

Article

Two Manifestations of Market Premium in the Capitalization of Carbon Forest Estates

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Abstract: In this study, the effect of capitalization premium in forest estate markets on forest management and climate change mitigation economics is investigated. It is shown that proportional goodwill in capitalization induces linear scaling of the financial return, without any contribution to sound management practices. However, there is a financial discontinuity, as harvesting deteriorates goodwill. Such deterioration might be partially avoided by entering the real estate market. Conversely, a capitalization premium set on bare land as a tangible asset would increase timber storage and carbon sequestration. Observations indicate that the proportional goodwill is closer to reality within the Nordic Region, resulting in continuity problems.

Keywords: capital return rate; expected value; carbon storage; carbon rent



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1. Introduction

A carbon sink is a system with a positive time change rate of stored carbon—a device of negative emissions. There are two large sinks of atmospheric carbon on planet Earth: the oceans and the forests [1–4]. It is difficult to manipulate oceans, whereas forests can be managed. Carbon is permanently stored in oceans, whereas forests sequester carbon on a more temporary basis. The nearest decades, however, may be critical in climate change mitigation [5,6].

Enhanced carbon sequestration in forestry comes with financial consequences. Recent investigations have reported the magnitude of such capital return rate deficiency, as well as cost-effective technical means for sequestration [7,8]. A missing perspective is that of forest land investments, which is the subject of this paper.

During the third millennium, forest estates have been lucrative investments [9–17]. Proceedings from timber sales have developed conservatively or declined [18–21], but there has been a significant development in the valuation of estates [10,13,16,17]. The popularity of forests as investments probably has been related to declining market interest rates, impairing yields from interest-bearing instruments [22,23]. In other words, it is suspected that the inflated capitalizations are due to factors external to the forestry business cf. [24–28]. It also is worth noting that vertical integration within the forestry sector might, at least in principle, induce a valuation premium for forest estates [10,29]. A third factor is that private-equity timberland often appears as a favorable component in diversified portfolios [10,30–32].

The positive development of the valuation of forest estates obviously has been related to an ownership change. In North America and in the Nordic Countries, forest product companies have divested forest land to institutions concentrating on the business of investing [9,10,29,33]. Recently, forestry institutions have dominated the estate market in comparison to private individuals [15,17,34]. For climate change mitigation purposes, some institutions include carbon sequestration in their business strategies [35,36]. However, enhanced carbon sequestration generally induces a deficiency in the gained financial benefit [7,8,37–39].

Computational methods of financial economics have recently been applied in the analysis of forestry investments. The capital asset pricing model (CAPM), as well as arbitrage pricing theory (APT), has been applied [10,33]. However, private-equity timberland returns are poorly explained by CAPM [10,33], even if stumpage prices appear to support timberland returns [40]. Improving investor sentiment impairs timberland returns [41]. APT is a very complicated approach, including an intuitive selection of explaining factors. It appears to be able to reproduce differences between geographic areas, as well as temporal effects, provide the timberland returns are used to explain themselves [33].

The increased and possibly increasing capitalizations contribute to the financial return in operative forestry. Greater valuation inevitably reduces the return of capital invested. The greater valuations may or may not contribute to the economically feasible management practices. However, change in valuations necessarily contributes to the financial burden induced by economically suboptimal actions such as enhanced carbon sequestration, biodiversity advancement, or recreational modifications.

Instead of merely referring to average market prices of forest estates, we discuss valuations in terms of tangible and intangible value components appearing on forest stands and estates: trees, land, amortized investments, and eventual goodwill values. Such an insight will enable considerations of the eventual effect of economically feasible management practices on the stand and estate levels.

Two manifestations of inflated capitalization in forest estates are discussed. One manifestation contributes to the economically feasible management procedures, as the other one does not. Any of the two manifestations contribute to the financial return of operations, as well as to the expense of enhanced carbon sequestration. Interestingly, one of the manifestations results in a financial discontinuity, severely problematizing operative forestry.

In the remaining part of this paper, we first review the financial theory and develop it further for the discussion of inflated capitalization. Then, experimental materials are described. Third, the effect of inflated capitalization on capital return rate, capitalization per hectare, and the expense of enhanced timber storage is discussed. The enhanced timber storage is introduced in terms of restrictions on thinning practices. Finally, the observations are arranged in relation to a common reference, resulting in the financial feasibility of different management actions on enhanced carbon sequestration under the two manifestations of inflated capitalization.

2. Materials and Methods

2.1. Financial Considerations

We applied a procedure first mentioned in the literature in 1967 but applied only recently [7,8,42–48]. Instead of discounting revenues, the capital return rate achieved as relative value increment at different stages of forest stand development is weighed by current capitalization, and integrated.

The capital return rate is the relative time change rate of value. We chose to write

$$r(t) = \frac{d\kappa}{K(t)dt} \quad (1)$$

where κ in the numerator considers value growth, operative expenses, interests, and amortizations but neglects investments and withdrawals. In other words, it is the change in capitalization on an economic profit–loss basis. K in the denominator gives capitalization on a balance sheet basis and therefore is directly affected by any investment or withdrawal. Technically, K in the denominator is the sum of assets bound on the property: bare land value, the value of trees, and the non-amortized value of investments. In addition, intangible assets may appear. The pricing of forest estates may include goodwill value.

The momentary definition appearing in Equation (1) provides a highly simplified description of the capital return rate. In reality, there is variability due to a number of factors. Enterprises often contain businesses distributed to a variety of production lines, geographic areas, and markets. In addition, quantities appearing in Equation (1) are not

necessarily completely known but may contain probabilistic scatter. Correspondingly, the expected value of capital return rate and valuation can be written, by definition,

$$\langle r(t) \rangle = \frac{\int p \frac{dK}{dt} d\frac{dK}{dt}}{\int p_K K(t) dK} = \frac{\int p \frac{dK}{dt} r(t) K(t) d\frac{dK}{dt}}{\int p_K K(t) dK} \quad (2)$$

where p_i corresponds to the probability density of quantity i .

Let us then discuss the determination of capital return rate in the case of a real estate firm benefiting from the growth of multiannual plant stands of varying ages. Conducting a change in variables in Equation (3) results in

$$\langle r(t) \rangle = \frac{\int p_a(t) \frac{dK}{dt}(a, t) da}{\int p_a(t) K(a, t) da} = \frac{\int p_a(t) r(a, t) K(a, t) da}{\int p_a(t) K(a, t) da}. \quad (3)$$

where a refers to stand age. Equation (3) is a significant simplification of Equation (2) since all probability densities now discuss the variability of stand age. However, even Equation (3) can be simplified further.

In Equation (3), the probability density of stand age is a function of time, and correspondingly, the capital return rate and the estate value evolve in time. A significant simplification would occur if the quantities appearing on the right-hand side of Equations (2) and (3) would not depend on time. Within forestry, such a situation would be denoted “normal forest principle”, corresponding to evenly distributed stand age determining relevant stand properties [49].

$$\langle r(t) \rangle = \frac{\int \frac{dK}{dt}(a) da}{\int K(a) da} = \frac{\int r(a) K(a) da}{\int K(a) da}. \quad (4)$$

The “normal forest principle” is rather useful when considering silvicultural practices but seldom applies to the valuation of real-life real estate firms, with generally non-uniform stand age distribution. However, it has recently been shown [7] that the principle is not necessary for the simplification of Equation (3) into (4). This occurs by focusing on a single stand, instead of an entire estate or enterprise, and considering that time proceeds linearly. Then, the probability density function $p(a)$ is constant within an interval $[0, \tau]$. Correspondingly, it has vanished from Equation (4).

Application of Equations (1)–(4) does require knowledge of an amortization schedule. Here, regeneration expenses are capitalized at the time of regeneration and amortized at the end of any rotation [48].

By definition, inflation of capitalization corresponds to the emergence of a surplus in the capitalization K appearing in the denominator of Equations (1)–(4). Simultaneously, the value change rate $\frac{dK}{dt}$ in the numerator may or may not become affected.

Before discussing the details of inflated capitalization, a periodic boundary condition is given as

$$\int_a^{a+\tau} \frac{dK}{dt} dt = 0, \quad (5)$$

where τ is rotation age. On the other hand, the value growth rate sums up as free cash flow as

$$\int_a^{a+\tau} \frac{dK}{dt} dt = \int_a^{a+\tau} \frac{dC}{dt} dt, \quad (6)$$

where $\frac{dC}{dt}$ refers to the rate of free cash flow.

Let us then discuss a few possible manifestations of inflated capitalization. First, one must recognize that the free cash flow is due to sales of products and services and is not directly affected by inflation of estate capitalization. Secondly, it is found from Equations (1) to (4) that provided the capitalization K and the value change rate $\frac{dK}{dt}$ are affected similarly; the

capital return rate is invariant and does not trigger changes in management practices. Then, however, Equation (6) is apparently violated. It must be complemented as

$$\int_a^{a+\tau} \frac{d\kappa}{dt} dt = \int_a^{a+\tau} \frac{dC}{dt} dt + \int_a^{a+\tau} \frac{dD}{dt} dt, \quad (7)$$

where $\frac{dD}{dt}$ refers to the rate of intangible market premium (or “goodwill”). The intangible market premium, however, can be liquidized only on the real estate market, not on the timber market. Unless the real estate market is exploited, the closed integral is under periodic boundary conditions as

$$\int_a^{a+\tau} \frac{dD}{dt} dt = 0. \quad (8)$$

Further, the change rate of capitalization can be decomposed as

$$\frac{dK}{dt} = \frac{d\kappa}{dt} - \frac{dC}{dt} - \frac{dA}{dt} + \frac{dD}{dt} + \frac{dI}{dt}, \quad (9)$$

where $\frac{dA}{dt}$ is the rate of amortization, and $\frac{dI}{dt}$ is the rate of capitalized investments. In accordance with Equations (5), (7) and (8), with periodic boundary conditions, the closed integral

$$\int_a^{a+\tau} \left(\frac{d\kappa}{dt} - \frac{dC}{dt} + \frac{dD}{dt} \right) dt = \int_a^{a+\tau} \left(\frac{d\kappa}{dt} - \frac{dC}{dt} \right) dt = 0 \quad (10)$$

cannot retain intangible market premium unless the real estate market is exploited in the creation of revenue, instead of merely harvesting. As any accumulated premium deteriorates with harvesting, the phenomenon is here denoted as a *continuity problem* of value creation.

