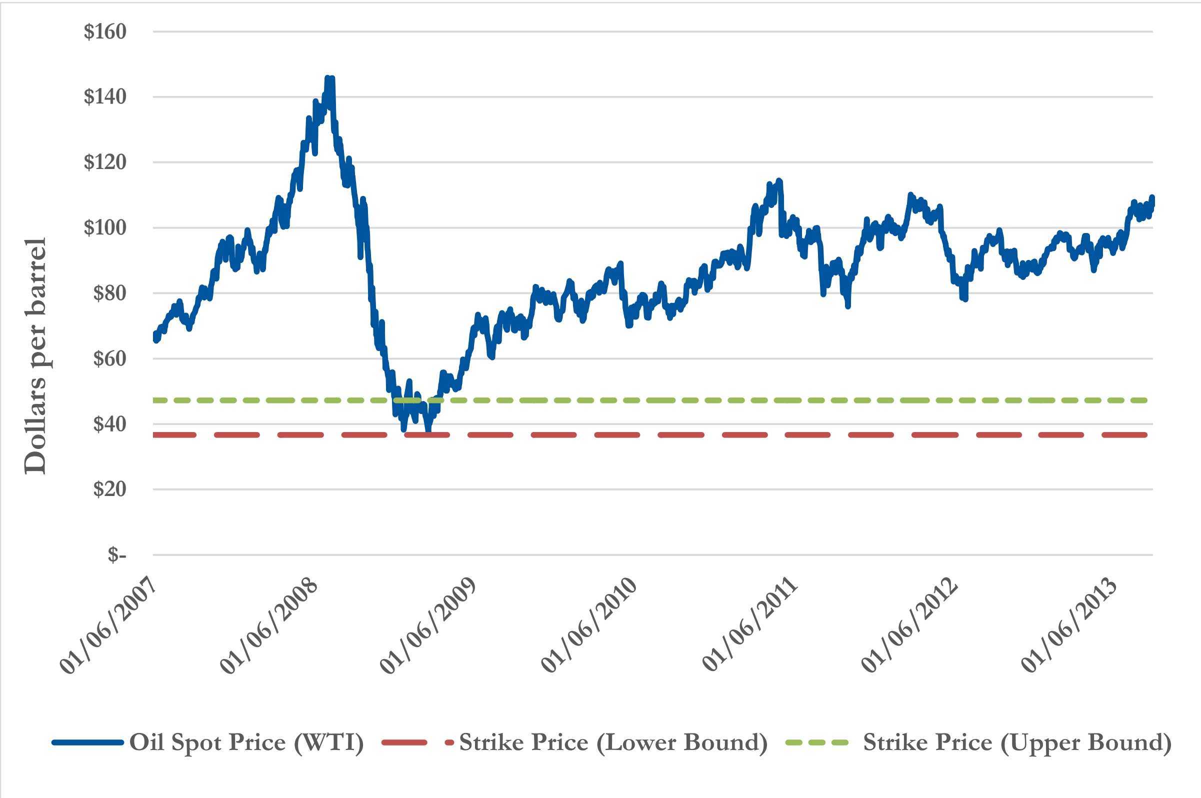
Our financial approach incorporates the marginal harm H' and provides a wider set of conditions for which the YNP may be preserved. In this sense, it is a more informative and simplified approach than the original ITT Initiative.

3.3 Financial issues and implications

The main implications of our theoretical model are as follows: 1) our proposal effectively reduces the counterparty risk (i.e. the risk of default or non-compliance) because of the direct transfer of property rights (the extraction rights) from the Ecuadorian government to investors or donors (the coalition), and 2) our proposal constructs a realistic appraisal (i.e. mark-to-market) of the ITT-block oil reserves.

The ITT Initiative may be considered a forward contract that is contingent on the price of oil, with indefinite maturity and a strike price of US$36.64 (US$47.24) at a discount rate of 6 per cent (12 per cent) (Figure 4). Based on our simulations and the increase in oil prices observed between June 2007 and August 2013, this contract was in-the-money (i.e. it generated value to the Ecuadorian government) only 0.6 per cent (4.4 per cent) of the time. This situation was exacerbated by the non-permanent nature of the commitment to keep oil underground (commonly labelled as Plan B) so that, from the perspective of the investors/donors, there was a high counterparty risk, which made the Initiative unattractive from a financial point of view. Our proposal, however, effectively reduces the counterparty risk because of the direct transfer of the property rights from the Ecuadorian government to the coalition. This transaction aligns the incentives of both parties: the government succeeds in keeping the oil underground for a fair compensation obtained from selling property shares of the ITT block, and the coalition obtains an asset at its fair value with a perspective of revalorization over time. Furthermore, as we proved in Section 3.2, for both parties their optimal strategy consists of delaying oil extraction in order to capitalize the value of the ITT block, which was, in fact, the objective of the ITT Initiative in the first place.

