Chapter

Assessment of the Impacts of an Inheritance Taxation Relief on the Profitability of Forest Investments

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Abstract

The place and importance of forest biomass production is widely recognized in natural resources and energy policy in many countries. However, for a part of them, including France, the forest belongs mainly to private owners. Consequently, fiscal policy, including inheritance taxes, is an essential tool to orient biomass production. France is one of the countries where an inheritance tax is levied. In the case of forests, given the slow production cycle, this means that each tree is taxed several times before it reaches maturity. This situation could discourage the practice of forestry. For this reason, a tax abatement has been introduced, which consists of taxing forests at only one-quarter of their value in the calculation of the inheritance tax. This abatement is subject to a commitment to good management for 30 years. Thus not all forests benefit from it. In this work, we intend to quantify this advantage when it is attributed, so that the interested parties can compare it to the costs and inconveniences of the commitment, and above all, to estimate the additional profitability that it provides to the forest compared to other investment alternatives, all other things being equal. To this end, we set up a demographic model to represent the inheritance sequence and an economic model with the current tax rates. In the end, we find that this tax rebate is a good incentive to invest in the forest, and therefore to produce more biomass on the long term and a good incentive to produce the significant positive externalities associated with the presence of forests.

Keywords: economy, forest, inheritance, succession, taxation, valuation

1. Introduction

Biomass production through the forestry sector are particularly characterized by three phenomena, which are not specific to them but are at the origin of regulations, taxation or management rules that are different from those used in other fields of economic activity. Firstly, the standing trees are both the productive capital and the products; secondly is the length of the production cycle (40 years for a maritime pine, two centuries for some oaks); and thirdly, the importance of the externalities of forestry on the economic, social and environmental levels ("Forests precede peoples, deserts follow them", falsely attributed to Chateaubriand).

However, the government is subject to budgetary constraints, requiring different sectors of the economy to contribute to the expenditures, including forestry (e.g. see [1, 2]). In this context, many governments have adapted tax regulations where they have to be applied to forests. Broadly speaking, forest-related taxes can be classified (see [3]) into the following categories: (1) taxes based on the assumed productivity of woodlands (such as the land tax or forest income tax in France), (2) taxes on production (such as the value-added tax, where applicable), (3) taxes on wealth (such as the IFI—tax on real estate wealth in France) and (4) taxes on inheritance.

The effects of the first three taxes have been studied by forest economists: what are their impacts on the profitability of forests, the silviculture practiced, the interest of forestry vis-à-vis other activities or investments (see [4–6]). Some particular aspects have been the subject of detailed work. For example, Aschan (in [7]) shows how a progressive income tax directly impacts harvests and thus silviculture; the impact of various financial market conditions has been studied [8–10]. Some authors (see [11, 12]) have shown how these taxes decrease the value of forests, but also how, by inducing owners to change their forest management, these taxes create distortions leading to a further economic loss (e.g., by inducing to reduce or increase the rotations, i.e., the age at which the trees are cut before the forest is regenerated, compared to a situation without taxes).

The inheritance tax, applied when the owner dies, or when he gives his forest to a child or grandchild, is another possible instrument providing revenue to the government. It has a significant impact on the decisions taken by nonindustrial private forest owners and on the allocation of their capital between forest and other investments, as shown in Barua et al. [13] with a two-period theoretical model (see also [14]). As a result, it can be used to implement forest policy [15, 16]. Such a tool is used, for example, in France, but also in 23 other OECD countries [17], with very different modalities (e.g., exemption of the equivalent of the first inherited 17,000 dollars in Belgium versus the first 11,000,000 dollars in the USA) for a parent-child transmission; moreover, many assets are sometimes exempted, such as the principal residence, farms, life insurance, etc. The separation of usufruct and bare ownership is then in some countries a way of reducing the burden of this tax.

Here we are interested in the situation in France, where forests can benefit from exemption from inheritance tax for three-quarters of their value (only one-quarter is taxed), subject to a commitment to good forest management for 30 years (a commitment to be respected by the heir and possibly by his successors). The legislator's idea was to avoid taxing the same tree several times before it was harvested, and above all to avoid premature cutting of trees simply to pay this tax. On the basis of the approximation that the value of trees is on average (according to species, age, region, economic conditions, etc.) equal to three times the value of the forest land, this amounted in a way to taxing the land but not the trees. This is a very general average, as the value of the trees can be anywhere from zero to more than 20 times the value of the land (see [18]). This commitment to good future management gives the owner an incentive to abstain from harvesting trees prematurely, and this incentive is materialized in a lower amount of tax to be paid to fiscal authorities.

Our objective here is to calculate the burden that this tax represents under the present conditions, depending on whether or not this abatement (known as the "Monichon" abatement, named after the French senator Max Monichon, 1900–1977) is obtained, so as to better quantify the incentive it provides to subscribe to this commitment to good forest management. And above all, to better quantify the competitive advantage it gives to the forest among other possible investments that would not benefit from this partial exoneration.