Considering a scaling factor $(1 + u)$ for capitalization K and the value change rate $\frac{d\kappa}{dt}$, the expected value of capital return rate may approach

$$\langle rI \rangle = \frac{\int_a^{a+\tau} \frac{d\kappa'}{dt} dt}{\int_a^{a+\tau} K' dt} = \frac{\int_a^{a+\tau} (1 + u) \frac{d\kappa}{dt} dt}{\int_a^{a+\tau} (1 + u) K dt} = \frac{\int_a^{a+\tau} \frac{d\kappa}{dt} dt}{\int_a^{a+\tau} K dt} = \langle r \rangle, \quad (11)$$

if goodwill premium on the real estate market is fully exploited. However, if the cash flow is created by timber sales only, the capitalization premium deteriorates with harvesting, and the expected value of the capital return rate becomes

$$\langle rI \rangle = \frac{\int_a^{a+\tau} \frac{d\kappa'}{dt} dt}{\int_a^{a+\tau} K' dt} = \frac{\int_a^{a+\tau} \frac{d\kappa}{dt} dt}{(1 + u) \int_a^{a+\tau} K dt}. \quad (12)$$

It is of interest that Equation (11), at best, retains the capital return rate, which, however, requires effective exploitation of the real estate market. It is also worth noting that even if Equation (11) is the same as Equation (4), the numerical value of the capital return rate generally is not the same. Deterioration of intangible goodwill in harvesting is avoided only in the absence of thinning, and omission of thinning generally contributes to the capital return rate.

Equation (12) performs a linear scaling of the capital return rate by the inverse of the capitalization scaling. Any of the two cases retain management practices in terms of optimal rotation ages and thinning schedules.

A capitalization premium does not need to be intangible. A tangible asset able to absorb a premium while timber prices and sales proceedings are retained is the bare land. Such capitalization premium does not affect the value change rate in the numerator of Equations (1)–(4). On the other hand, other components but the bare land in the denominator being retained, the effect on the expected value of the capital return rate depends on the proportions of the capitalization components. Correspondingly, there is no linear scaling of Equations (1)–(4), and the feasible management practices such as rotation ages and thinning schedules are not retained along with changed bare land valuation. It is worth noting that inflated bare land value does not induce any continuity problem.

2.2. The Two Applied Datasets

Two different sets of initial conditions have been described in four earlier investigations [7,47,48,50]. Firstly, seven wooded, commercially unthinned stands in Vihtari, eastern Finland, were observed at the age of 30 to 45 years. The total stem count varied from 1655 to 2451 per hectare. A visual quality approximation was implemented. The number of stems deemed suitable for growing further varied from 1050 to 1687 per hectare. The basal area of the acceptable-quality trees varied from 28 to 40 m²/ha, in all cases dominated by spruce (*Picea abies*) trees.

As the second set of initial conditions, a group of nine setups was created, containing three tree species and three initial sapling densities [48]. The idea was to apply the inventory-based growth model as early in stand development as applicable, to avoid approximations of stand development not grounded on the inventory-based growth model [51]. This approach also allowed an investigation of a wide range of stand densities, as well as a comprehensive description of the application of three tree species. The exact initial conditions here equal the ones recommended in [48], appearing there in Figures 8 and 9.

The two manifestations of inflated capitalization discussed above are applied to both datasets. Firstly, a proportional goodwill $(1 + u) = (1 + 1/2)$ is applied according to Equation (12). Secondly, a bare land value inflated by a factor $(1 + p) = (1 + 3)$ is applied in Equations (1)–(4). Both inflation factors are arbitrary. However, they are based on recent observations [13,15,17], including very recent observations by the author: large, productive forest estates appear to change owners at 150% of the fair forestry value determined by professionals.

3. Results

Figures 1 and 2 show the expected value of the capital return rate within seven stands first observed at the age of 30 to 45 years, in the presence of inflated capitalization and eventual thinning restrictions. Inflated bare land value yields greater capital return rates than proportional goodwill. The proportional goodwill retains rotation times, whereas inflated bare land value often increases rotation times. Thinning restrictions somewhat reduce the capital return rate and shorten rotation times. However, there are cases in which thinnings restricted to the removal of large trees only increase rotation times.

Figures 3–5 show the expected value of the capital return rate within stands of three tree species where the growth model is applied as early as applicable. Again, inflated bare land value yields slightly greater capital return rates than proportional goodwill. The proportional goodwill retains rotation times, whereas inflated bare land value generally increases rotation times. It is found that rotation times maximizing capital return rate become shorter with an increase in the strength of thinning restrictions.

Figures 6 and 7 show the stand capitalization as a function of stand age within seven stands first observed at the age of 30 to 45 years, in the presence of inflated capitalization and eventual thinning restrictions. The capitalizations are plotted until the rotation age maximizing the expected value of the capital return rate. Again, the proportional goodwill retains rotation times, whereas inflated bare land value often increases rotation times. Thinning restrictions mostly shorten rotation times; however, there are cases in

which thinnings restricted to the removal of large trees only increase rotation times. Despite the generally shorter rotation times, the gentler thinnings slightly increase capitalization.

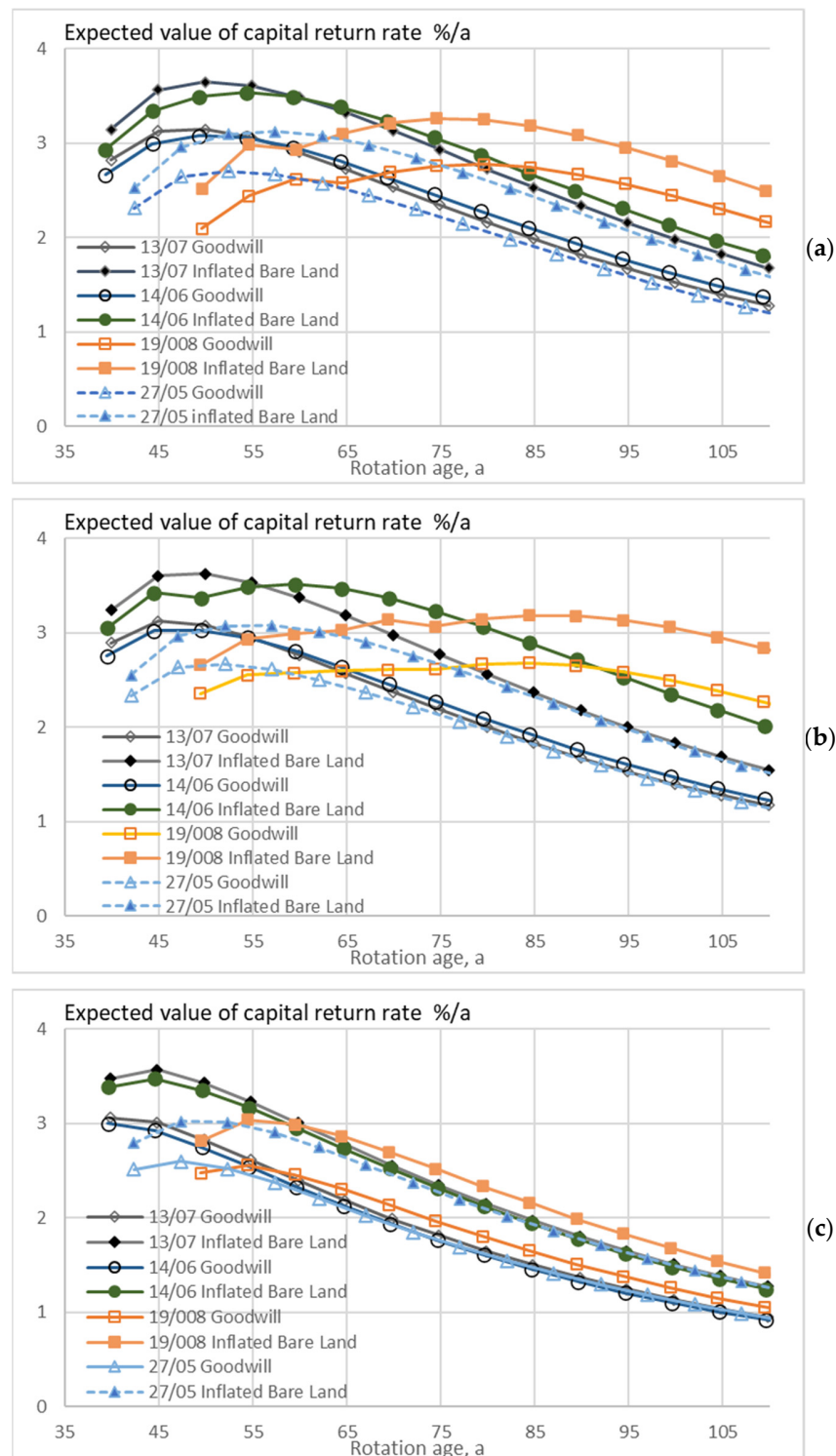


Figure 1. The expected value of capital return rate, as a function of rotation age, when the growth model is applied to four observed wooded stands, without any thinning restriction (a), good-quality trees of at least 238 mm of diameter only removed in thinning (b), and without any commercial thinning (c). Inflated capitalization is introduced either as proportional goodwill or as inflated bare land value; the numbers in legends identify stands and observation plots.

