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Pricing Forest Carbon: Implications of Asymmetry in Climate Policy

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Abstract

In this paper, we use an integrated assessment model to examine the implications of not recognizing, and partially recognizing forest carbon in climate policy. Specifically, we investigate the impact of an asymmetric carbon policy that recognizes emissions from fossil fuels while ignoring emissions from forests. We additionally investigate the relative importance of not recognizing positive emissions from a reduction in the stock of forest biomass, or of not recognizing negative emissions from the growth of forest biomass. We show that asymmetric carbon policies lead to lower levels of welfare, as well as higher emissions and carbon prices. This occurs because the forest resource will be allocated inefficiently under these carbon policies. Broadly, we find that when the social planner does not account for neither positive or negative forest emissions, the planner will set bioenergy levels that are too high and afforestation and avoided deforestation levels that are too low. Our results further reveal that not recognizing forest emissions leads to larger welfare losses than not recognizing sequestration.

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1 Introduction

This paper uses an integrated assessment model, that accounts for the dynamics of the forest, to investigate the effectiveness of climate policy when positive and negative (sequestration) emissions of forest carbon are not recognized or only partially recognized by policy makers. Specifically, we will consider two asymmetric carbon policy regimes. In the first regime, which resembles the current state of climate policy, policy makers will take into account carbon emissions from fossil fuel but will not take into account either emissions or sequestration from forests. In the second regime, we will establish the relative importance of not recognizing forest emissions in relation to not recognizing carbon sequestration from forests.

Recently, policy makers have begun to coalesce around the idea of pricing carbon. In theory, a dynamic Pigouvian tax, which amounts to the marginal cost of carbon in the optimal emissions path, could fully internalize the adverse effects of carbon emissions. As all sources of carbon emissions are equal in terms of climate impact, the carbon price should be universal. However, a global carbon price covering all emissions is far from reality.

In practice, policy makers have favored levying taxes on fossil energy, while taxation of other emissions, such as those from bioenergy production, have been to a large extent disregarded. As shown by Lundgren et al. (2008) in a theoretical setting, this asymmetry in carbon policy leads to a distortion of the price differential between fossil energy and bioenergy which results in too high levels of bioenergy being produced. At the heart of this debate is the question of whether bioenergy production is carbon neutral. Previous literature has shown that treating bioenergy as carbon neutral will underestimate the negative climate impact of bioenergy production (e.g., Searchinger et al. (2009); Cherubini et al. (2011)). This occurs because bioenergy production is not carbon neutral in the short run. The release of carbon from bioenergy production is instantaneous, while sequestration via biomass growth occurs over time. Lundgren and Marklund (2013) show that policies that rely on the carbon neutrality assumption are misleading and can lead to a reduction in welfare.

Lundgren et al. (2008) also highlight that pricing carbon requires not only taxing all emissions including those from bioenergy but also subsidizing at the same rate negative emissions from forest growth. From the bioenergy policy debate, it is thus clear that policies that aim to price carbon, risk falling short in two respects. First, by limiting the scope of sources of emissions. Second, by encouraging efforts to reduce emissions, while not valuing efforts to increase carbon sequestration.

Under the assumption that policymakers fully recognize forest carbon, the forest can play a key role in climate policy both through fossil-fuel substitution and carbon sequestration in biomass. In a review of sequestration cost studies, Richards and Stokes (2004) conclude that different forestry practices to increase carbon sequestration can significantly and cost-effectively reduce atmospheric carbon. However, as highlighted by another strand of the literature, there are various synergies and trade-offs between policies that incentivize the use of biomass for fossil-fuel substitution and those to increase the stock of biomass for carbon sequestration (e.g., Lecocq et al. (2011); Kallio et al. (2013)). It is therefore of particular importance to analyze the role of the forest and asymmetric policy regimes, in a framework that accounts for these trade-offs as well as the interactions between the various climate policies.

In this paper, we use such a framework to further develop the intuition of the bioenergy literature as discussed by Lundgren et al. (2008). Specifically, we extend the discussion in two ways. First, we use an integrated assessment model that accounts for the dynamics of the forest. This framework allows us to provide estimates of the price of carbon under optimal and asymmetric policy regimes. Second, we take the discussion of asymmetric carbon policy to a broader category of forest controls, which besides bioenergy harvest also includes avoided deforestation and afforestation. These controls are especially important as the amount of forest land is directly related to the potential to increase forest biomass and thus bioenergy harvest. More broadly, including this controls, allows us to increase the scope of the analysis, as we are now able to study the dynamics and the interactions between various controls capable of altering the stock of forest biomass.

Using an extended version of the FOR-DICE (Eriksson, 2015), we investigate the impact of two types of asymmetric carbon policy regimes. In this model, the social planner maximizes welfare by choosing the level of forest controls in addition to savings and energy abatement. In the first asymmetric policy regime, the social planner does not account for positive or negative forest carbon emissions when choosing the level of the forest controls. In the second regime, we investigate two variations: in the first variation, the planner accounts for negative emissions from forests but not for positive emissions. In the second variation, the planner accounts for positive emissions from forests but not for negative emissions. These regimes are compared against the optimal case where the social planner fully recognizes all sources and types of emissions considered in the model.

The model provides three key findings: First, asymmetric carbon policy regimes lead to considerable distortions in the allocation of forest resources. Specifically, not accounting for emissions or sequestration from forests will lead to levels of bioenergy harvest that are too high, and to levels of afforestation and avoided deforestation that are too low. This inefficient allocation leads to the lowest level of welfare, the highest emissions, and the highest carbon prices. Second, while it is always preferable to account for both positive and negative forest emissions in carbon policy, we can avoid the largest welfare losses, and achieve close to optimal levels of total emissions, by just accounting for forest emissions. Third, our back of the envelope calculation, on the optimal forest tax and subsidy scheme, indicates that the cost of the subsidy would outpace the revenue from taxing forest emissions. However, this subsidy could be financed by a broader tax policy that also include revenues from taxing fossil fuels.