The transmission of a legacy to future generations is also an important motive for forestry (see [19]), especially since, beyond a capital asset, a whole set of values is transmitted [20, 21]. And for private forests, the lifetime of investments often exceeds the remaining life expectancy of the owners (cf. for example [22], and the models of overlapping generations; see also [7], which illustrates how an initial investment can allow for a sequence of revenues, but only after a long duration).

In the remainder of this chapter, we build a demographic model to represent the sequence of transmissions. We then obtain the evolution of the age of the owner of a woodlot, or any other asset transmitted from generation to generation. For this, we use data for the French population. In a second step, we describe the economic model, present its results, and in a third step, we make some comments.

2. The demographic model

The demographic model is constructed to represent the transmission of the relevant part of the estate from its owner to one of his/her heirs. Various details of its construction are mentioned in Appendix 1.

We use directly the most recent data available from Insee, the French National Institute of Statistics and Economic Studies, corresponding to the year 2019 [23]. Note in this regard that the data for the years 2020 and 2021 may have been affected by the COVID-19 pandemic.

These data represent average values for the French population, and it is clear that for a particular investor, his/her own values concerning the age of children or life expectancy may differ significantly. Our results will therefore be average values, and may therefore differ from the result of a valuation that would be made for a particular case.

2.1 Generation gap

Data from Insee [23] allow us to calculate the probability distribution of the age gap between two generations. We represent below (**Figure 1**) the number of children born alive according to the age of the mother, which has the same shape as this distribution. The average age of the mother is 31 years, with a standard deviation of 5.27 years.

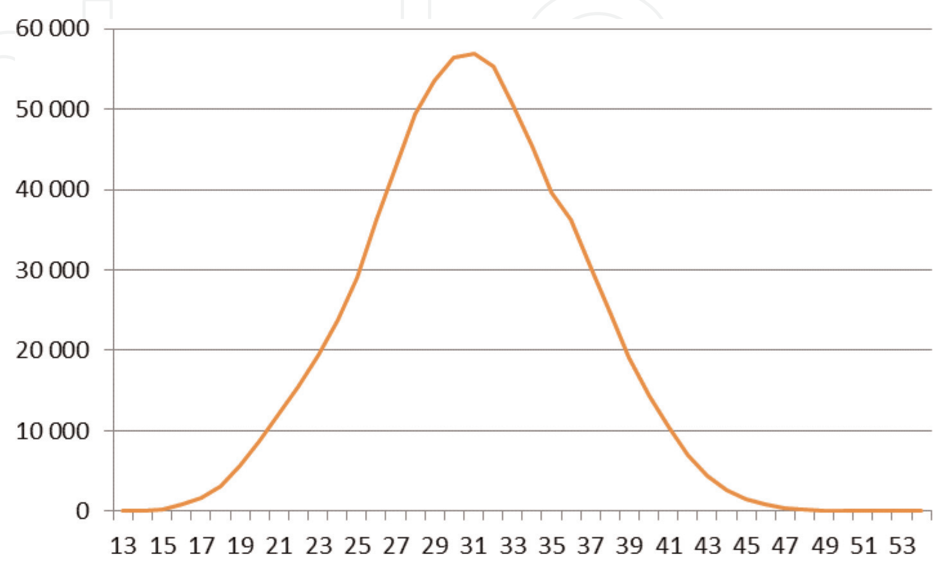

Figure 1.
Number of children born alive by age of mother. x-axis: age of mother in years; y-axis: number of children. Data for France (excluding Mayotte), 2019 (source: [23]).

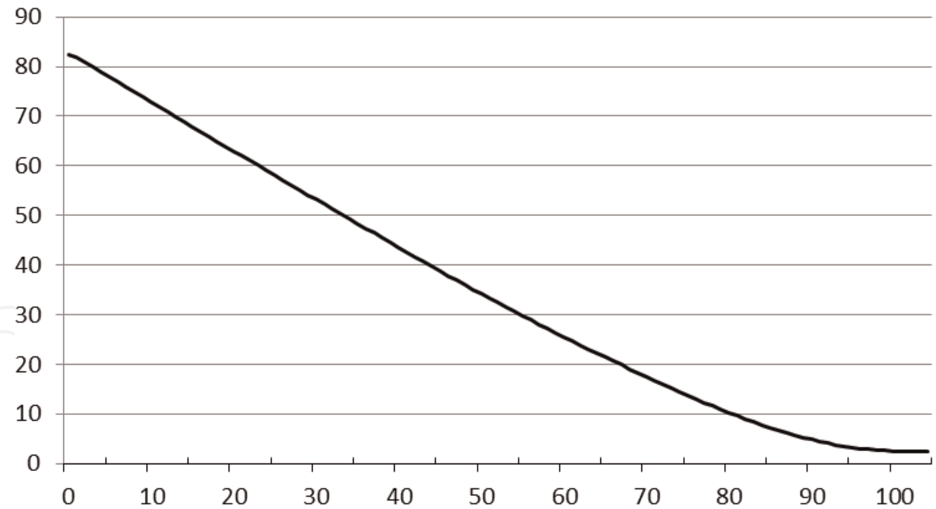

Figure 2.
Life expectancy by age (men and women). x-axis: age; y-axis: life expectancy, in years. Data for France, 2017–2019 (source: [23]).