Figure 4: WTI crude oil spot price and strike prices of ITT Initiative as forward contract (June 2007–August 2013)



Source: Authors' illustration based on data from Federal Reserve Bank of St. Louis (n.d.)

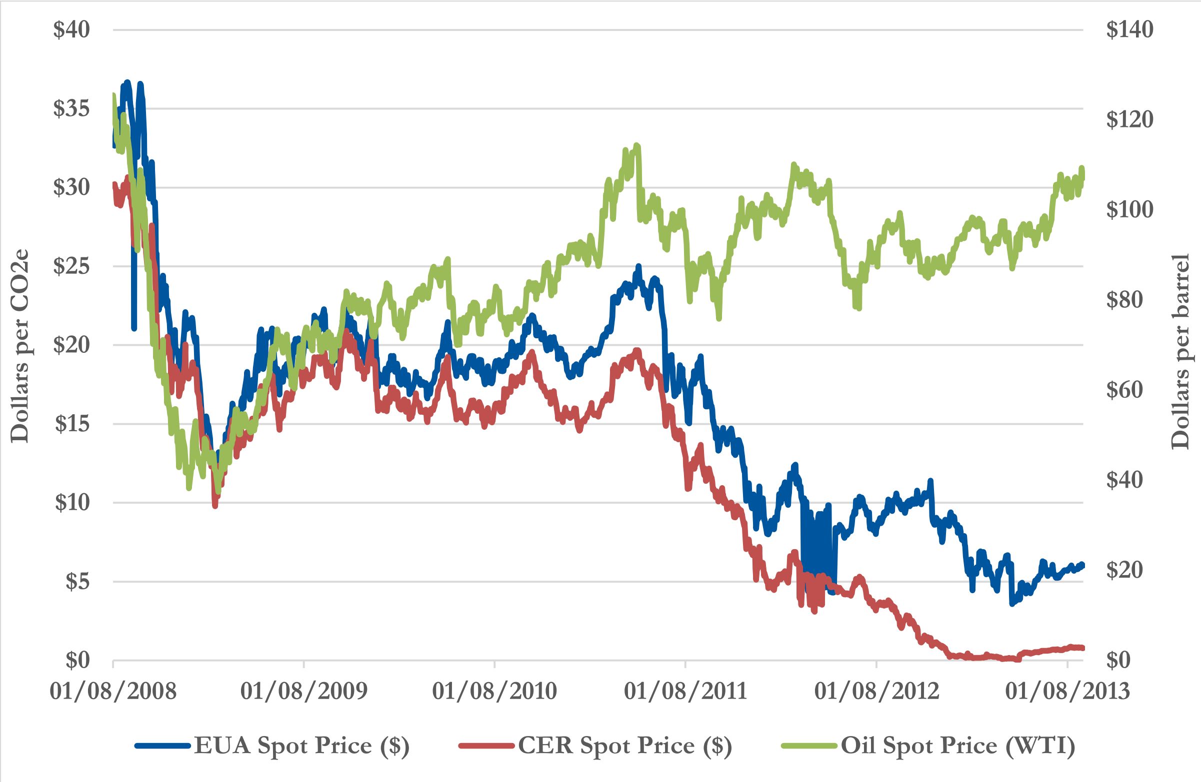
In 2010, the ITT Initiative was restructured to make it more attractive to investors/donors. The objective was to reduce the (non-compliance or default) risk by framing the Initiative as a carbon offset instrument to be implemented through an independent Trust Fund. The TOR established that the Initiative should be valued based on the YGCs and that if the Ecuadorian government failed on its promise, the bond holders would be reimbursed at the YGCs' face value.[4] It remains an open question if these provisions actually helped to reduce the counterparty risk, but it is clear that the incentives were never appropriate either for the donors/investors or for the Ecuadorian government.