The paper is organized as follows: Section 2 presents briefly the integrated assessment model that is used. Section 3 presents the main findings from the analyzed scenarios, as well as a discussion. Finally, Section 4 offers some concluding comments and direction for future research.

2 The Integrated Assessment Model

This paper uses a version of the FOR-DICE model by Eriksson (2015). The FOR-DICE model is an extension of the DICE-2007 (Nordhaus, 2008). FOR-DICE key extensions include the modeling of the global forest biomass and the introduction of forest controls. In this section, we briefly describe the main features of the framework and the channels of forest carbon emissions. The reader is referred to Eriksson (2015) for further details on the model.

FOR-DICE is a global neoclassical economic growth model where carbon emissions, via the global mean temperature, affects the economic output through a damage function. Total carbon emissions come from fossil carbon and forest carbon net of sequestration. The objective function of the FOR-DICE is the present value sum of all future utility of consumption. A social planner maximizes the objective function by choosing the levels of investment, abatement, bioenergy harvest, and avoided deforestation. In this paper, we additionally extend the controls of the FOR-DICE model by including afforestation.

Energy in the FOR-DICE is a perfect complement to the Cobb-Douglas production function of capital and labor. Total energy consists of non-carbon based energy and carbon-based energy. Non-carbon energy is represented by abatement and corresponds to all types of energy that are not based on carbon sources.[1] Carbon energy consists of fossil energy and forest bioenergy. Specifically, carbon energy is produced by a constant return to scale Cobb-Douglas function of fossil fuel carbon and of bioenergy harvest from each of the types of forest.[2]

The model has three types of forest stocks: tropical forest, temperate forest, and boreal forest. The dynamics of each of these stocks of biomass follows a logistic growth function formulation. The growth rate of the forest biomass is close to its intrinsic growth rate when the stock is small and decreases as the stock approaches its carrying capacity. Accordingly, while removing forest biomass will decrease the size of the stock, it will have a positive impact on the growth rate. In this model, total removals consist of harvest for goods and services and harvest for bioenergy.[3]

[1] Non-carbon based energy are, for instance, solar and nuclear power.

[2] The Cobb-Douglas function implies an imperfect substitution between bioenergy harvest and fossil fuel carbon which requires each of these inputs to be strictly positive, as long as the global economy remains dependent on carbon energy. While this assumption is limiting, it avoids the unrealistic case of perfect substitution between these inputs.

[3] Harvest to produce goods and services other than energy in the FOR-DICE is exogenous and grows linearly with labor. This simplification implies that the demand of biomass for energy and climate purposes are subordinate.

Besides harvest, forest stocks are also affected by changes in forest area.[4] Ongoing deforestation is reducing the forest area and the stock of forest biomass in the tropics. In the FOR-DICE, baseline deforestation is exogenous and declining over time, following the path of emissions from land in the DICE-2007 model. This baseline deforestation can be reduced by the deforestation control variable.[5] The cost of the deforestation control in FOR-DICE is derived from estimates by Kindermann et al. (2008). This cost can be seen as a payment to land owners necessary in each period to prevent the conversion of forest land.

The global forest area can also change through afforestation.[6] In this paper, afforestation in the temperate and tropical zone are control variables.[7] The costs of afforestation follow the ones derived in Eriksson and Vesterberg (2016). The marginal costs of afforestation in Eriksson and Vesterberg (2016) are estimated from total agricultural production value per hectares from the Global Agro-Ecological Zones (GAEZ v3.0) geospatial dataset (Fischer et al., 2012). The marginal cost curves of afforestation, like avoided deforestation, are upwards sloping due to the opportunity cost of land. In addition to this cost of land, the total afforestation cost also includes a plantation cost.[8]

Forest carbon emissions are directly linked to the change in the growing forest biomass. Specifically, the forests release carbon through the loss of forest biomass from deforestation and harvest. Conversely, the forests sequestrate carbon through the gain of forest biomass from growth.[9] As previously mentioned, harvest decreases the stock of forest biomass but at the same time increases growth the rate of the stock. Deforestation, on the other hand, both decreases the size of the stock and the carrying capacity such that the dynamics of remaining biomass is unchanged. Afforestation increases the growth of forest biomass through an increased carrying capacity. Since bioenergy harvest and deforestation actions lead to an instantaneous increase of emissions from loss of biomass, in the short run, the climate benefits of reducing these actions will be larger than those of increasing afforestation.

[4]FOR-DICE disregards any potential climate effects on forest growth or forest cover.

[5]The model does not consider leakages, namely, deforestation avoided in one location cannot be reallocated to another location.

[6]Afforestation refers both to the establishment of forests where there has not previously been any forests, and reestablishment of previously forested area.

[7]We exclude afforestation in the boreal zone due to the ambiguous climate benefits of increasing boreal forest cover.

[8]As in Eriksson and Vesterberg (2016), the plantation cost is taken from Nabuurs and Masera (2007).

[9]All carbon in biomass lost through harvest and deforestation is assumed to be released within one decade. This simplification disregards the fact that some of the carbon in wood from deforestation and harvest will be stored in long-lived wood products for a considerable amount of time.

3 Results

This section presents the key results for four scenarios: optimal (OPT), no forest policy (NF), forest sequestration policy (FS), and forest emissions policy (FE). The optimal control scenario represents utility maximization when all control variables are determined optimally. These control variables include capital investment, abatement, and the forest controls (bioenergy harvest, afforestation, and avoided deforestation).

To examine the implications of asymmetric forest carbon pricing, we explore two types of asymmetric policy regimes: The first regime, focuses on an asymmetry between fossil carbon and forest carbon. This asymmetry is explored in the no forest policy scenario (NF) where the forest controls are set without consideration of the role of the forest carbon in the climate cycle. The second regime refers to an asymmetry within the pricing of forest carbon, specifically, between carbon emissions and sequestration by forests. This type of asymmetric carbon policy regime is investigated in the forest emissions policy scenario (FE) and the forest sequestration policy scenario (FS). In these scenarios, the social planner recognizes only forest emissions, or only sequestration, when setting the controls. Table 1 summarizes the main scenarios.