2.2 Life expectancy as a function of age

According to the same source, we know the life expectancy as a function of age, for men and women taken together. In **Figure 2**, we represent this expectation, which has a convex shape, especially after the age of 80, meaning that at each birthday, the estimated date of death is pushed forward.

For instance, if at the age of 70, life expectancy for a woman (resp. man) is 19.20 years (resp. 15.91 years), ten years later, for a woman who has reached the age of 80, it is not 9.20 years (resp. 5.91 years), but 11.28 years (resp. 9.20 years). Note that the COVID-19 pandemic has recently reduced life expectancy in most countries by a few months.

2.3 Mortality quotient

We represent below (**Figure 3**) the mortality quotient per 100,000 survivors at age x, i.e., assuming a representative population of 100,000 persons of the same age x, the number of persons dying in year n.

2.4 Evolution of the age of the owner of a plot of forested land

Let us now suppose that we examine the evolution of the age of the owner of a well-identified plot of forested land, or a forest as a whole but which will not be divided in the future by inheritance. For example, let us assume that the owner has at the beginning ($t = 1$) an age $a(1) = 38$ years. The following year, at $t = 2$, the probability of death being very low at this age, the owner will have, with a high probability, the age $a(2) = 39$. And so on, finally leading him/her to pass on the plot, following his/her death, whose probabilities have been evaluated according to his/her increasing age (see **Figure 3**).

This transmission benefits a direct descendant (a child, whose age probability distribution is calculated from the data presented in **Figure 1**), or an indirect descendant (grandchild), if the direct descendant is already deceased (the probability is known); and so on if the indirect descendant is himself/herself deceased (see more details in Appendix 1).

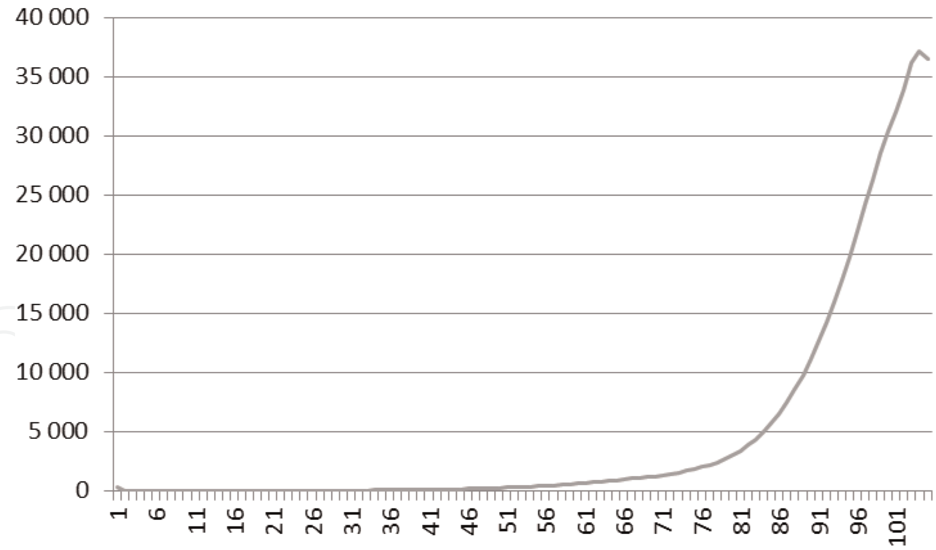

Figure 3.
Number of deaths in a year based on a population of 100,000 people of the relevant age (men and women). x-axis: age; y-axis: number of deaths. Data for France, 2017–2019 (source: [23]).

Figure 4 allows us to visualize that the probability distribution of this age converges to a stable distribution, which is, in fact, independent of the starting age a(1) of the woodlot owner.

2.5 Comparison of model results and forest owner ages

We present in **Figure 5** the year-by-year probability distribution of the age of the owner of the woodlot or forest under consideration, after a sufficiently long time for this distribution to stabilize.