The main factor that negatively affected the incentives was the structure of the Initiative, and the estimation of its fair value. On one hand, for the Ecuadorian government, the value of the Initiative (particularly its opportunity cost) was linked to the foregone oil revenues from the ITT field. As the price of oil increased, the opportunity cost of the Initiative also increased, making it less likely for the Ecuadorian government to keep its promise. On the other hand, for the donors/investors the value of the Initiative derived from two sources: 1) an intrinsic value related to their altruistic behaviour, and 2) the possibility of trading the YGCs. Figure 5 shows that until late 2009 the behaviour of carbon credits followed closely the behaviour of oil prices. From late 2009 onwards, however, the two markets showed a tendency to divorce from one another. In particular, while oil prices show a tendency to recover following their fall during the financial crisis, the prices of carbon offsets remain flat until 2011 when they experienced a dramatic fall. In other words, from 2011 the value of the ITT Initiative for the Ecuadorian government declined because oil extraction became more valuable, while for the investor/donors the value of the Initiative decreased because hypothetically the YGCs became less valuable in the carbon market. Hence, the strategy of incorporating carbon offsetting did not eliminate an important problem, because by definition the YGCs did not allow mark-to-market of the fair value of the Initiative from both the perspective of the government of Ecuador and that of the investors/donors. Our approach resolves this incompatibility of incentives between the government and the coalition by setting an unambiguous and realistic appraisal of the ITT-block oil reserves: linking its fair value only to oil prices.

Furthermore, we gain in simplification as we do not need complex valuations of the ecosystem services of the YNP in order to set up the transaction of the property rights within this market setting.

[4] Note that according to the TOR, the YGCs did not earn interest.

Figure 5: Spot prices of WTI crude oil, EUAs and CERs (August 2008–August 2013)



Source: Authors' illustration based on data from Thomson-Reuters EIKON (n.d.).

4 Discussion

The ITT Initiative sought to become an innovative instrument for the mitigation of GHG emissions and climate change. Its main premise was to keep oil underground in exchange for a monetary compensation equivalent to half of the foregone oil revenues, i.e. US$3.6 billion over a period of ten years. Despite the interest and support it garnered after its announcement, the Initiative was terminated in 2013 because of its inability to collect the requested compensation. Numerous authors still defend the Initiative and argue that it should be reinstated and serve as a model to other countries.

In this paper we prove that the ITT Initiative was severely flawed since its inception. Not only was it infeasible from a financial perspective, but it also lacked sound theoretical grounds that would make it credible and compatible to the incentives of potential donors or investors. Thus, there was no possibility that the compensation could have been raised. First, the YGCs did not have any financial value because they did not comply with any of the CDM/REDD+ criteria (i.e. permanence, additionality, non-leakage, and certainty) to be considered equivalent to the CERs and be part of carbon markets. Second, although donors' contributions went further than could have been expected according to a rational-economic perspective, a higher level of altruism would have been required to reach the requested compensation.

We propose a theoretical and practical framework for the development of a 'New ITT Initiative' based on Harstad (2012b). Our main premise is the sale or transfer of the property rights to the ITT fields from the Ecuadorian government to a coalition of countries or parties that would be interested in keeping the oil underground. We develop conditions for the maximization of the utility for both parties. In particular, we prove that the price for this transaction is linked to the behaviour of oil prices.

Several caveats should be mentioned, however. First, the Ecuadorian government claims that oil activities would only affect 0.01 per cent of the Reserve. In this case, the coalition would not be motivated to preserve that share of the Reserve given its negligible size.[5] Second, our approach does not resolve the non-additionality of the ITT Initiative: that is, the YNP has been a protected reserve for decades and no further efforts should be invested in what is supposed to be a commitment from the Ecuadorian government. Third, we acknowledge that our proposal is not free of controversy, particularly for a country and government that might claim that the lease/transfer of the oil fields would be a violation of national sovereignty.

Finally, there are several political and practical implementation considerations, where many issues may still appear. Most importantly, there are two aspects of our proposal that need to be considered: 1) the make-up of the coalition and its ability to coordinate, and 2) the guarantee of the rights to oil fields.

Consider first the make-up of the coalition. While the proposed transfer of rights reduces the counterparty risk, it comes at the cost of creating a coordination problem on the demand side. From the perspective of the coalition members, it makes sense to acquire rights to the oil fields only if they trust that the other members will also do so and that they will keep the oil underground. If oil starts being extracted by any one of the members, or if they sell their rights to an oil producer, the value of the others' rights will fall. Thus, the counterparty risk is indeed transferred from one actor (the Ecuadorian government) to multiple actors (the members of the coalition). This is important because it can create a hold-up problem: anticipating the inability of other members to commit not to exploit oil in the YNP, each member decides not to acquire rights to the oil fields in the first place. Besides, the non-additionality of oil extraction from the YNP also limits the incentives of the coalition members to buy these rights.