Table 1: Scenarios

Scenarios	
OPT	*Optimal scenario with full climate policy.* Controls are set when recognizing climate damages.
NF	*No forest carbon are included in climate policy.* Controls are set without recognizing the role of forest emissions and sequestration in global emissions.
FE	*Forest carbon emissions are included in climate policy.* Controls are set without recognizing the role of sequestration in global emissions.
FS	*Forest carbon sequestration is included in climate policy.* Controls are set without recognizing the role of forest emissions in global emissions.

The results concerning global carbon emissions from the different scenarios are presented in Figure 1. The figure illustrates clearly that forest carbon plays an important role in the total global emissions. The figure plots the total emissions from fossil fuel and forest carbon over the next 100 years for four scenarios. Figure 1 reveals that recognizing forest carbon in climate policy leads to lower emissions. Furthermore, it is revealed that while the lowest emissions are achieved by recognizing both the sequestration and forest carbon emissions, the largest reductions are the result of taking into account the emissions from loss of forest biomass.

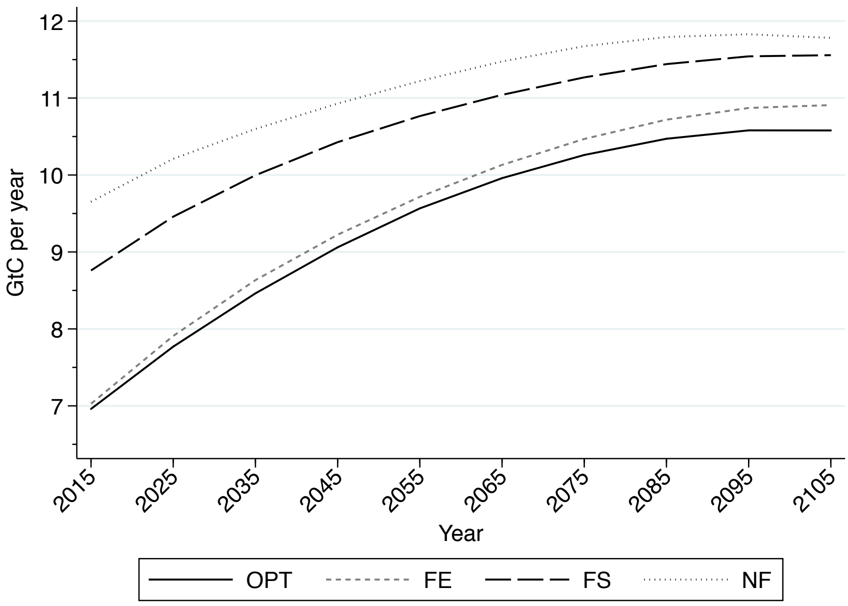

Figure 1: Total global carbon emissions, GtC per year

Figure 2 shows the path of total forest carbon emissions net of sequestration. Consistent with the previous figure, emissions are lowest when both sequestration and forest carbon emissions are recognized. As before, accounting for forest carbon emissions play the largest role. This figure additionally reveals that just recognizing forest carbon sequestration is not enough to offset the release of carbon from not taking emissions from the forest into account. On the other hand, just recognizing the emissions from forests in carbon policy leads to a negative emissions path, in other words, under this scenario the forest acts as a net carbon sink.

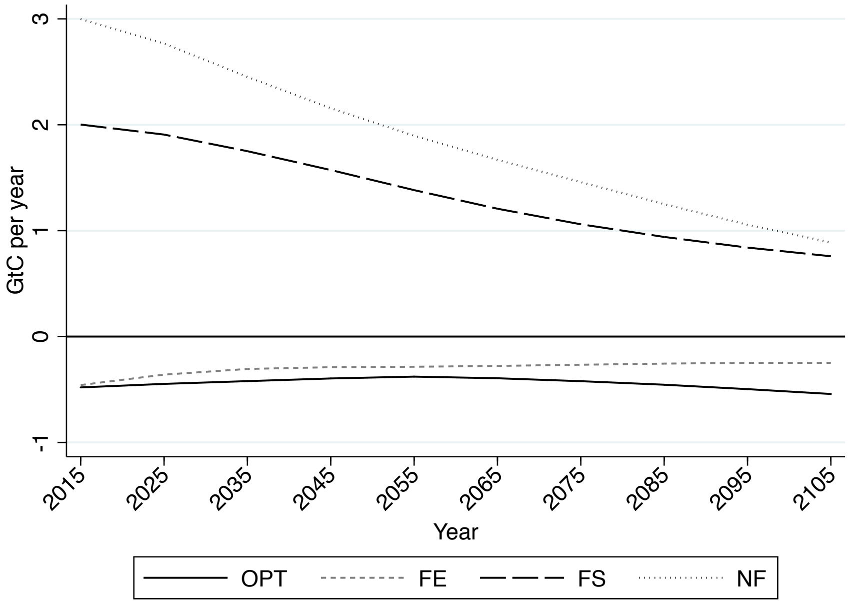

Figure 2: Forest carbon emissions net of sequestration, GtC per year

Forests differ substantially in their biological characteristics, baseline forest cover, and bioenergy efficiency. For these reasons, the model predicts a clear ranking of the forest types in terms of the potential to reduce emissions through forest controls. Figure 3 plots for each type of forest, the carbon emissions net of sequestration under the two most extreme scenarios shown in the previous figure, that is, optimal and no forest policy scenario. The figure illustrates that the largest potential carbon reduction lies in the tropical forest. The tropical forest is a large source of carbon emissions in the no forest policy scenario due to high bioenergy harvest and deforestation. However, under optimal forest climate policy, the tropical forest acts as a net carbon sink. Moreover, the temperate and boreal forest are also sources of carbon emissions in the no forest policy scenario while roughly being carbon neutral in the optimal scenario. In accordance with previous literature, these results suggest that forest policy efforts should be focused in countries with tropical forests.