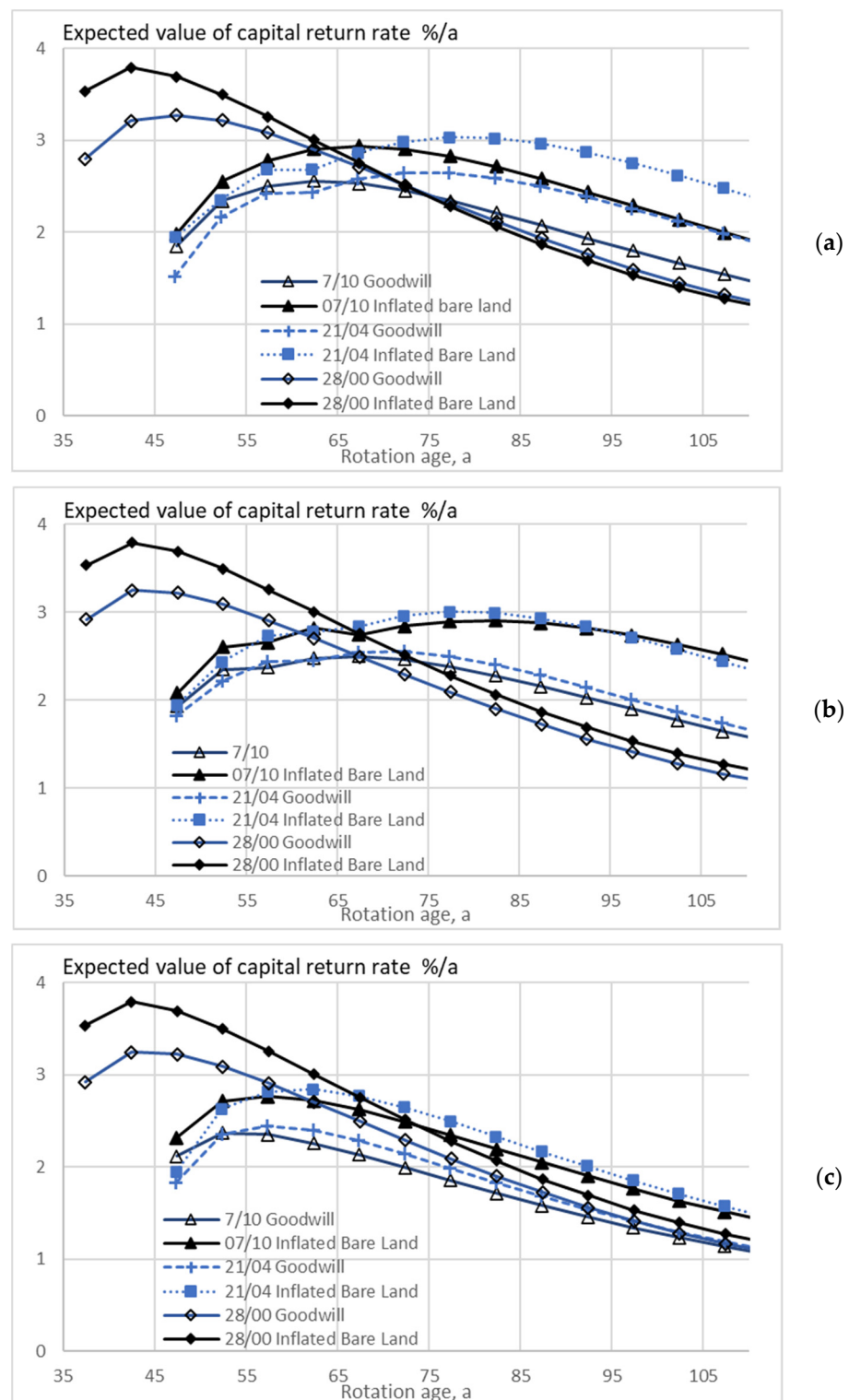


Figure 2. The expected value of capital return rate, as a function of rotation age, when the growth model is applied to three observed wooded stands, without any thinning restriction (a), in good-quality trees of at least 238 mm of diameter only removed in thinning (b), and without any commercial thinning (c). Inflated capitalization is introduced either as proportional goodwill or as inflated bare land value; the numbers in legends identify stands and observation plots.

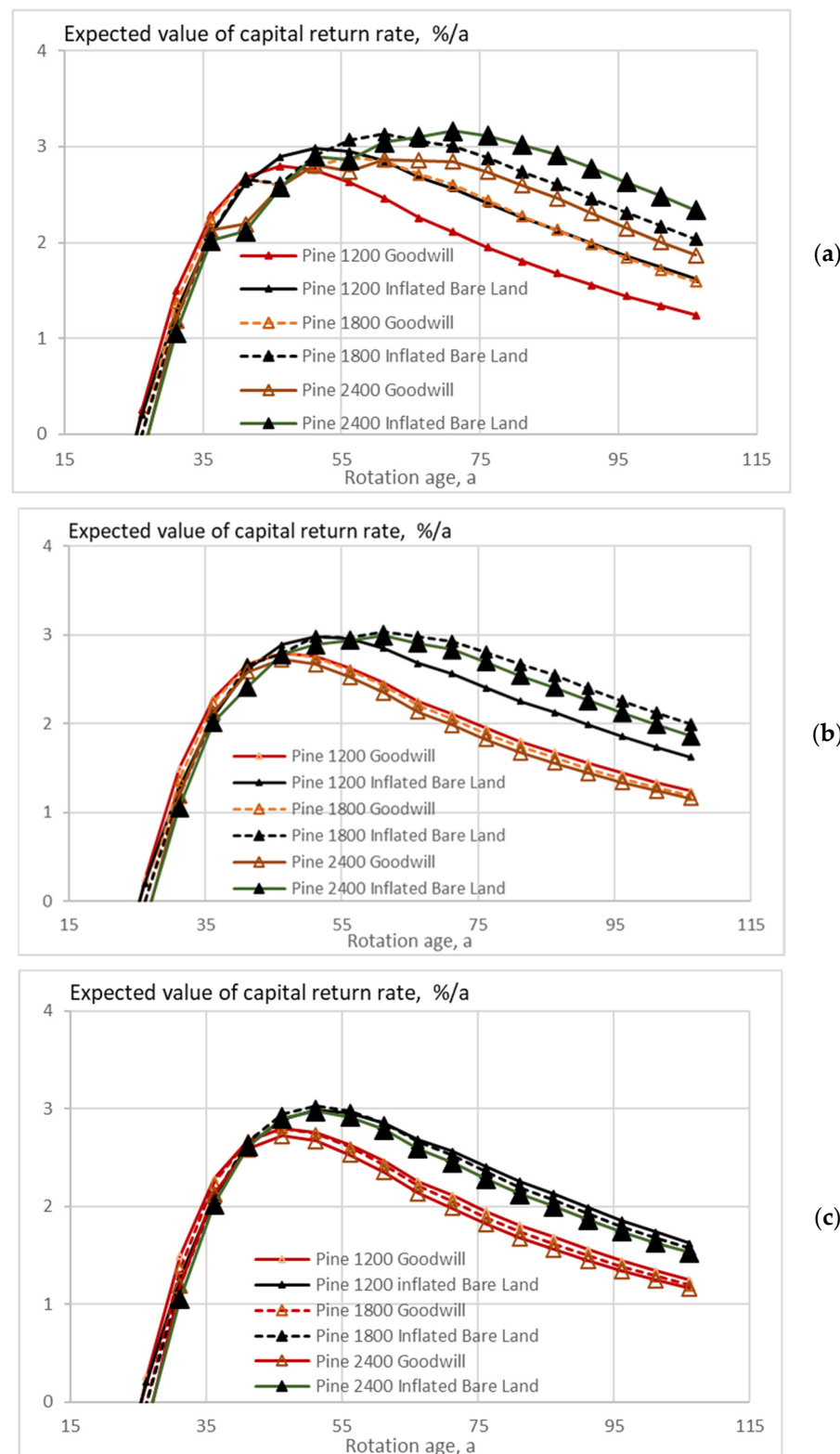


Figure 3. The expected value of capital return rate on pine (*Pinus sylvestris*) stands of different initial sapling densities, as a function of rotation age, when the growth model is applied as early as applicable, without any thinning restriction (a), in good-quality trees of at least 238 mm of diameter only removed in thinning (b), and without commercial thinning (c). Inflated capitalization is introduced either as proportional goodwill or as inflated bare land value.

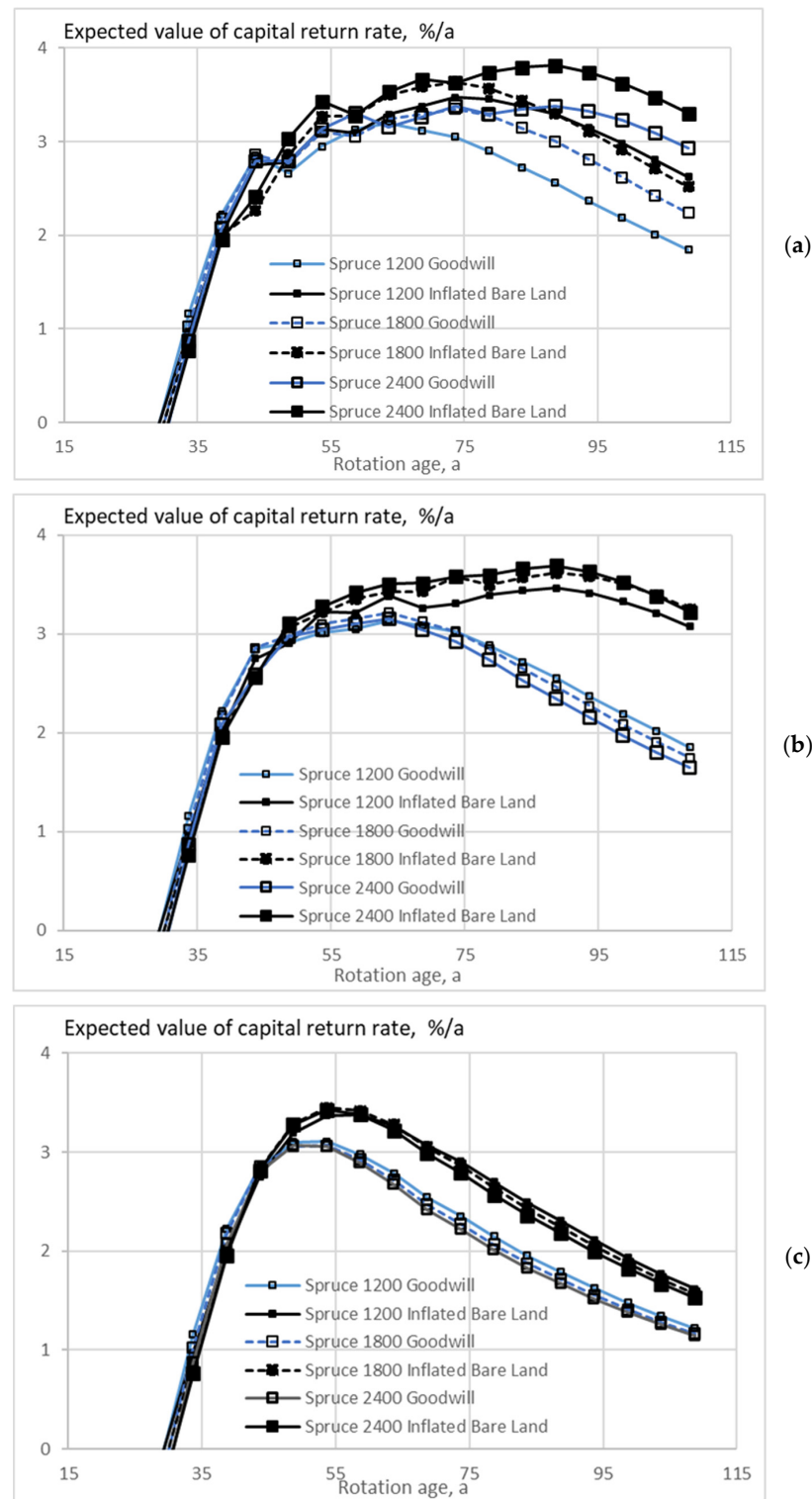


Figure 4. The expected value of capital return rate on spruce stands of different initial sapling densities, as a function of rotation age, when the growth model is applied as early as applicable, without any thinning restriction (a), in good-quality trees of at least 238 mm of diameter only removed in thinning (b), and without commercial thinning (c). Inflated capitalization is introduced either as proportional goodwill or as inflated bare land value.