We can now compare these probabilities with data from the general population in France and from the Agreste survey of forest owners [24] in Aquitaine. As there are

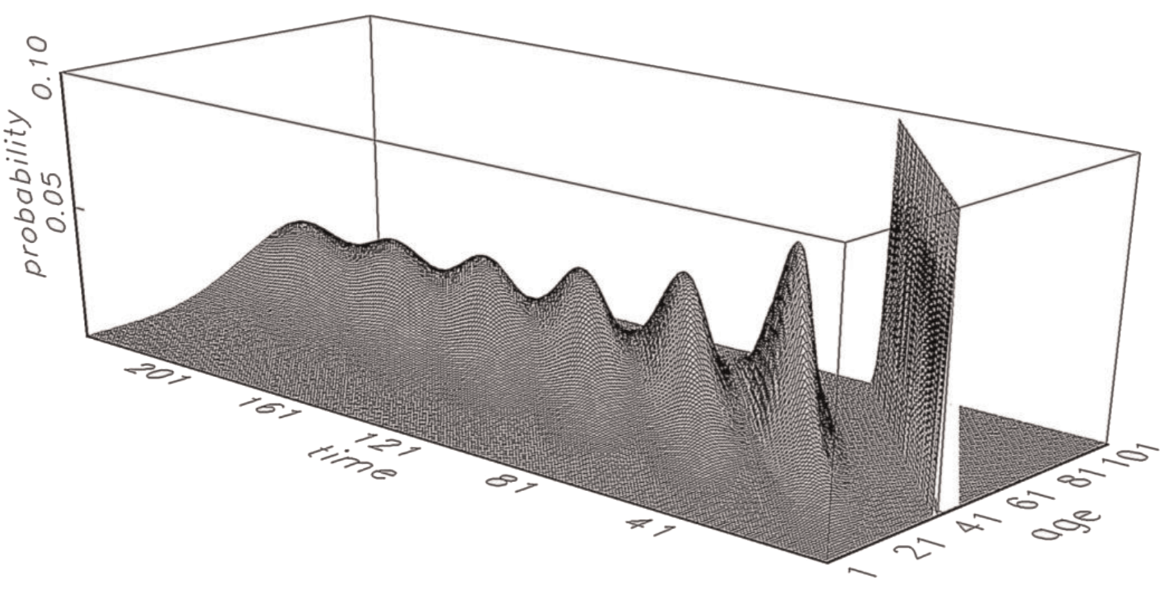

Figure 4.
Evolution of very low at this age, the owner will have, with a high probability, the age a(2) = 39. For better visibility, the graph is truncated at a probability of 0.1. As time goes by, this graph converges, whatever the age of departure, toward a distribution of this age which is stable with respect to time.

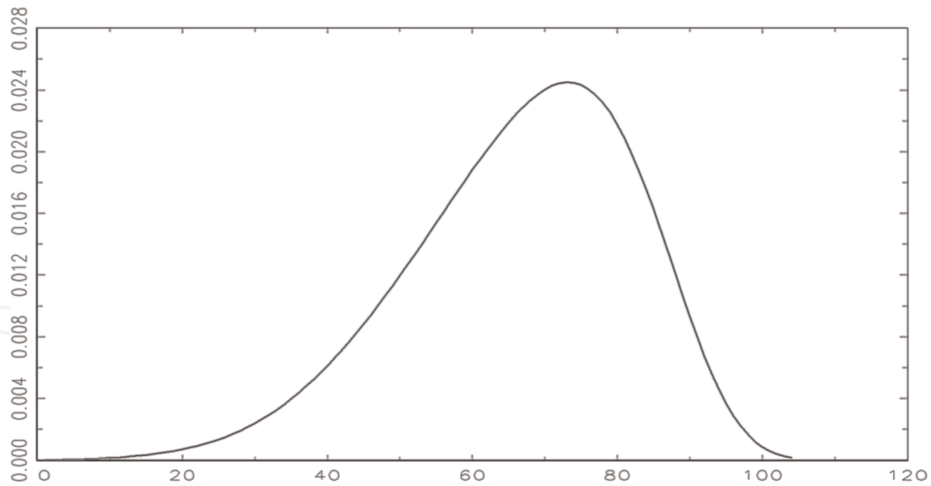

Figure 5.
Age limit distribution of the owner of the forest or woodlot under consideration. x-axis: age of owner; y-axis: probability year by year. Result of the model presented above and in Annex 1.

