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Should Forest Transition Theory include effects on forest fires? The case of Spain in the second half of the twentieth century

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ABSTRACT

This paper analyses the increase in forest surface covered by trees in Spain in the second half of the twentieth century in the light of Forest Transition Theory and explores the existence of a statistical relationship between this process and forest fires. The study describes the afforestation policy based on new forest plantations developed by Franco's Dictatorship in the period 1940–1988, linking it to the forest fires that occurred in the period 1968–2002, in order to determine, at a provincial level, the extent to which the afforestation activity affected the number of hectares burnt. The evidence shows a significant positive relationship between forest fires and the afforested hectares, especially 30–35 years after plantations. The effect increases when the model is implemented exclusively for the Cantabrian and Atlantic north-west provinces, especially affected by afforestation programmes. Our findings reinforce the need to complement certain models of Forest Transition based on tree plantations, taking into account the possible relationship that they have with fires, particularly in environmental contexts prone to fires.

1. Introduction

Since its formulation in the 1990s, the concept of Forest Transition (FT) and its consideration as a Theory (the Forest Transition Theory–FTT) has generated a vast body of literature and much controversy (Mather, 1992; Grainger, 1995; Mather and Needle, 1998, Perz, 2007; Barbier et al., 2010; Nunez-Mir et al., 2015). The first version of FTT seeks to describe and explain the reversal of forest cover change trends, from long-term deforestation to stable or increasing forest cover in some countries, explaining it as a process linked to economic and social development (Mather, 1992, 2001). Based on the original version, some studies try to explain FT by the increase in GDP per capita, suggesting the existence of an inverted U shape curve between economic growth and deforestation, that is, the existence of an Environmental Kuznets Curve for deforestation (Barbier and Burgess, 2001), although the evidence for this claim is far from being conclusive (Culas, 2012). Other versions explain FT in a more complex manner, including several variables influencing the evolution of forest surface. The increase in agricultural productivity enabling the concentration of food production on the more productive lands freeing up space for forest; the increase in the demand for forest products and prices which incentivizes forestation processes; the development of State policies promoting forest recovery; or the effects of globalization on the trade of forest products lowering pressures on some forests, are the main variables considered (Rudel et al., 2005; Lambin and Meyfroidt, 2010; Meyfroidt et al., 2013). On the other hand, although most of the research seeking to measure FT has considered only forest surface, the type of forest resulting from the transition could be of prime importance. An FT based on the reforestation of primary or secondary forests could be very different from an FT based on afforestation with tree plantation (Perz, 2007). In this regard, studies have been conducted that attempt to measure the environmental effects of tree plantations on biodiversity, water reserves, flood control or carbon sequestration (Kauppi et al., 2006; Bremer and Farley, 2010; Meyfroidt and Lambin, 2011; Heilmayr, 2014; Pirard et al., 2016). But the effects of FT on forest fires have barely been considered by the literature. Only for the case of Portugal has a relationship between FT and wildfires been considered (Mather and Pereira, 2006) with the suggestion that fires might be reversing FT in some areas of the country. In the case of Spain, some studies have also pointed to a direct relationship between FT based on tree plantation and forest fires, which is worth exploring.

The evolution of forest surface in Spain in the second half of the twentieth century could be explained by some of the postulates of FTT. After a secular process of deforestation proved at least for the nineteenth century and the first decades of the twentieth century (Iriarte-Goñi, 2013), forest surface covered by trees started to grow from the

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middle of the century. Available data for the whole country suggest that the forest surface covered 12.000 ha in 1950 and 16.000 in 2000, increasing by 33% (Infante et al., 2014).[1] Although the FT process has not been studied in depth, the causes of this growth seem to coincide with some of the postulates of the FTT. The growth of agricultural productivity, the intense rural exodus and the increase in the trade of forest products (particularly the trade of timber to produce pulpwood for paper) during the period, suggest that the main means described for FT, according to Rudel et al. (2005) and Lambin and Meyfroidt (2010) could have worked in Spain. But in parallel to those factors, the most directly related cause of the increase in forest surface covered by trees was, undoubtedly, State afforestation policy. Beginning in the forties, just after the end of the Spanish civil war, the Forest Administration of the Franco regime started an intense afforestation policy which lasted for more than four decades and affected more than 3.5 million hectares of forests until the 1980s. The objectives of this forest policy had a protective component related to the management of the basins and rivers and to soil protection. But most of all they had a clear economic component, which sought to increase the production and large-scale exploitation of timber and to protect the large reservoirs which were being built in order to increase the irrigated areas and increase the production of electricity (Gómez Mendoza and Mata Olmo, 1992). The increase in forest surface covered by trees between the 1940s and the 1980s was based on tree plantation programmes which were developed through an authoritarian top-bottom policy, with no consideration of the needs and interests of the people living on the land. From an environmental point of view, plantation was carried out with resinous trees (mostly pines) and in some cases eucalyptus which were planted in large areas covered by a single species, creating woodlands of poor ecological status in terms of age structure, diversity and maturity, fostering the spread of tree diseases, pests and other forest problems (Prieto, 1989; García Abril et al., 1989; Chauvalier, 1990; Rico, 1995, 2008a,b; Cervera et al., 2016).