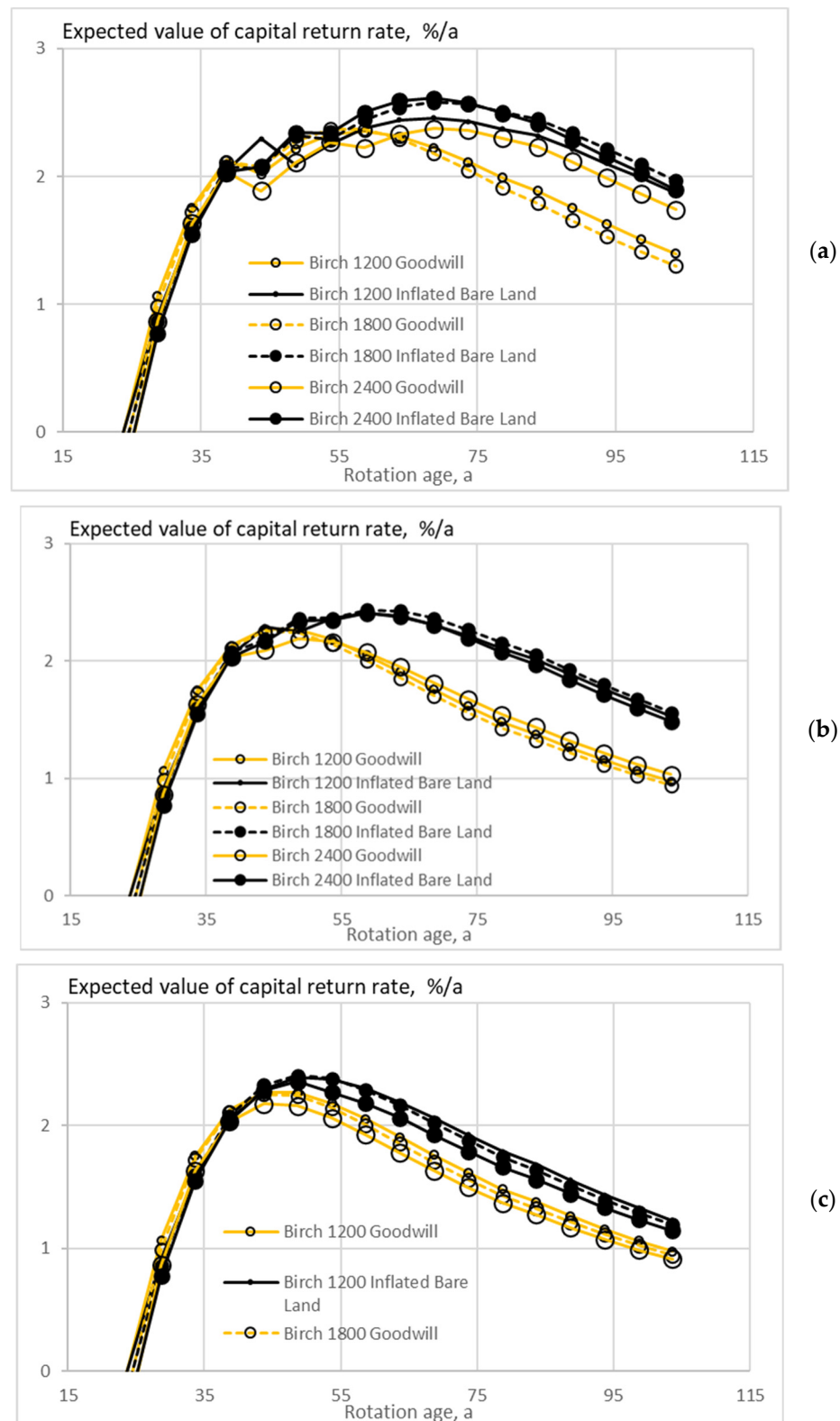


Figure 5. The expected value of capital return rate on birch (*Betula pendula*) stands of different initial sapling densities, as a function of rotation age, when the growth model is applied as early as applicable, without any thinning restriction (a), in good-quality trees of at least 238 mm of diameter only removed in thinning (b), and without commercial thinning (c). Inflated capitalization is introduced either as proportional goodwill or as inflated bare land value.

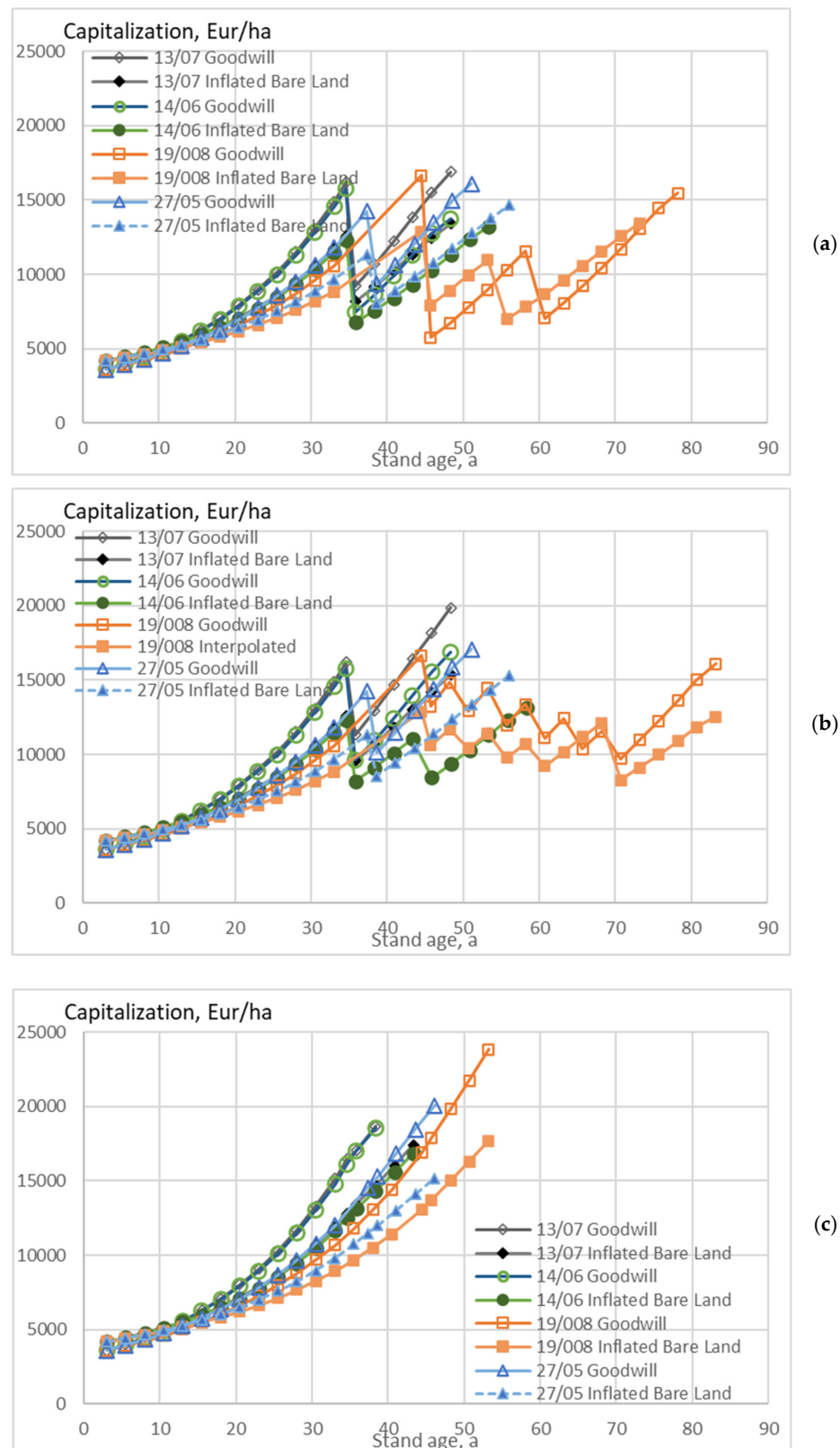


Figure 6. Stand capitalization as a function of stand age, when the growth model is applied to four observed wooded stands, without any thinning restriction (a), in good-quality trees of at least 238 mm of diameter only removed in thinning (b), and without any commercial thinning (c). Inflated capitalization is introduced either as proportional goodwill or as inflated bare land value; the numbers in legends identify stands and observation plots.