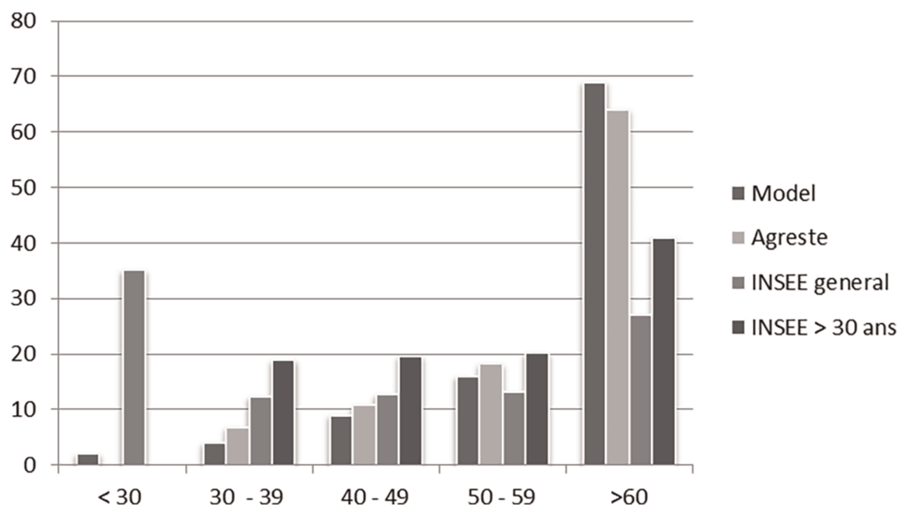

Figure 6.
Comparison of model results (left bars), then Agreste survey data [24] on forest owners, then [23] on the general population, and finally the same Insee data [23] for the population over 30 years old. x-axis: age group; y-axis: percentage (see text).

very few forest owners under 30 years old, we also show the distribution of the French population (see [23]) for only those over 30 years old (**Figure 6**).

Overall, we see that the results of the model are very close to the results of the Agreste survey and quite different from those of the general population. This can be explained by and corroborates the fact that "family transmission appears to be the essential factor in the acquisition process. Nearly three out of four owners received their first "forestry property" by inheritance or donation. The purchase, with a view to building up a forest estate, concerns 27% of owners (30% of surfaces) and the creation by planting of wooded territories less than 1%" [24].

3. The economic model

3.1 The objective

We assume that an investor has a capital that can be invested in a forest and that the required conditions (commitment to good management over 30 years) are then satisfied to benefit from the 75% deduction for inheritance tax. This capital can also be used for an alternative investment (forest without the commitment of good management, finance, real estate, etc.). To facilitate the understanding of the analysis, we assume that the investments provide the same return without this inheritance tax. Our objective is to quantify this benefit of the partial exemption from this tax in terms of additional profitability, depending on the general inheritance tax rate, the time horizon, and the current age of the investor.

3.2 Assumptions on tax rates and wealth growth

We use here the current (2021) inheritance tax rates in France. The practical details have been simplified over the last 30 years (see [15]) since the marginal tax rates are now the same for the transmissions between (a) parents and children, (b) parents and grandchildren, and (c) parents and great-grandchildren. On the other hand, an exemption from inheritance tax applies for the first euros according to the degree of parenthood (respectively (a) €100,000, (b) €31,865, and (c) €5,310). Depending on the total value of the inherited wealth, this exemption is likely to change the marginal tax rate of the forest, but for simplicity, we assume that this is not the case (otherwise, the numerical results are only slightly changed, since the difference between these marginal rates is relatively small, 5% or 10%).

The tax rates, after the aforementioned partial exemption, are presented in **Table 1** (source: e.g., Le Particulier, 1183, July–August 2021). We will use these different marginal tax rates in the following sections.

To simplify the presentation of the results, we assume that these rates will remain the same in the future. We also assume that the overall value of the estate held by the heir(s) concerned by the forest may change in the future, but without involving a change in these marginal tax rates, so that successive heirs face the same marginal tax rates.

We will assume that the annual return on capital invested in and out of the forest, regardless of inheritance tax, is constant and equal to r. The annual returns are capitalized (added to the capital) and the value of the capital, therefore, grows regularly at the rate of r, except in the case of payment of inheritance tax, in which case the tax is deducted from the capital transmitted. Furthermore, the nature of the investment (forest or non-forest) is assumed not to change in the future.

Amount	Marginal tax rate
Less than €8,072	5%
Between €8,073 and €12,109	10%
Between €12,110 and €15,932	15%
Between €15,933 and €552,324	20%
Between €552,325 and €902,838	30%
Between €902,839 and €1,805,677	40%
Greater than €1,805,677	45%

Table 1.
Marginal tax rate according to the amount of wealth transferred to the heir under consideration, after exemption of the first euros (see text).

Future values are discounted at a constant rate of a. To simplify the interpretation of the results, and thus assuming that forest owners are perfect altruists, we do not change the discount rate when an inheritance occurs. Numerically, if we take a = r, this leads to a present value of capital that is constant excluding inheritance taxes. Numerically, we use r = 4% (for the forest this corresponds to the results of [18] and a = 4% (see e.g., [25–27]).

3.3 The importance of the inheritance tax

The model of the evolution of the wealth subject to inheritance tax is presented in more detail in Appendix 2. The results make it possible to construct **Figure 7**, in which we present the percentage of the wealth that will be used to pay this inheritance tax over the next 20 years, depending on the marginal tax rate and whether or not the partial allowance is obtained.