It is within this framework that some studies claim that the characteristics of the afforestation model developed in Spain by the dictatorship aggravated the problem of fires and could have been a contributing factor to their increased prevalence (Prieto, 1989; Cabana 2009; Seijo, 2009). To understand the scope of the problem is worth noting that forest fires have constituted one of the main environmental problems in Spain since the second half of the twentieth century. Official statistics collecting forest fire data from 1968 to 2014 reveal that 7.1 million hectares of woodland (trees and scrubs) and pastures have been burnt (more than 150,000 ha per year as a mean). In this period, fires affected more than 25% of the total forest area calculated for the country in the third National Forest Inventory (IFN3, 2006). To date, the relationships between afforestation programmes and forest fires have only been described as a possibility, and there are no studies that statistically link these two phenomena. But this possibility opens up a new front in the study and assessment of Forest Transition that is worth exploring, particularly in environmental contexts susceptible to fires.

So, the objective of this study is to explore the existence of statistical linkages between afforestation in the period 1940–1988 and forest fires that occurred in the period 1968–2002, in order to determine the extent to which the afforestation activity affected the number of hectares burnt in the country on a provincial level. It should be noted from the outset that this paper does not seek to offer a complete view of the causality of forest fires, but simply to combine some of the variables that the literature has considered as important in this causality, introducing afforestation as another variable, in order to assess the specific effect that this may have had. In other words, our objective is not to explain the causes of the forest fires, but to analyse the role that afforestation could have had played in them. This information could be an important element in assessing the effects of some model of forest transition.

After this introduction, section two addresses the essential issues of the problem; Section three presents the data used and the model. The fourth section presents the main results which are discussed in section five. Some conclusions are drawn in the final section.

2. Approaching the problem

Forest fires are a very difficult problem to analyse on all levels, as assessing their causality is a complex task (Montiel Molina, 2013; Viedma et al., 2015; Vilar et al., 2016). They can be started by natural causes unrelated to human activity or caused by mere negligence or accidents. They can be due to economic and social causes related to land use, natural resource management, activities developed in the forests and the interests associated to all of them (Martínez-Fernández et al., 2013). They can even be caused by problems that are not environmental, economic or social (for example, in the case of random fires started by arsonists suffering from a mental illness). In order to start clarifying this complexity, we can separate the generic causes of forest fires into two different categories, differentiating between the ignition causes and the causes affecting the severity and extension of the fire.

Starting with the ignition causes, the studies addressing this aspect all indicate that the majority of fires are started by humans. According to a study published by the FAO (2007), the “number of naturally occurring fires is small in comparison with those caused by people”. The studies analysing the Spanish case can be divided into those that attribute 96% of fires to human action (Prieto, 1989; Vilar et al., 2016) and those that attribute 70% to humans, although this second group observes that 20% of fires have unknown causes (Seijo, 2005). The majority of fires caused by human action in Spain seem to be due to agricultural burning. Fire has traditionally formed part of farm management practices such as stubble burning in order to fertilise the following crop with the ashes or the burning of scrubland in order to create temporary pasture land. In many areas, these practices are still used and other factors, (such as rural depopulation or the ageing of agricultural assets), may lead to an easier loss of control of the fires, causing the destruction of adjacent forest areas. On the other hand, some forest fires are caused by fortuitous accidents related to factors such as the amount of tourists visiting the forests or the proximity and density of the infrastructure (roads, railway tracks or electrical power lines) that runs through them. Similarly, the “agriculture-forest” and “urban-forest” interfaces may give rise to more accidental fires (Badía et al., 2011; Viedma et al., 2015). Finally, there are other types of fire that can be divided into those due to individual causes (arsonists) and those caused by different types of social conflict related to the ownership of the forests or the types of use that the different social and economic sectors wish to give to them (e.g., reclassification of land for building, recreational uses, farming and forestry uses, etc. Fuentes-Santos et al., 2013). There have also been cases in which there is a perverse relationship between the increase in the costs and infrastructure related to the extinguishing of the fires (the “Economy of Fire”) and the incidence of fires. In this respect, some authors defend the existence of “a growing number of fires set intentionally to obtain temporary jobs in firefighting services” (Chas, 2007).

With regard to the factors that may exacerbate the fires, the technical reports refer to three groups of causes, namely the terrain, the weather and the greater or lesser fuel accumulation within the forests (Martínez Ruiz, 2013). The former two are related to natural causes that are difficult to control. A rugged terrain with many ravines and gorges or with steep hillsides can accelerate the spread of fire and make it more difficult to extinguish (Nunes, 2012). Furthermore, high temperatures, low rainfall or intense, fast winds with low levels of humidity

[1] The increase in Forest Surface covered by trees was compatible with a decrease in Total Forest Surface (including surface covered by scrub, bushes and natural pastures) due to the extension of cultivated land until the seventies. From the eighties on, FT culminated in Spain with the raise of Total Forests Surface until now (Infante et al., 2014, Table 1Table 1, p.10).