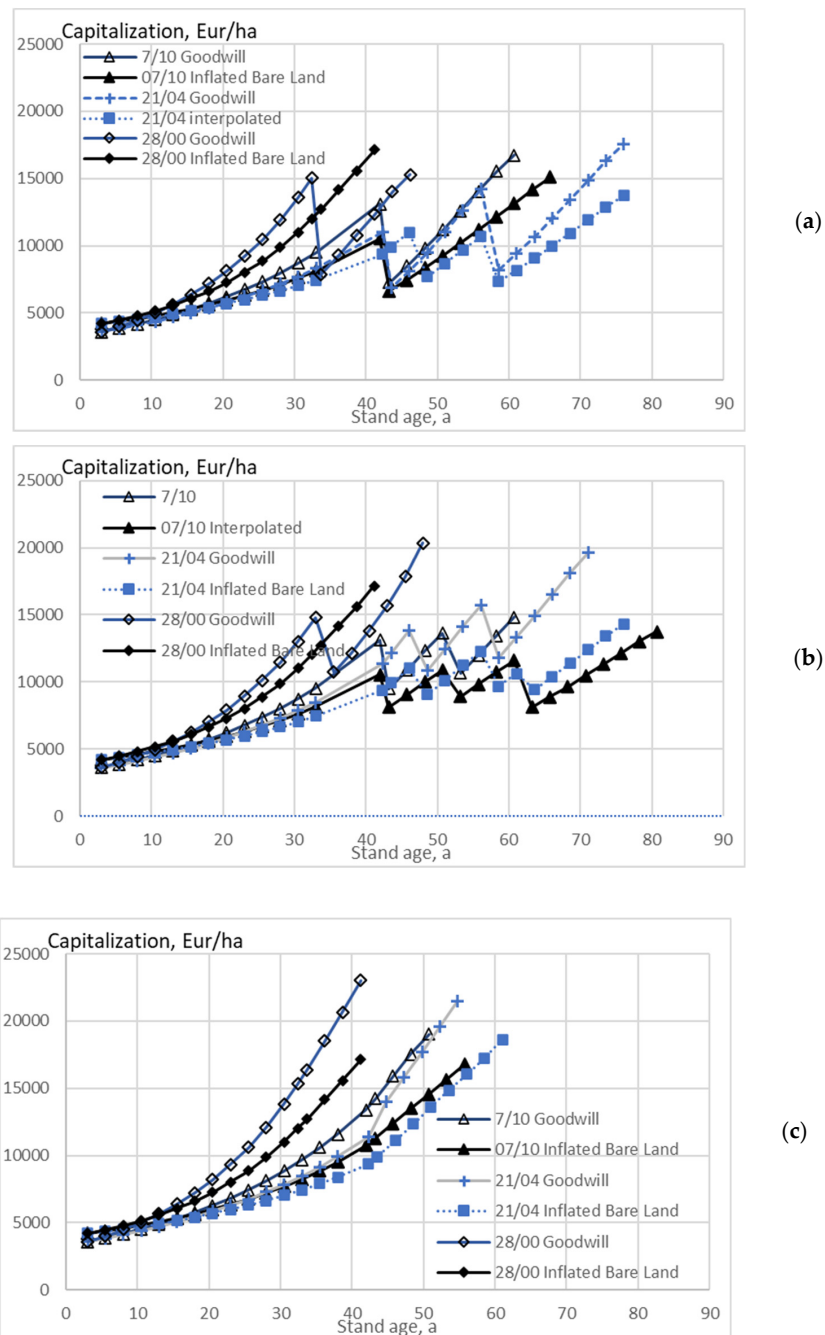


Figure 7. Stand capitalization as a function of stand age, when the growth model is applied to three observed wooded stands, without any thinning restriction (a), in good-quality trees of at least 238 mm of diameter only removed in thinning (b), and without any commercial thinning (c). Inflated capitalization is introduced either as proportional goodwill or as inflated bare land value; the numbers in legends identify stands and observation plots.

Figures 8–10 show the stand capitalization as a function of stand age within stands of three tree species where the growth model is applied as early as applicable, in the presence of inflated capitalization and eventual thinning restrictions. The capitalizations are plotted until the rotation age maximizing the expected value of the capital return rate. Again, while the proportional goodwill retains rotation times, inflated bare land value generally increases rotation times. Within spruce stands (Figure 9), there are cases in which thinnings restricted to the removal of large trees only increase rotation times. At young stand age,

inflated bare land gives greater capitalization; at a mature age, the proportional goodwill yields greater capitalization. Thinning restrictions shorten rotations. It is also found that thinning restrictions increase capitalizations.

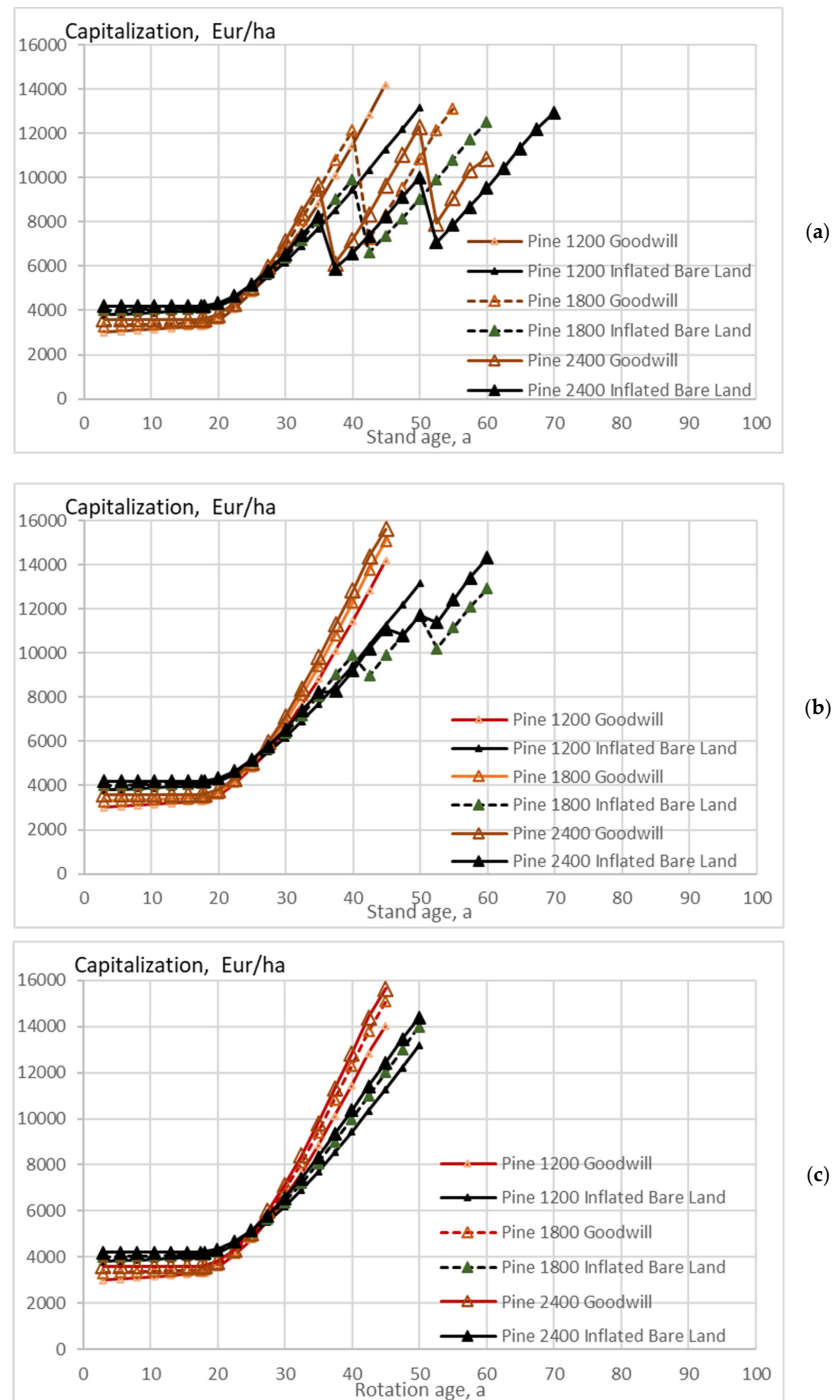


Figure 8. Capitalization on pine stands of different initial sapling densities, as a function of stand age, when the growth model is applied as early as applicable, without any thinning restriction (a), and in good-quality trees of at least 238 mm of diameter only removed in thinning (b), and without any commercial thinning (c). Inflated capitalization is introduced either as proportional goodwill or as inflated bare land value.

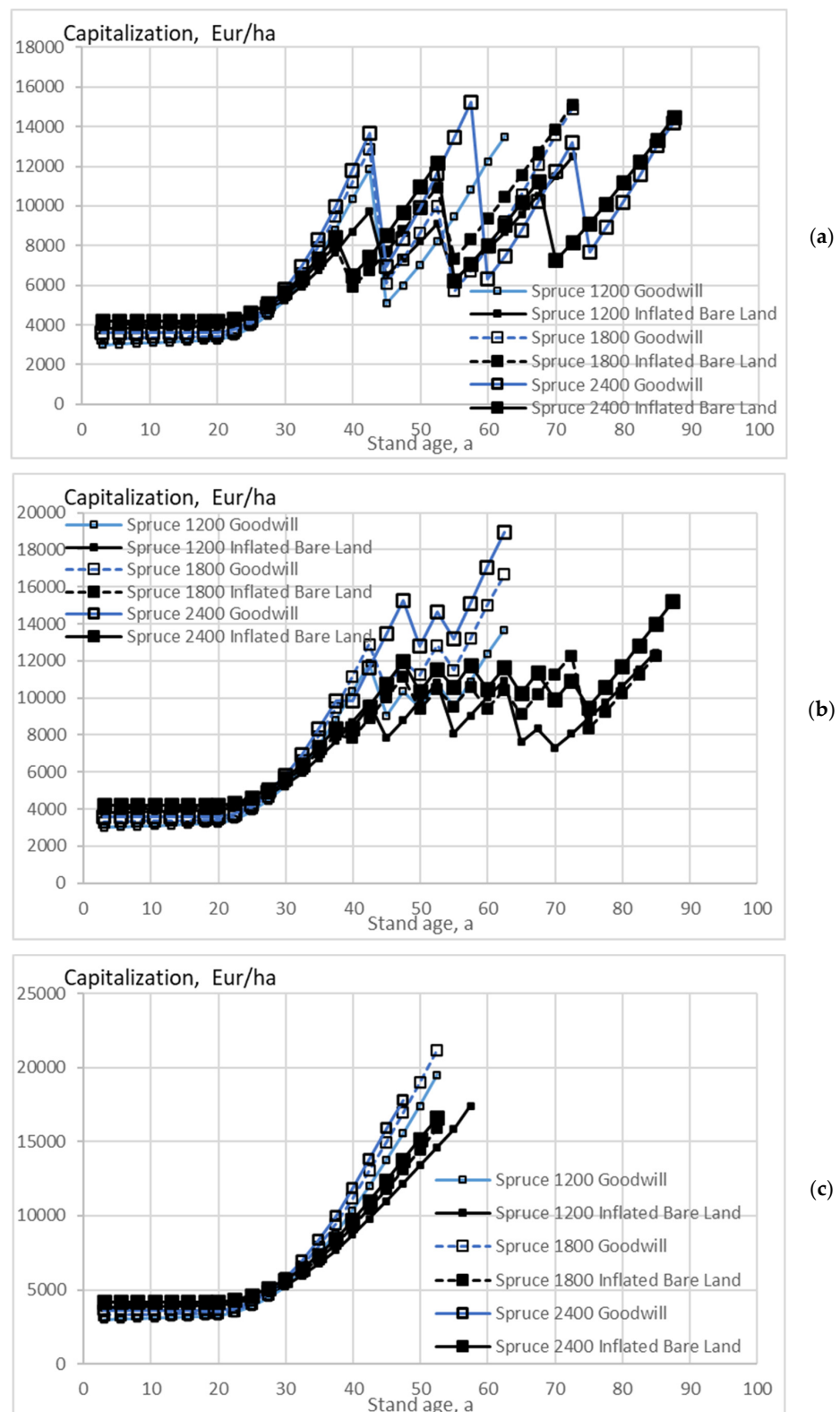


Figure 9. Capitalization on spruce stands of different initial sapling densities, as a function of stand age, when the growth model is applied as early as applicable, without any thinning restriction (a), in good-quality trees of at least 238 mm of diameter only removed in thinning (b), and without any commercial thinning (c). Inflated capitalization is introduced either as proportional goodwill or as inflated bare land value.