We can then deduce the additional profitability induced by this partial inheritance tax relief, which we express in terms of additional annual growth of the capital invested (**Figures 8** and **9**). Obviously, this interest in the allowance is closely linked to the marginal tax rate, i.e., indirectly, to the capital transmitted to each heir. It is also closely linked to the age of the current owner (**Figure 8**) and to the considered time horizon (**Figure 9**).

The rate is higher when the current owner is older (the transmission is closer, so the benefit obtained from this abatement is relatively greater, due to discounting). In the case of a relatively old investor, it is more important when the horizon of the calculation is not very distant, as we see in the **Figure 9**.

Whatever the tax rate, **Figure 9** shows that this exemption first increases, then decreases according to the time horizon considered, taking a maximum between 25 and 30 years, for an owner who is 70 years old: for a short time horizon, he/she has little probability of dying before this time horizon, and the advantage provided by this abatement is not very significant. For a long time horizon, the successive transmissions are smoothed out over a longer period of time, and likewise the advantage provided by this abatement.

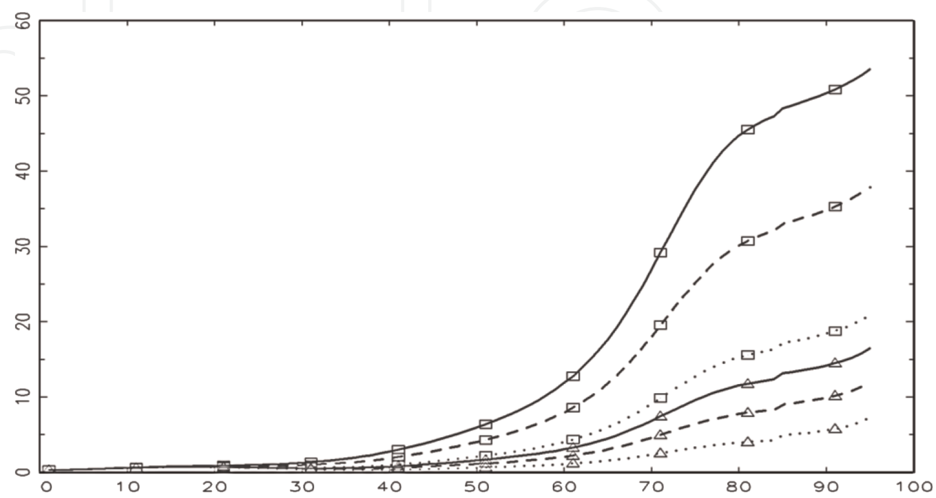

Figure 7.
On the x-axis, the age of the owner (of the forest or of the investment); on the y-axis, the share of this wealth represented by the inheritance tax to be paid over the next 20 years. Curves with squares: without tax abatement. Curves with triangles: with partial tax abatement (Monichon). Solid curve: marginal tax rate: 45%; dashed: 30%; dotted: 15%.

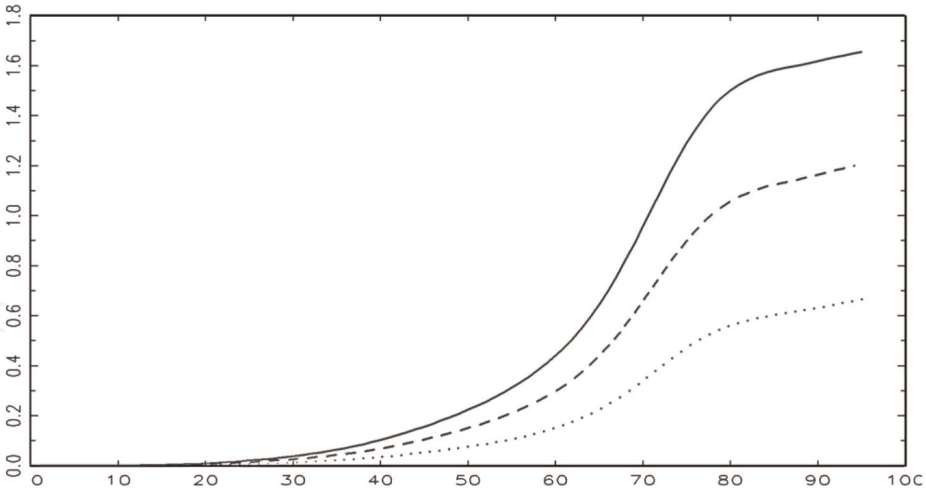

Figure 8.
For a time horizon of 20 years: on the x-axis, the age of the owner; on the y-axis, the equivalent investment performance increase (in yield points; 1 = 1% more return) due to the partial abatement (Monichon), depending on the tax rate: solid curve: marginal tax rate: 45%; dashed: 30%; dotted: 15%.