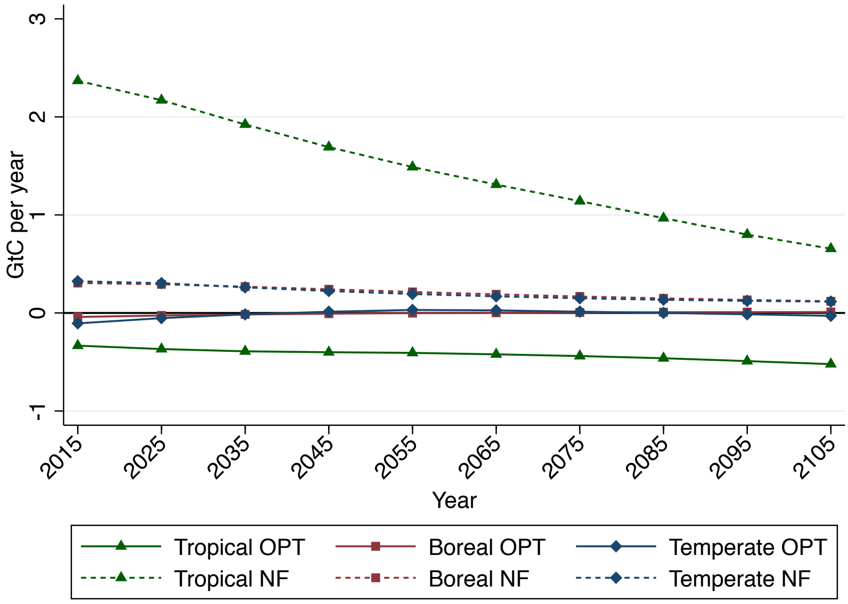

Figure 3: Forest carbon emissions net of sequestration, GtC per year

The paths of forest carbon emissions and sequestration depends on the change of forest biomass. In the model, forest biomass depends on the levels of forest controls. In what follows, we discuss how different policy scenarios affect the choice of forest controls, that is, avoided deforestation, afforestation, and bioenergy harvest.

As previously mentioned, deforestation is a large source of carbon emissions in the tropical forest. Avoiding deforestation decreases the emissions from the tropical forest through both a direct reduction of the baseline carbon released at deforestation and an increase in current and future sequestration. Figure 4 shows the avoided deforestation as a fraction of baseline deforestation. The optimal scenario displays the highest rate of avoided deforestation. Furthermore, not including forest carbon emissions in the carbon policy lead to a lower avoided deforestation than not including the benefit of sequestration. Interestingly, when both forest carbon sequestration and emissions are excluded in the carbon policy, the avoided deforestation is not zero. This avoided deforestation in the medium to long run occurs to meet the demand for biomass to produce bioenergy. Note, however, that the baseline deforestation is declining over time.

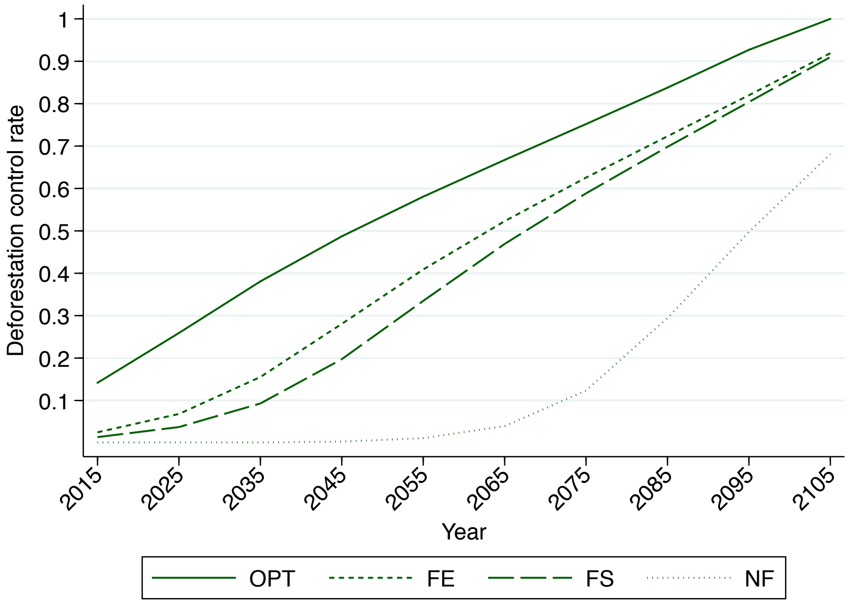

Figure 4: Avoided deforestation, share of baseline deforestation

Figure 5 and 6 shows the cumulative afforestation in the tropical and temperate region, respectively. The highest cumulative afforestation occurs in the optimal scenario. Because the climate benefit of increasing forest land comes through sequestration, the lowest level of afforestation occurs when sequestration is not included in carbon policy. The level of afforestation, while low, is not zero because there is demand for biomass to produce bioenergy, especially in the long run.

The scenario that only takes into account sequestration leads to a level of afforestation that is different from the level in the optimal scenario. To see why this is the case, note that in this scenario emissions from forests are not being taken into account. This implies two things: First, that overall emissions will be misleadingly low, thereby reducing the incentives to undertake sequestration efforts. Second, that the true cost of using bioenergy will not be observed, thereby increasing the incentives to increase the forest biomass. The combination of this two counteracting demands leads to different effects on the level of afforestation for the two forest types. For the tropical forest, the level of afforestation in the scenario that only takes into account sequestration is lower than the optimal scenario. For the temperate forest, the level of afforestation in the scenario that only takes into account sequestration is higher in the short run, but lower in the long run.