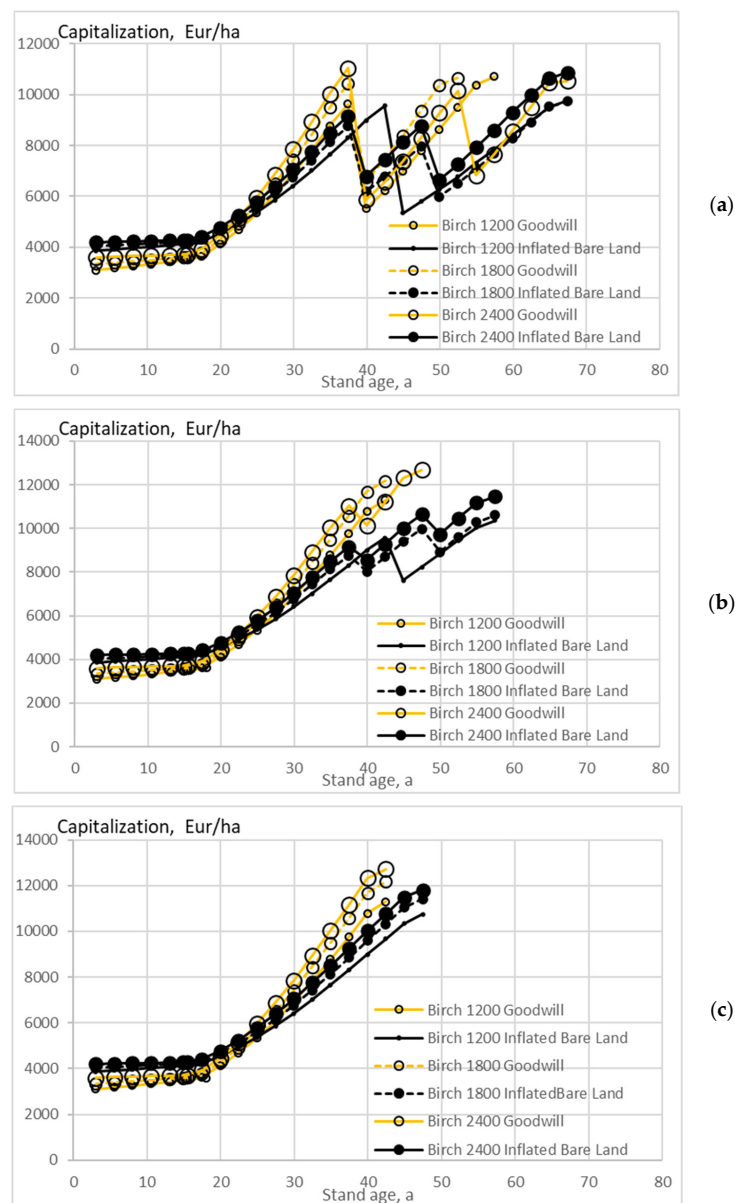


Figure 10. Capitalization on birch stands of different initial sapling densities, as a function of stand age, when the growth model is applied as early as applicable, without any thinning restriction (a), in good-quality trees of at least 238 mm of diameter only removed in thinning (b), and without any commercial thinning (c). Inflated capitalization is introduced either as proportional goodwill or as inflated bare land value.

In the absence of any thinning restrictions, management procedures maximizing the capital return rate correspond to a particular expected value of commercial timber appearing per hectare. Such average timber storage is shown in Figure 11, for the seven stands observed at the age of 30 to 45 years, and in the case of the nine setups where the growth model is applied as early as possible. It is found that the application of inflated bare land value (vertical axis) increases the expected value of stand volume by 2% to 23%. The magnitude of the increment does depend on the magnitude of bare land value inflation, and its variability is greater in the first dataset. The greatest relative increment occurs when inflated bare land value results in the omission of a thinning. On the other hand, the application of the proportional goodwill (horizontal axis) does not contribute to the timber storage, as indicated by Equation (12). It is, however, worth noting that if Equation (11) would be applied, the timber storage would be affected due to the omission of thinnings.

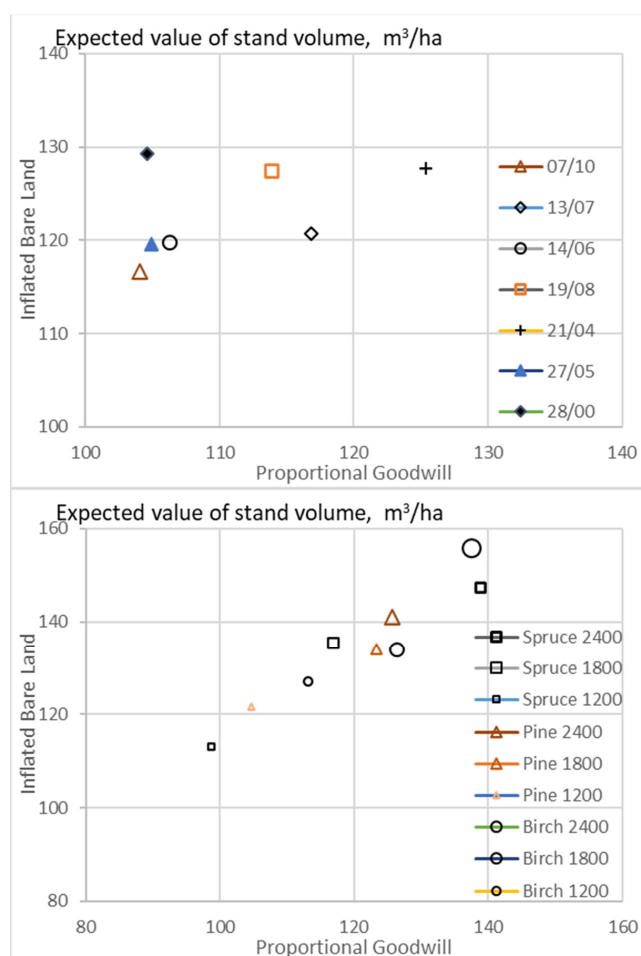


Figure 11. The expected value of commercial stand volume within the two manifestations of inflated capitalization, without any thinning restrictions, for the two datasets.

Any deviation from the procedures corresponding to the maximum capital return rate induces a deficiency in the capital return rate. Annual monetary deficiency per hectare can be gained by multiplying the deficiency in percentage per annum by the current capitalization per hectare. Any deviation from the procedures corresponding to the maximum capital return rate also changes the expected value of the volume of trees per hectare. In case the volume is greater than the volume corresponding to the maximum capital return rate, there is a positive expected excess volume (also a negative excess volume may appear). The annual monetary deficiency per hectare can be divided by the excess volume to yield a measure of the financial burden of increasing the timber stock.

Figure 12 shows the expected value of the capital return rate deficiency per excess volume unit as a function of excess volume, within seven stands first observed at the age of 30 to 45 years, in the presence of inflated capitalization and eventual thinning restrictions. The proportional goodwill shows a greater capitalization in Figures 6 and 7 and correspondingly a smaller capital return rate in Figures 1 and 2. These findings result from using Equation (12). However, the greater stand capitalization compensates for the smaller percentage deficiency. In other words, the capital expense for carbon storage is unchanged. Thinning restrictions reduce the deficiency and increase available excess volume. Thinnings restricted to trees larger than 237 mm in diameter show the smallest deficiency with moderate excess volume, while the omission of thinnings shows the smallest deficiency at large excess volumes.

Figures 13–15 show the expected value of the capital return rate deficiency per excess volume unit as a function of excess volume, within stands of three tree species where the

growth model is applied as early as applicable, in the presence of inflated capitalization and eventual thinning restrictions. The proportional goodwill shows a greater capitalization in Figures 8–10 and correspondingly a smaller capital return rate in Figures 3–5. These findings are due to using Equation (12). However, the greater stand capitalization compensates for the smaller percentage deficiency. In other words, the capital expense for carbon storage is unchanged. Thinning restrictions reduce the deficiency and increase available excess volume. Thinnings restricted to trees larger than 237 mm in diameter show the smallest deficiency with moderate excess volume, while the omission of thinnings shows the smallest deficiency at large excess volumes.