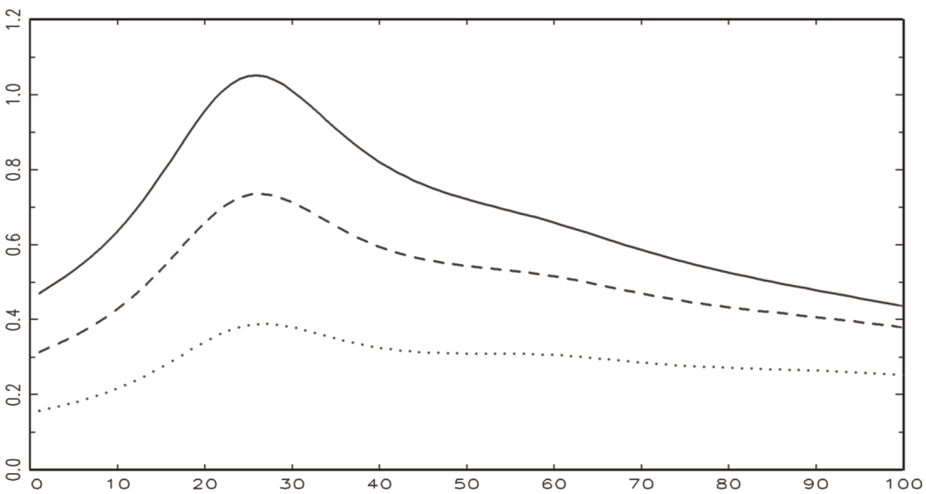

Figure 9.
For a 70-year-old owner, on the x-axis, the time horizon of the computation; on the y-axis, the equivalent performance increase of the investment (in yield points; 1 = 1% more return) due to the partial abatement (Monichon), depending on the tax rate, for the tax payable in the coming years up to the horizon of the calculations. Solid curve: marginal tax rate: 45%; dashed: 30%; dotted: 15%.

4. Conclusion

Our results concerning the age structure of French forest owners confirm that forests are most often inherited, conserved and managed, and then are passed on to heirs. Furthermore, we have a better understanding of why older forest owners generally cut fewer trees than younger ones, as noted, for example, in [22]. This is not without consequence on the production of biomass.

Some of the reasons could be that at the age of inheritance, in a country where longevity is relatively high, and different means (pension system, different forms of financial savings …) may be sufficient to meet the current needs of retirees, forests are kept in the portfolio firstly for philosophical reasons and motives other than financial (feeling of stability provided by trees, various amenities). Secondly, forests are also seen more as precautionary savings (in case of major temporary difficulties) than as a source of income. Finally, they are a means of transmitting a heritage marked for the following generations by the personal investments and forest management decisions of the owner. All this encourages the retention of standing trees and the delaying of harvesting.

And from an economic point of view, as we have seen, inheritance tax relief is not an incentive for the owner to sell his/her forest or cut down his/her trees, but rather to pass on his/her heritage in the form of woodland.

We have also seen that the older the owner, the more he/she has an interest in doing so, and in particular in postponing the age at which trees are cut, but also in investing in silviculture (pruning, maintenance, etc.) to give more value to his/her forests. In doing so, forest owners create externalities that benefit society as a whole, most of which are positive: more biodiversity (cf. [28]), more carbon storage, more attractive forests for walkers, etc. Tax relief on forests, of the type studied here, can thus be a very useful tool for public authorities to obtain such externalities at a low cost. It can also be used to guide the short- or long-term commercialization of the biomass produced.

However, in France, these effects may be partly counterbalanced, for certain estates, by the tax on forest assets (named IFI: Impôt sur la Fortune Immobilière). If one compares forest investments that are subject to this tax (also with an abatement of three-quarters of the value of the forest, under the same conditions of commitment as the tax on inheritance studied here) with financial investments that are not subject to this burden, this IFI encourages cutting down trees and passing on financial assets. The calculation of this incentive remains to be done, and for the forests that are subject to it, the synthesis of the two effects to be calculated, both on the biomass production and on the externalities; it is a new research to be undertaken.

Finally, it should be remembered that the quantitative results presented here are based on average parameter values for the demographic and economic models, and are not a substitute for an expert appraisal, which is the only way to advise a particular forest owner or individual investor.

Acknowledgements

This study has been carried out with financial support from the French National Research Agency (ANR) in the frame of the Investments for the Future Program, within the Cluster of Excellence COTE (ANR-10-LABX45), thanks to the LUCAS Project.

A. Appendix 1: additional information on the demographic model

We consider that the evolution of the population of owners of the assets considered (forest, financial portfolio …) can be entirely deduced from its current state. Consequently, a Markov model can be used [29]. We still have to implement it.

For simplicity, and in the absence of any other realistic hypothesis, we assume in the following that the demographic parameters (life expectancy, etc.) do not change. We use Insee data (see [23], data for the year 2019, before the COVID-19 pandemic).