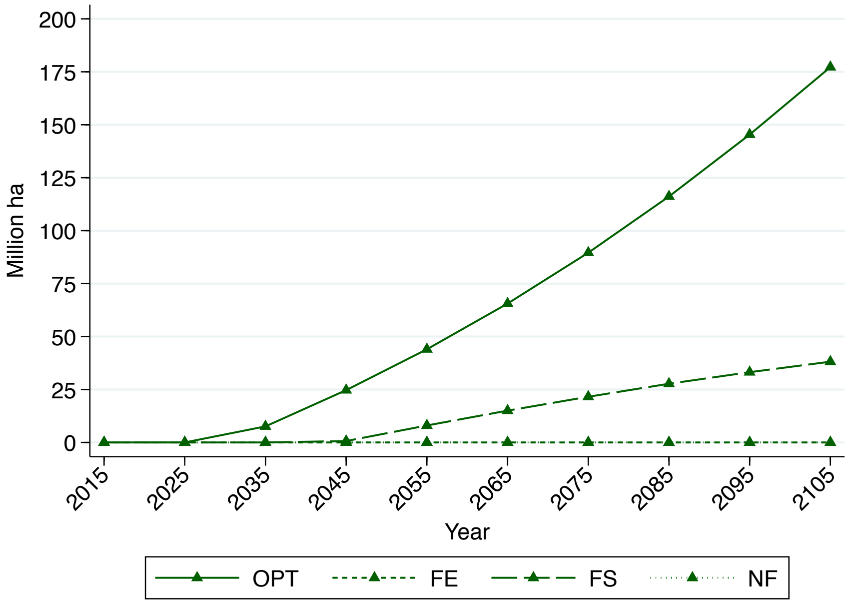

Figure 5: Cumulative tropical afforestation, million hectares

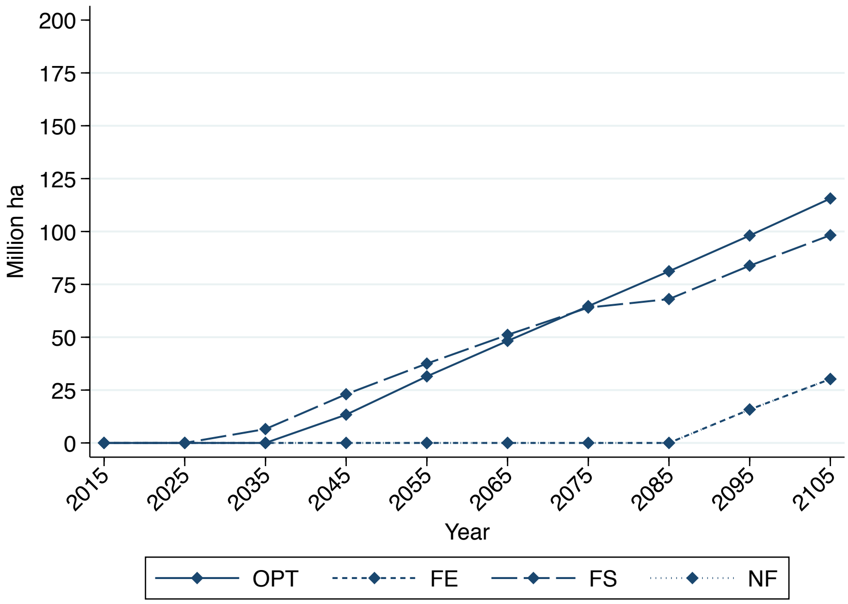

Figure 6: Cumulative temperate afforestation, million hectares

Figure 7, 8, and 9 shows the level of bioenergy harvest in the tropical, temperate, and boreal forest, respectively. Not recognizing the forest carbon in carbon policy gives remarkably high harvest levels. This harvest is especially high in the early time periods, but decline over time as the stocks of forest biomass decreases. Figure 10, 11, and 12 in the Appendix shows the evolution of forest biomass stocks under the different scenarios. Furthermore, not including the cost of release of carbon from forests also leads to higher bioenergy harvest than optimal for all types of forests. Not including the benefits from sequestration, on the other hand, leads to a lower bioenergy harvest than optimal for the tropical and temperate forest. This result follows from the logistic growth function formulation of the forest biomass where harvest increases the relative growth rate of the forest biomass and, hence, the rate of sequestration. The effect on the boreal forest is insignificant as the intrinsic growth rate of the boreal forest is low.