This problem can be solved in various ways. Of course, if the coalition is formed by only one member (e.g. a single country), the hold-up problem disappears. This suggests that a possible solution might be to craft a contract allowing only one buyer, e.g. by means of an auction. However, it seems unlikely that one single member of the coalition would be willing to assume full responsibility for the YNP, which brings us back to the standard case of a coalition comprised of several members. In what follows we discuss two elements that can help reduce the hold-up problem under this assumption.

First, suppose that before the transfer of property rights takes place there is an opportunity for coalition members to (credibly) signal their commitment to the proposal. This signal could come for instance from their current commitments regarding the Intended National Determined Contributions (INDCs) under the UNFCCC, or from their previous achievements on emission reductions. Using this information, the transfer contract could restrict participation only to those countries that have reduced emissions beyond a particular level in the past and whose promises for further reductions surpass a specific threshold. Alternatively, the contract could provide incentives for the members satisfying these conditions such as deductions from the buying price.

Second, to limit the incentives to breach their commitments, the contracts could establish clauses explicitly disallowing oil extraction by the members of the coalition as well as the sale of rights for that purpose. In the case of violations, the contracts could specify damage payments

[5] See Reuters (2013).

following a Pigovian structure that would impose a payment on those reneging on their promises equal to the social cost generated (i.e. the fall in the value of other members' rights).

Consider next the guarantee of rights to oil fields. The fact that the fields remain under the geographic domain of the Ecuadorian government implies that a risk of expropriation exists even after the transfer of rights. While it is not easy to eliminate, the experience with oil contracts provides important insights about possible ways to reduce this risk. In the past, oil companies have recurred to international settlement mechanisms to solve disputes with governments in cases of expropriation. An important case is the recent settlement of the Ecuadorian government with Occidental Petroleum Corporation—Oxy. After nine years of litigation, the International Centre for Settlement of Investment Disputes (ICSID) concluded that the actions of the Ecuadorian government vis-à-vis Oxy back in 2006 amounted to expropriation and established a compensation of around US$1 billion that the Ecuadorian government has agreed to pay. While the process was slow and costly, it shows that if the transfer of rights to the oil fields can be framed within the rules of investment protection governing this type of contracts, the ICSID can serve as a third-party guarantor of those rights.

The proposed tools for implementing our proposal have the added advantage of providing a better commitment mechanism for the Ecuadorian government to signal compromise and to establish a reputation for protecting the environment. A question that remains is under what circumstances the Ecuadorian government would accept such limitations, especially in light of the experience with the ITT initiative. This will occur only if and when the Ecuadorian society demands it.

5 Conclusion

In this paper we presented a new ITT Initiative which is much more transparent and simplified than the failed original ITT Initiative. In our initiative, transparency is gained because the transaction uses existing financial mechanisms through forward contracts on oil prices, and does not require the creation of instruments such as the YGCs.

Our proposed initiative is also more flexible, as the negotiations for the lease/transfer of the oil fields may involve the terms and time horizon of the contract, so the compensation may be calculated on a period-by-period basis according to the behaviour of oil markets. This feature was not present in the original ITT Initiative because it involved a lump-sum payment that confounded oil revenues and the valuation of ecosystem services. The simplified nature of our proposal relies on the fact that the ITT Initiative lacked estimates of the marginal change of ecosystem services given the impact of oil extraction. However, a monetization proxy was attributed through the oil revenues foregone. That is, as implied by the TOR, the valuation of the ecosystem services of the whole YNP is approximated with the foregone oil revenues. Conceptually, this is not correct as it oversimplifies the complexity of the biodiversity of the reserve. Thus, a thorough (and complicated) valuation experiment would be necessary. Had this experiment been carried out, it would have improved decision-making and informed potential donors. Yet, in spite of the major advances in the valuation literature, it remains controversial whether the valuation would have comprehensively captured the nature of the YNP. Hence, another advantage of our proposal is that there is no need to complete this valuation in order to keep the oil underground, but only to guarantee the transaction of the oil fields and the enforcement of the lease/transfer.

The fair value of our proposal would mark-to-market at oil prices, aligning the incentives of the Ecuadorian government and the coalition members. And finally, the counterparty risk is reduced because our proposed strategy entails the effective transfer of property rights to the coalition.

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