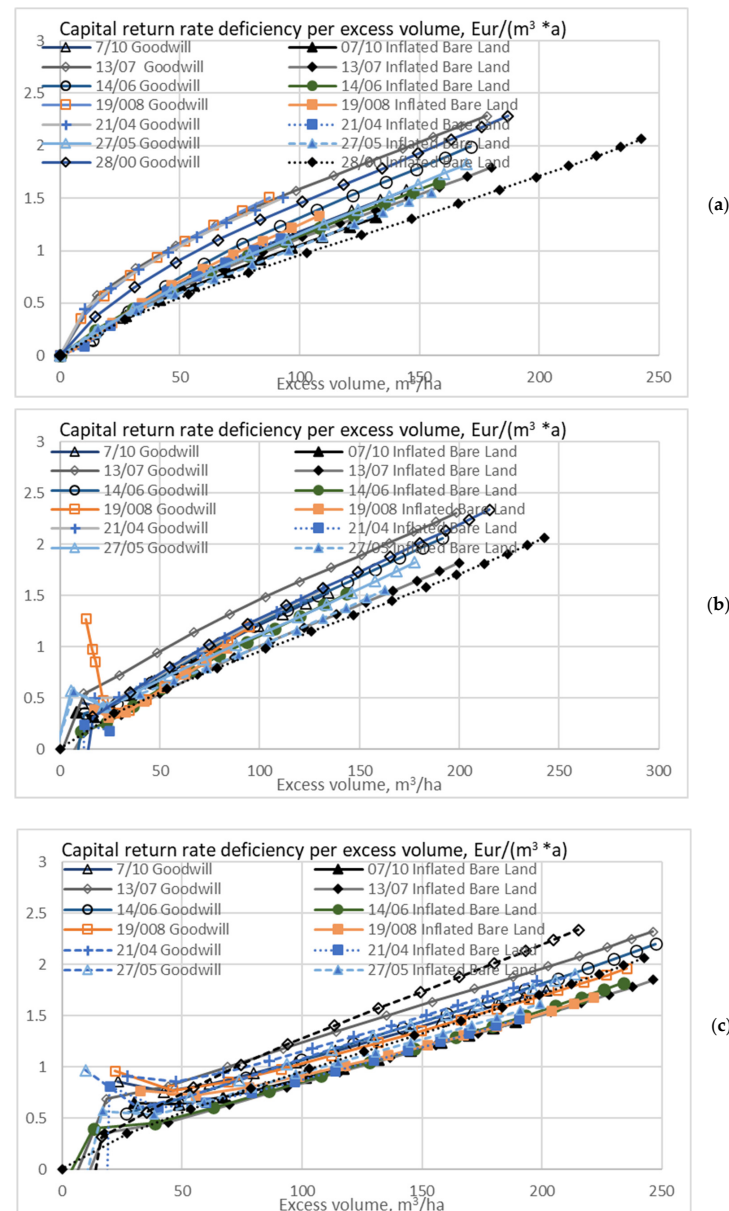
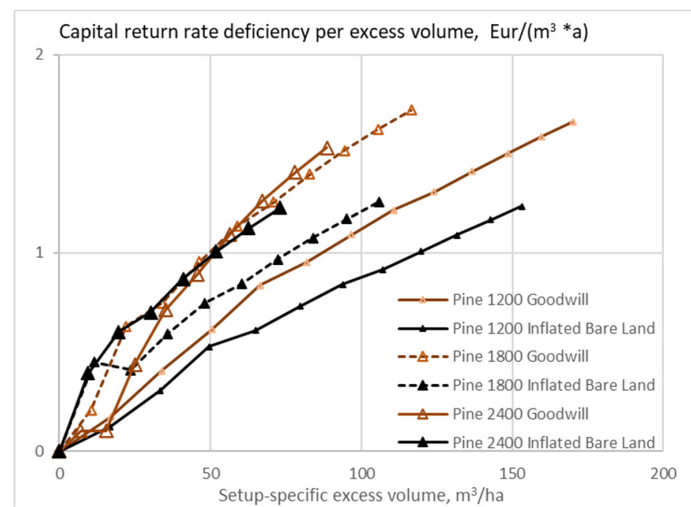
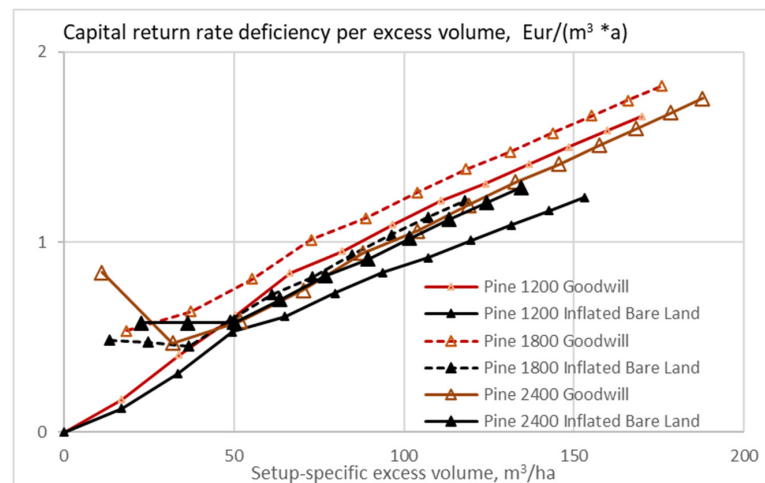


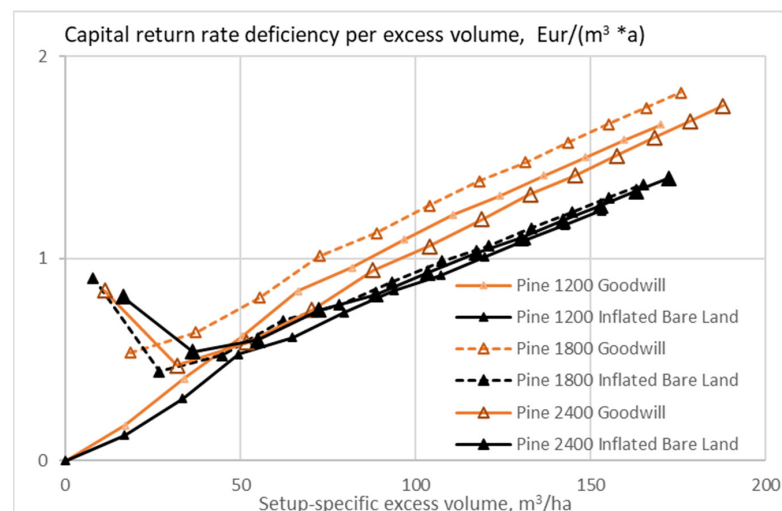
Figure 12. The expected value of capital return rate deficiency per excess volume unit, as a function of excess volume, when the growth model is applied to seven observed wooded stands, without any thinning restriction (a), in good-quality trees of at least 238 mm of diameter only removed in thinning (b), and without any commercial thinning (c). Inflated capitalization is introduced either as proportional goodwill or as inflated bare land value; the numbers in legends identify stands and observation plots.



(a)



(b)



(c)

Figure 13. The expected value of capital return rate deficiency per excess volume unit on pine stands of different initial sapling densities, as a function of excess volume, when the growth model is applied as early as applicable, without any thinning restriction (a) and in good-quality trees of at least 238 mm of diameter only removed in thinning (b), and without any commercial thinning (c). Inflated capitalization is introduced either as proportional goodwill or as inflated bare land value.

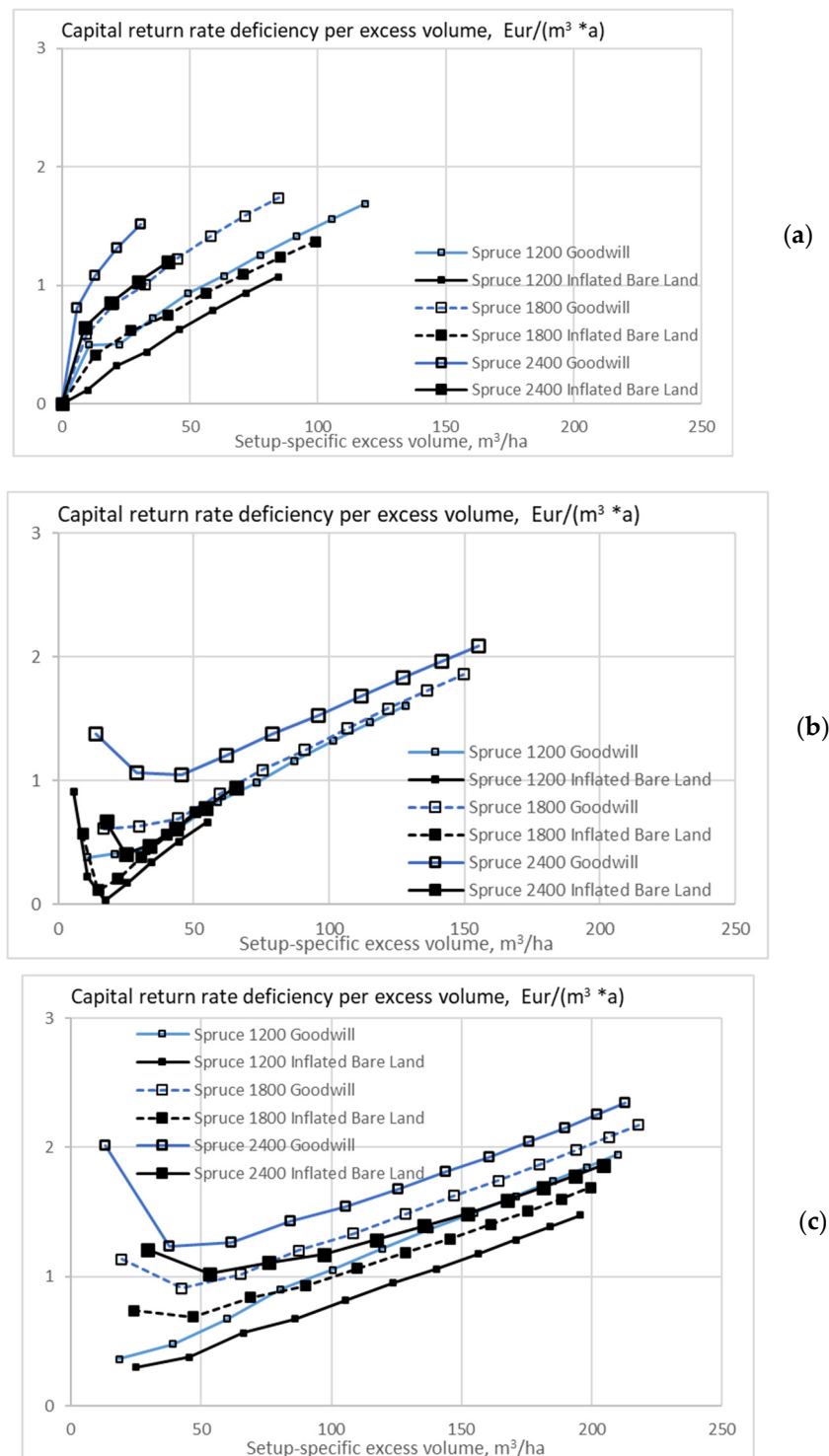


Figure 14. The expected value of capital return rate deficiency per excess volume unit on spruce stands of different initial sapling densities, as a function of excess volume, when the growth model is applied as early as applicable, without any thinning restriction (a), in good-quality trees of at least 238 mm of diameter only removed in thinning (b), and without any commercial thinning (c). Inflated capitalization is introduced either as proportional goodwill or as inflated bare land value.