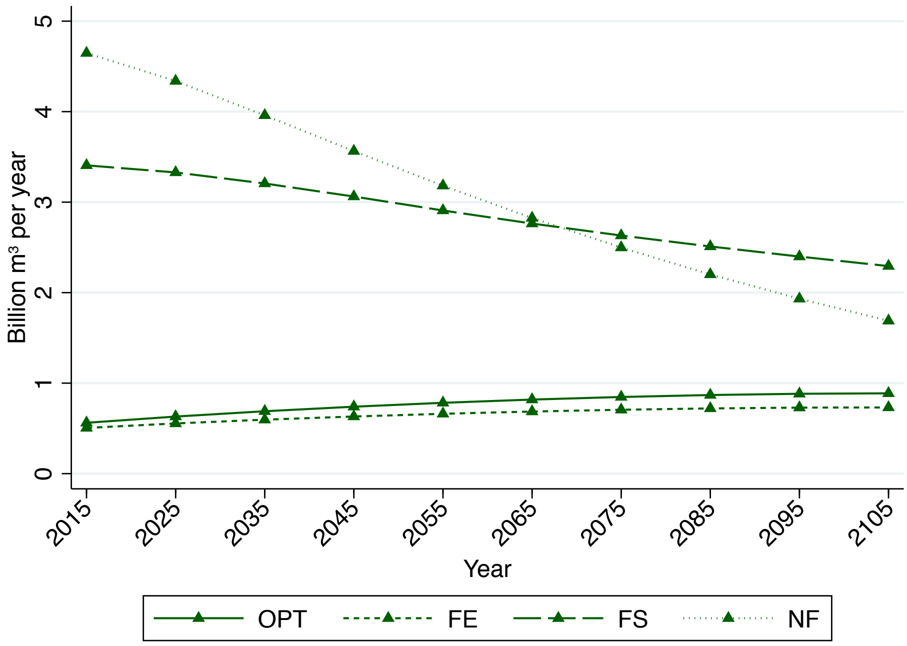

Figure 7: Tropical bioenergy harvest, billion m^3 per decade

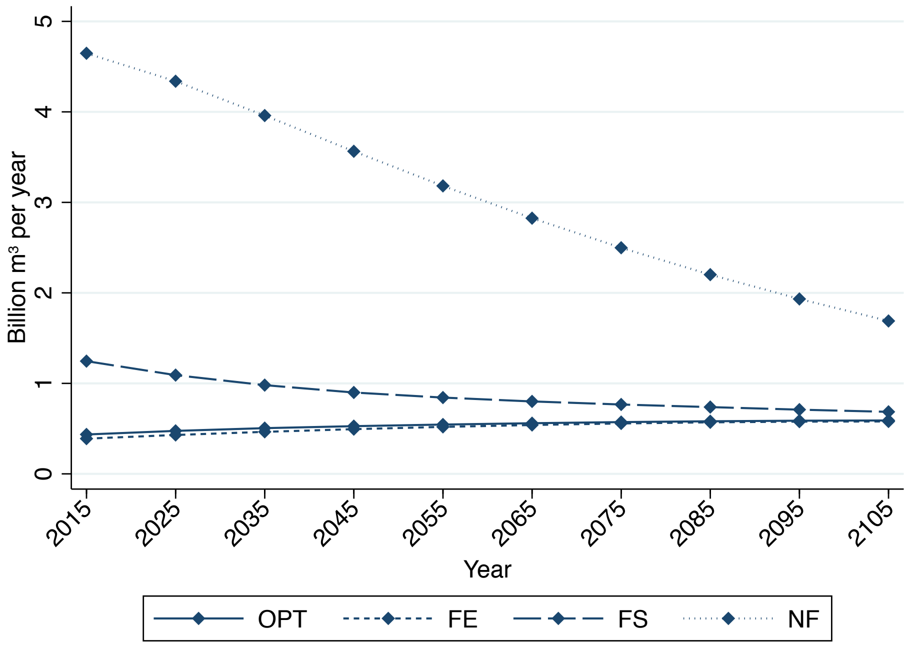

Figure 8: Temperate bioenergy harvest, billion m^3 per decade

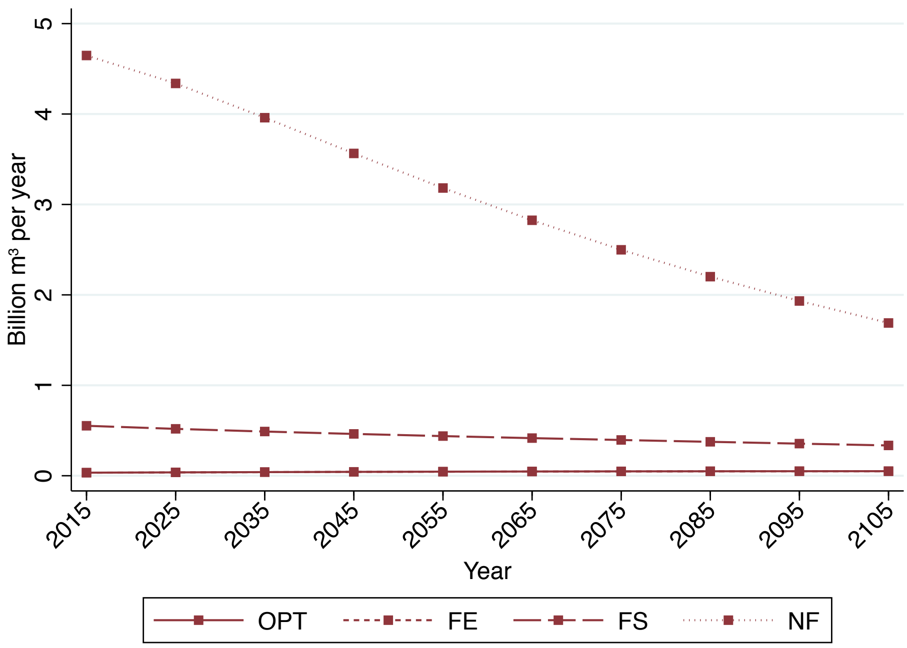

Figure 9: Boreal bioenergy harvest, billion m^3 per decade

The overall effect of the various scenarios can be expressed in terms of the price of carbon, which reflects the Pigouvian tax that should be introduced to internalize the negative externalities of carbon emissions. Table 2 shows the carbon price for the different scenarios. The optimal scenario leads to the lowest carbon prices. Ignoring all types forest carbon in climate policy leads to the highest carbon prices. Moreover, in line with our previous results, not recognizing forest carbon emissions leads to higher carbon prices than not recognizing forest carbon sequestration.

Table 2: Carbon prices, 2005 U.S. dollar per tC

	2015	2035	2055	2075	2115
OPT	41.25	65.31	96.01	134.73	242.9
NF	42.51	67.10	98.15	136.89	244.6
FE	41.35	65.47	96.24	135.03	243.4
FS	42.17	66.64	97.64	136.43	244.3

Consistent with the carbon price results, we find that the social welfare for the scenarios has the following ranking, from high to low: OPT, FE, FS, and NF. On the whole, scenarios that recognize forest carbon emissions lead to the lowest carbon prices and the highest level of welfare. Note that while the difference in carbon prices between scenarios may seem small, these results are conditional on the damage function of the DICE model. The DICE model projects relatively small damages from climate change and the optimal temperatures will reach above 3°C in all scenarios. For example, in the optimal scenario, the temperature increase exceeds 2°C in 2075 and continues to increase until it peaks at 3.2°C by 2185. Table 4 in the Appendix shows the temperature increase in the different scenarios.