In the model, time, denoted by t, is discrete, the unit being a year; t = 1 is the present. Suppose that in year n, the owner of the forest (or of any other property or portfolio considered) has the age of a. Insee [23] tells us directly the probability that he/she will not die in year n. Otherwise, there is inheritance.

The publication [23] also provides us with the age of the mother for every birth in France (for fathers, there is no data; perhaps a problem of uncertainties …); we deduce the probability distribution of the age gap between a generation (between mothers and children).

If the owner (generation G) dies in year n, we thus have the probability distribution of the age of the heir child (generation G + 1). But he/she himself may have died (we know the probability, since [23] directly mentions the survival rate at a given age). In this case, the forest is passed on to the descendant of this heir, who is already deceased. This descendant (generation G + 2) himself may be already deceased, and in the calculation, we take this possibility into account by integrating the fact that the forest can be transmitted directly from generation G to G + 3. This consideration is important because the age of the heir, second or even third rank, does not follow the same probability distribution as in the case of a parent-child transmission.

In the (unlikely) case that the heir at G + 3 is also deceased, we assume that the forest is transmitted to another "branch" of the family, and we return to G + 1, to repeat the same calculations. We also suppose that the considered part of the inheritance is never divided, until the time horizon of the calculations. This is a weak assumption because if it were not the case, one can imagine that the calculation relates in fact only to one of the parts, after the partition.

For practical purposes, we consider a maximum age of 104 years: we assume that at this age, the owner voluntarily passes on his/her property to his/her heirs, under the same tax conditions.

We then define the real vector $X_t(104,1)$ with coordinates $X_t(i)$, each equal to the probability that the owner of the asset under consideration is i years old in year t.

We then define the Markov matrix M(104,104): M(i,j) is the probability that the assets owned by an owner aged j years in year t are owned by an owner aged i years in year t + 1. M(i,j) is calculated using the data presented in the text.

The evolution of Xt is given by:

$$X_{t+1} = M \cdot X_t \tag{1}$$

B. Appendix 2: additional information on the economic model

We start with an asset belonging to an owner of any age (less than 104 years). After a sufficiently long period of time, the after-tax value of this asset will depend on the past sequences of transfers, which also depends the present value of the taxes that will have to be paid.

We introduce $V_t(i) \in \mathfrak{R}^{*104}$, where i is the age of the owner at time t: If $t > 1$, $V_t(i)$ is the undiscounted after-tax value at time t of the investment if the owner is i years old, multiplied by the probability that the owner is that age. $V_1(i)$ is the initial value of the capital under consideration, with i the current age of the investor.

Since we assume that the tax rates do not change in the future, we are dealing with a Markov process.

In the case where there is no partial tax relief, we can define N, a 104×104 matrix of real coefficients, as follows:

$$V_{t+1} = N \cdot V_t, \forall t \geq 1; \tag{2}$$

N is calculated in a similar way to M, but the coefficients corresponding to a transmission are multiplied by a coefficient $(1 - F)$ representing the loss in value of the part of the estate in question due to taxation. The model takes into account the fact that the transmission may take place via one or more generation gaps: for example, the transmission of capital to an heir 40 years younger may involve either a direct transmission (parent-child) or a transmission with a generation skip (with a child 20 years younger but previously deceased, and a grandchild heir 40 years younger than the grandparent).

In the case where a partial tax relief ('Monichon') is obtained for a capital invested in forest, we define a new matrix N′ in the same way. The only difference with N is due to the use of the tax parameters F′ taking into account this abatement instead of the parameters F:

$$V_{t+1} = N' \cdot V_t \tag{3}$$

B.1 Expected present value of inheritance tax

We are now able to calculate $E(t)$ (resp. $E'(t)$), the present value of the capital at time t, in the case of an investment not benefiting from the abatement (resp. a forestry investment benefiting from it), a being the discount rate:

$$E(t) = \frac{\sum_{k=1}^{104} V_t(k)}{(1+a)^t} \tag{4}$$

We then define the discounted portion of the value of the estate that will be used in the future to pay inheritance taxes as follows

$$V_1(i) - E(t)\ (\text{resp.} V_1(i) - E'(t)) \tag{5}$$

with i the current age of the owner of the capital.

The numerical values of r (the annual return on the invested capital) and a (the discount rate) have both been taken to be equal to 4% per year, in real terms (zero inflation is assumed in the future, which does not affect the results presented in the text but simplifies their presentation).

B.2 Additional rate of return induced by the tax abatement

Finally, we define the additional rate of return s due to the partial estate tax abatement as the additional rate at which the non-forestry investment would have to grow to yield an expected value equal to the expected value of a forestry investment benefiting from the allowance, at the given time horizon t.

This additional rate s is defined by:

$$V_1(i) \cdot (1 + r + s)^t = V_1(i) \cdot (1 + r)^t + (E'(t) - E(t)) \cdot (1 + r)^t \tag{6}$$

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