In optimal climate policy instruments should include both taxing emissions and subsidizing sequestration. Table 3 provides a back of the envelope calculation on the optimal taxation of fossil and forest carbon over the next decades. The total tax and subsidy of forest carbon are also displayed by forest type. The table reveals that the subsidy will exceed the tax revenue from forest emissions. The tropical forest accounts for the bulk of this imbalance between tax and subsidy. To get a better a sense of the magnitudes consider that world GDP amounts to approximately $58.2 trillion, in 2015 this implies that the tax from forest emissions amounts to 0.15% of world GDP while the subsidy amounts to 0.18%. Notice, however, that the sequestration subsidy can be fully financed when tax revenue also includes taxes from fossil fuels, which amount to 0.53 % of world GDP.[10]

Table 3: Optimal total tax and subsidy payments, billion 2005 U.S. dollar per year

	2015	2025	2035	2045	2055
Forest Carbon Tax					
Tropical	48.5	58.5	68.8	80.3	93.1
Temperate	27.6	37.6	49.0	61.8	76.1
Boreal	9.5	12.9	16.7	21.0	25.8
Total	85.6	109.0	134.5	163.1	195.0
Forest Carbon Subsidy					
Tropical	62.3	77.9	94.4	112.2	132.2
Temperate	32.0	40.4	49.9	60.8	73.1
Boreal	11.2	14.2	17.7	21.6	26.0
Total	105.5	132.5	162.0	194.6	231.3
Fossil Carbon Tax					
Total	306.9	431.6	580.2	754.1	954.8

[10]The magnitudes are calculated using the 2014 World GDP in constant 2005 US dollars, as calculated by the World Bank. http://data.worldbank.org/indicator/NY.GDP.MKTP.KD

4 Conclusion and Policy Implications

This paper uses an extended version of FOR-DICE (2015) to investigate the effectiveness of climate policy under two asymmetric carbon policy regimes. In the first regime, policymakers account for carbon emissions from fossil fuels but do not account for positive or negative emissions from forests. In the second regime, policymakers do not account for either positive emissions, or negative emissions, from forests.

These regimes are represented by three scenarios which are compared against and optimal benchmark scenario. The model quantifies, by forest type, the level of forest controls that should be pursued in each scenario. These controls include avoided deforestation, afforestation, and bioenergy harvest. While it is not the aim of the paper to provide definitive policy targets for these controls, our results clearly highlight that asymmetric carbon policies have a large impact on the forest controls. In addition to the climate effects of the forest controls, these results are also important because they imply, apart from an overall welfare effect, distributional effects, both between regions and over time.

Our results from the first policy regime indicate that not recognizing positive and negative emissions from forests in carbon policy leads to the highest levels of total emissions, the highest carbon prices, and the lowest welfare. The intuition behind these results is that the forest resource will be allocated inefficiently if carbon values associated with the forest are not included in the decision-making process. Specifically, the relative value between using forest carbon and fossil fuel carbon will be distorted. These results are consistent with those of the bioenergy literature, where the price differentials between bioenergy and other energy will be distorted when we do not fully account for the total negative and positive impact of using forest biomass. Moreover, without any consideration of the climate impact from forests, afforestation and avoided deforestation will only be driven by the need to supply biomass for harvest to bioenergy and timber. In general, not accounting for emissions or sequestration from forests will lead to the highest levels of bioenergy harvest, and the lowest levels of afforestation and avoided deforestation. These effects on the forest controls are particularly strong for the tropical forest.

In the second policy regime, the social planner separately accounts for either positive emissions, or negative emissions, from forests. While both of these scenarios lead to lower levels of welfare that the optimal scenario, our results indicate that not recognizing positive emissions from forests leads to higher total emissions, higher carbon prices, and lower welfare, than not recognizing negative emissions. The intuition behind these results, as in the previous case, is that the failure to recognize either positive or negative emissions leads to a distortion in the cost and benefits of the forest controls. Broadly, we find that not recognizing forest emissions leads to the largest diversion from the optimal path for bioenergy harvest and avoided deforestation. While not recognizing sequestration leads to the largest diversion for afforestation.

The simple framework presented in this paper could be further developed to account for factors that could alter the impact of asymmetric carbon policy. One interesting extension would be to explicitly include the technological development of the use of biomass for energy. This is especially important since, for example, the development of bioenergy production with carbon capture and storage could in practice lead to energy production with net negative emissions. Another potentially important extension is to account for the risk of carbon leakage associated with the long-term storage of carbon in forests.

Despite its simple structure, the model allows us to draw three important policy conclusions. First, our results clearly indicate that the forest resource will be allocated inefficiently if forest carbon is not correctly priced. Correct pricing implies both taxing forest emissions as well as subsidizing carbon sequestration. Second, our results highlight that confronted with the choice between pricing forest emissions or pricing forest sequestration, it is relatively more important to price forest emissions. Accordingly, policy makers are encouraged to fully price forest carbon, or given implementation constraints to prioritize the pricing of forest emissions. Third, our back of the envelope calculation indicates that the overall subsidy for forest sequestration will be larger than the overall tax revenue from forest emissions, with this imbalance being largest for the tropical forests. Our calculation, however, also indicates that the sequestration subsidy can be fully financed in the context of a broader climate policy where revenue is derived from both taxing fossil fuels and forest emissions.

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Appendix

Figures

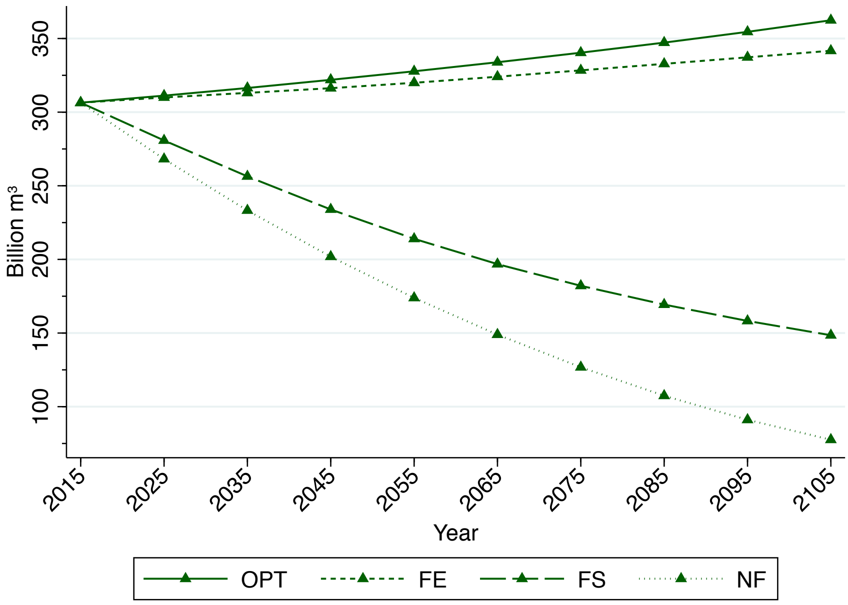

Figure 10: Growing tropical forest stock, billion m^3

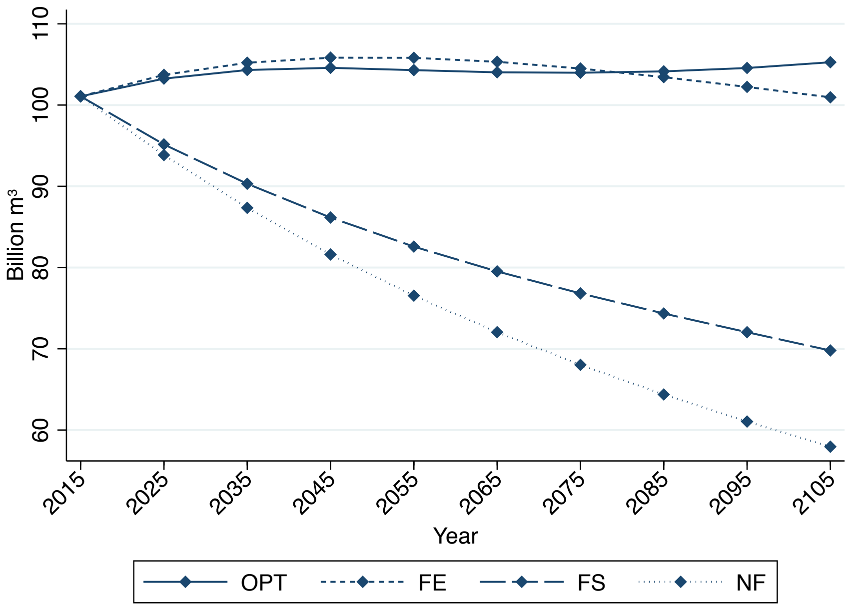

Figure 11: Growing temperate forest stock, billion m^3

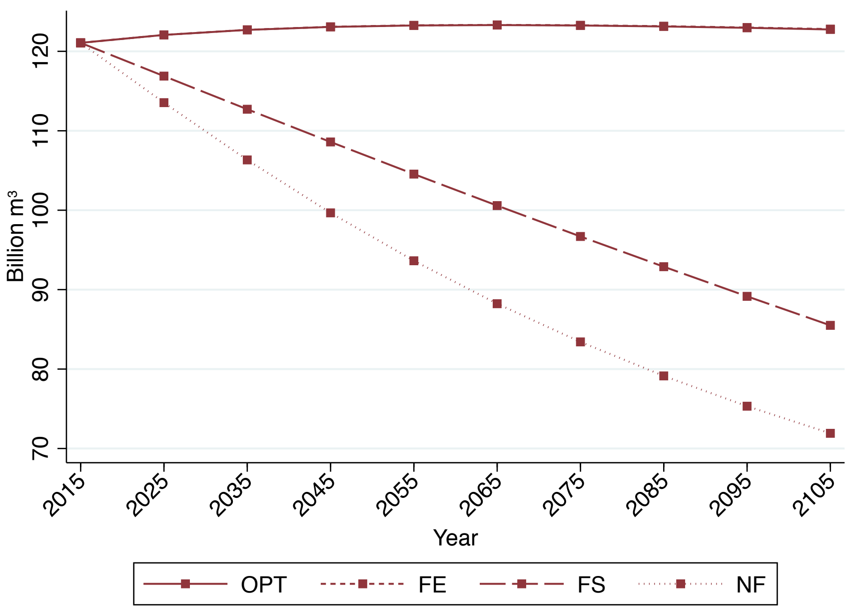

Figure 12: Growing boreal forest stock, billion m^3

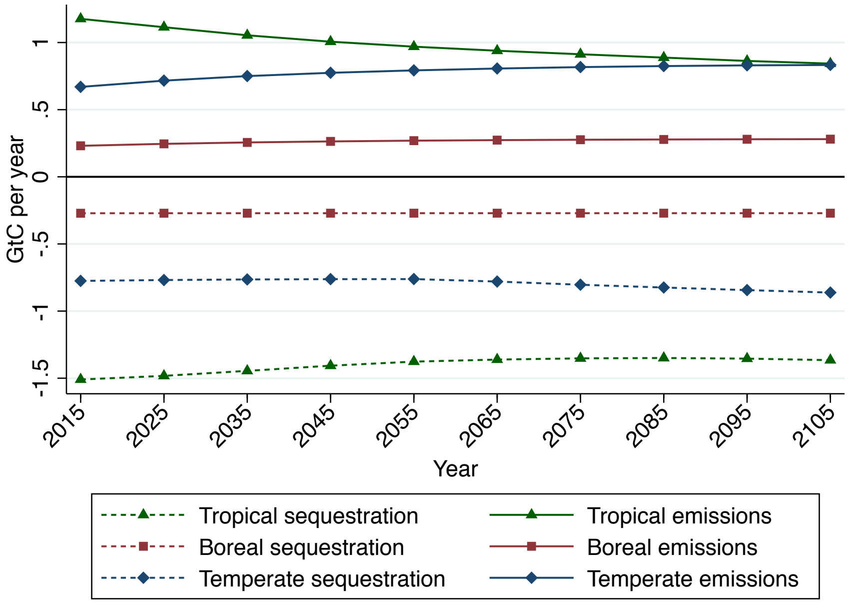

Figure 13: Forest carbon emissions, GtC per year

Table 4: Temperature increase, °C from 1900

	2055	2105	2155	2205
BASE	1.9	3.2	4.4	5.5
OPT	1.7	2.6	3.1	3.1
NF	1.9	2.8	3.4	3.4
FE	1.7	2.6	3.2	3.2
FS	1.8	2.7	3.3	3.4