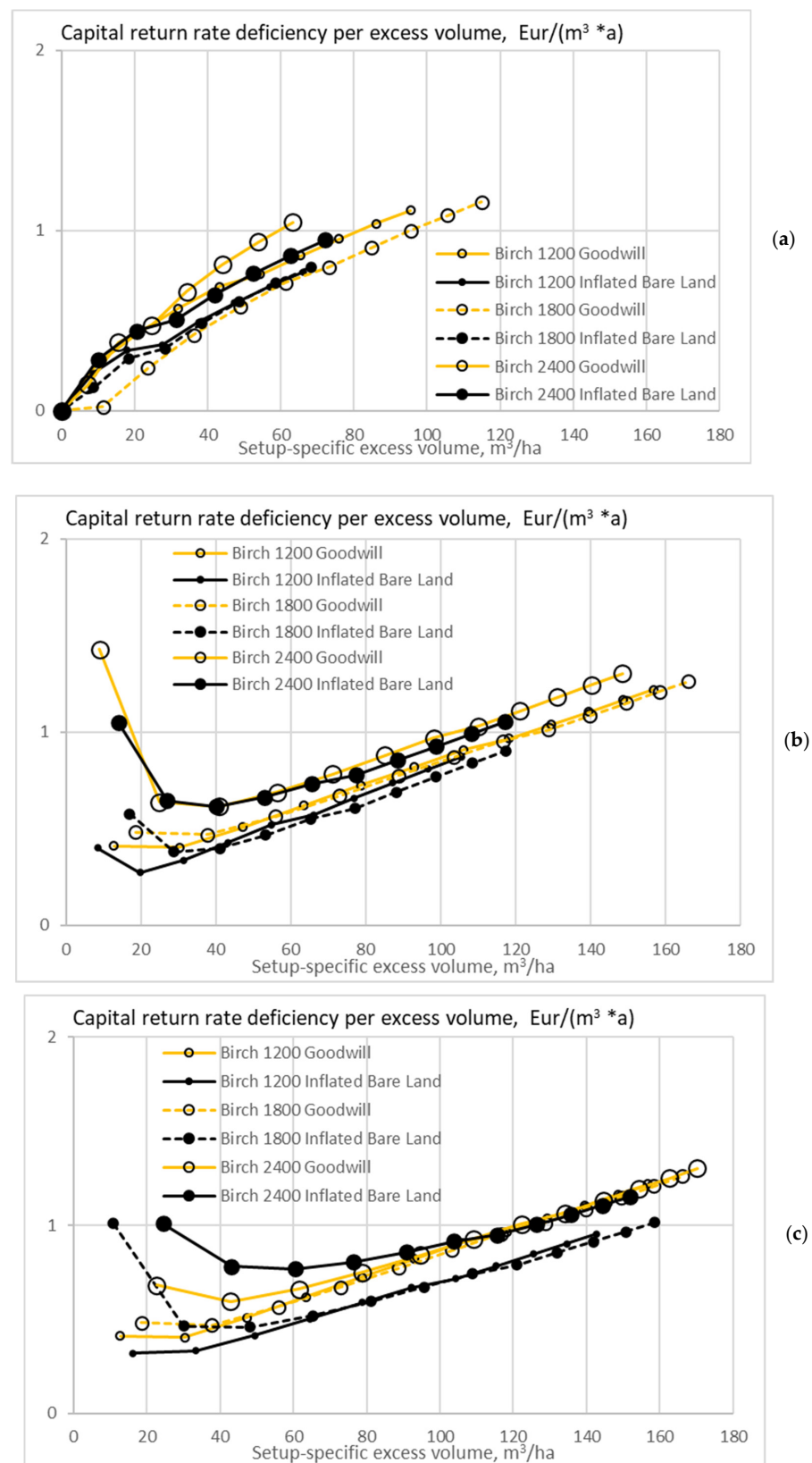


Figure 15. The expected value of capital return rate deficiency per excess volume unit on birch stands of different initial sapling densities, as a function of excess volume, when the growth model is applied as early as applicable, without any thinning restriction (a), in good-quality trees of at least 238 mm of diameter only removed in thinning (b), and without any commercial thinning (c). Inflated capitalization is introduced either as proportional goodwill or as inflated bare land value.

4. Discussion

When the growth model was applied on growing stands as early as applicable, control parameters included both thinning restrictions and the selection of tree species, as well as initial sapling densities. The capital return rate deficiencies plotted in Figures 13–15, however, are case-specific: Financially optimized treatment for any tree species and sapling density was taken as a reference point. It is possible to replot these figures with one common reference. We here selected spruce stands with a sapling density of 1200/ha as the common reference. The reason for this is that the capital return rate achievable according to Figure 4 is only slightly less than that obtained with spruce stands with greater sapling densities, but the duration risk is much less [52–54].

Applying a 50% proportional goodwill, it is found from Figure 16 that a small excess volume can inexpensively be gained by increasing sapling density. Greater excess volume is best achieved by restricting thinnings. A large excess volume is best achieved by omitting thinnings. These results are qualitatively the same as those in recent studies omitting any goodwill [7,8]. The reason is that the proportional goodwill merely induces a linear scaling in the capital return rate according to Equation (12), without affecting management practices.

There is another important consequence of the proportional goodwill in forest estate prices. As the intangible market premium cannot be liquidized at the timber market according to Equations (8) and (9), the premium deteriorates with harvesting. The premium can be converted into cash by selling the estate. Considering eventual tax implications, this may or may not be microeconomically feasible. Provided the forest-owning agent desires to stay in forestry, heavily wooded estates can be exchanged for young forests with a small intangible market premium. Then, it is a mystery what sense it makes to the buyer of any heavily wooded estate to purchase goodwill value that will later deteriorate in harvesting. This mystery may become partially explained by the ambitions of institutions willing to exit interest-bearing assets of negative real return [22,23].

Applying a 300% premium in bare land value, it is found from Figure 17 that a small excess volume can inexpensively be gained by increasing sapling density. Greater excess volume is best achieved by restricting thinnings. A large excess volume is best achieved by omitting thinnings. These results are qualitatively the same as those in recent studies omitting any goodwill [7,8]. The qualitative similarity appears even if the inflated bare land value does not induce any linear scaling in the capital return rate, and it indeed affects management practices, as indicated in Figures 1–15. The inflated bare land value changes the capital return rate according to Equations (1)–(4), and it also affects the capital return rate deficiency. As Figures 1–15 indicate, the expected values of capital return rate are greater and the capitalizations lower than those in the case of the proportional goodwill. This is due to the proportional goodwill hitting large capitalizations, whereas the bare land inflated is a relatively small capitalization component. However, the capital return rate deficiencies in Figures 16 and 17 are roughly the same order of magnitude. This is because the greater capitalization compensates for the reduced percentage deficiency appearing in Equation (12). The relationship, however, depends on the magnitude of the goodwill and the inflation.

Interestingly, the two independent sets of initial conditions appear to yield similar results. In addition, there are similar findings for the two manifestations of inflated capitalization. The capital return rate is a weak function of rotation age, which results in variability in the optimal number of thinnings (Figures 1–6). Restricting thinnings increases timber stock but reduces rotation age (Figures 1–10). Increased timber stock induces a capital return rate deficiency (Figures 12–17). The deficiency per excess volume unit is smaller if the severity of any thinning is restricted, in comparison to extending rotations (Figures 12–17). Moderate increases in timber stock can be gained by restricting thinnings to large trees, while large increases are best achieved by omitting thinnings (Figures 12–17). Interestingly, these results align with those reported previously without inflated capitalization [7,8].

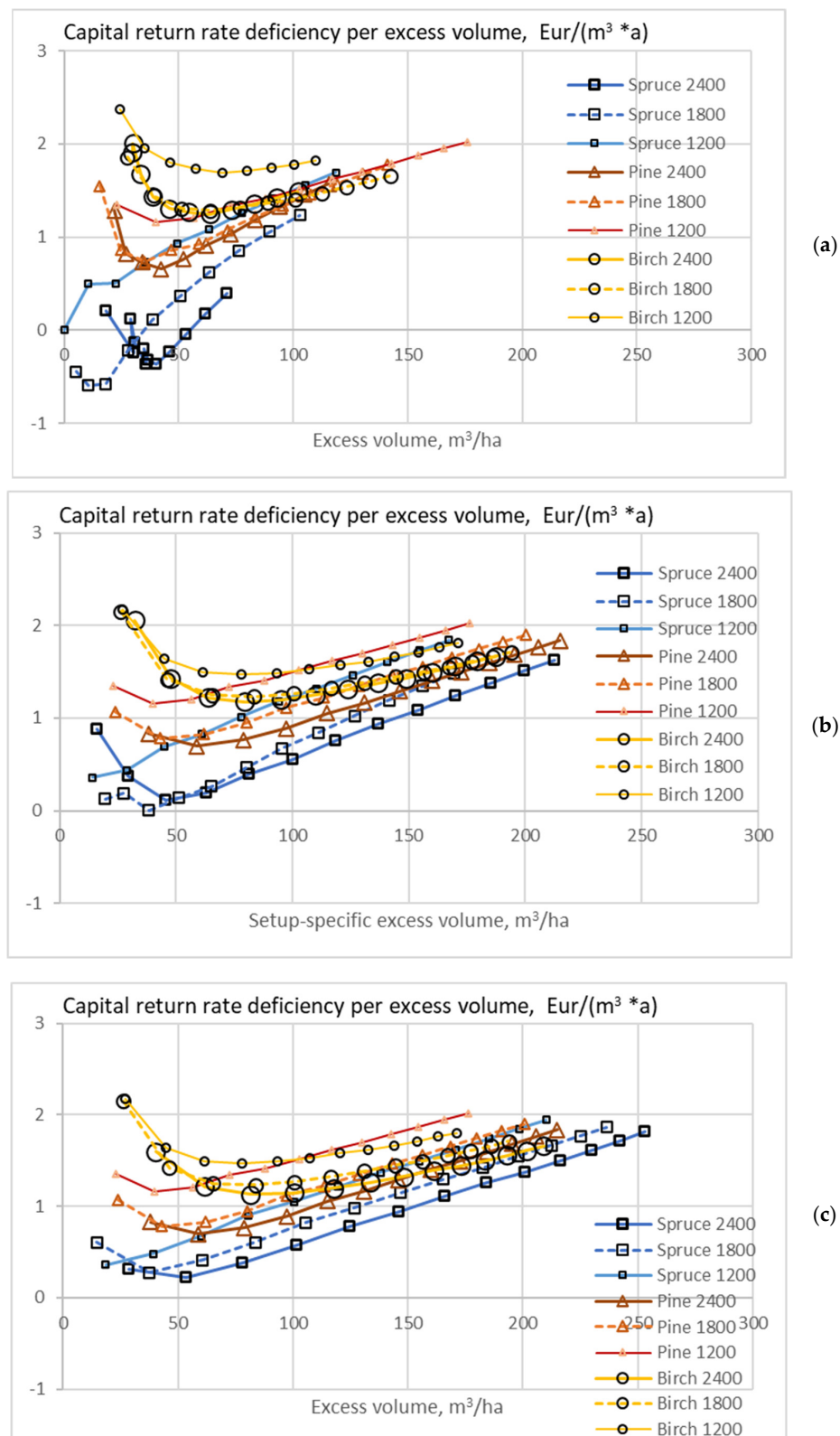


Figure 16. The expected value of capital return rate deficiency per excess volume unit on stands of different initial sapling densities, with proportional goodwill, as a function of excess volume, when the growth model is applied as early as applicable, without any thinning restriction (a), in good-quality trees of at least 238 mm of diameter only removed in thinning (b), and without any commercial thinning (c). The expected value of capital return rate and stand volume from spruce stands with 1200 saplings per hectare is taken as the common reference.

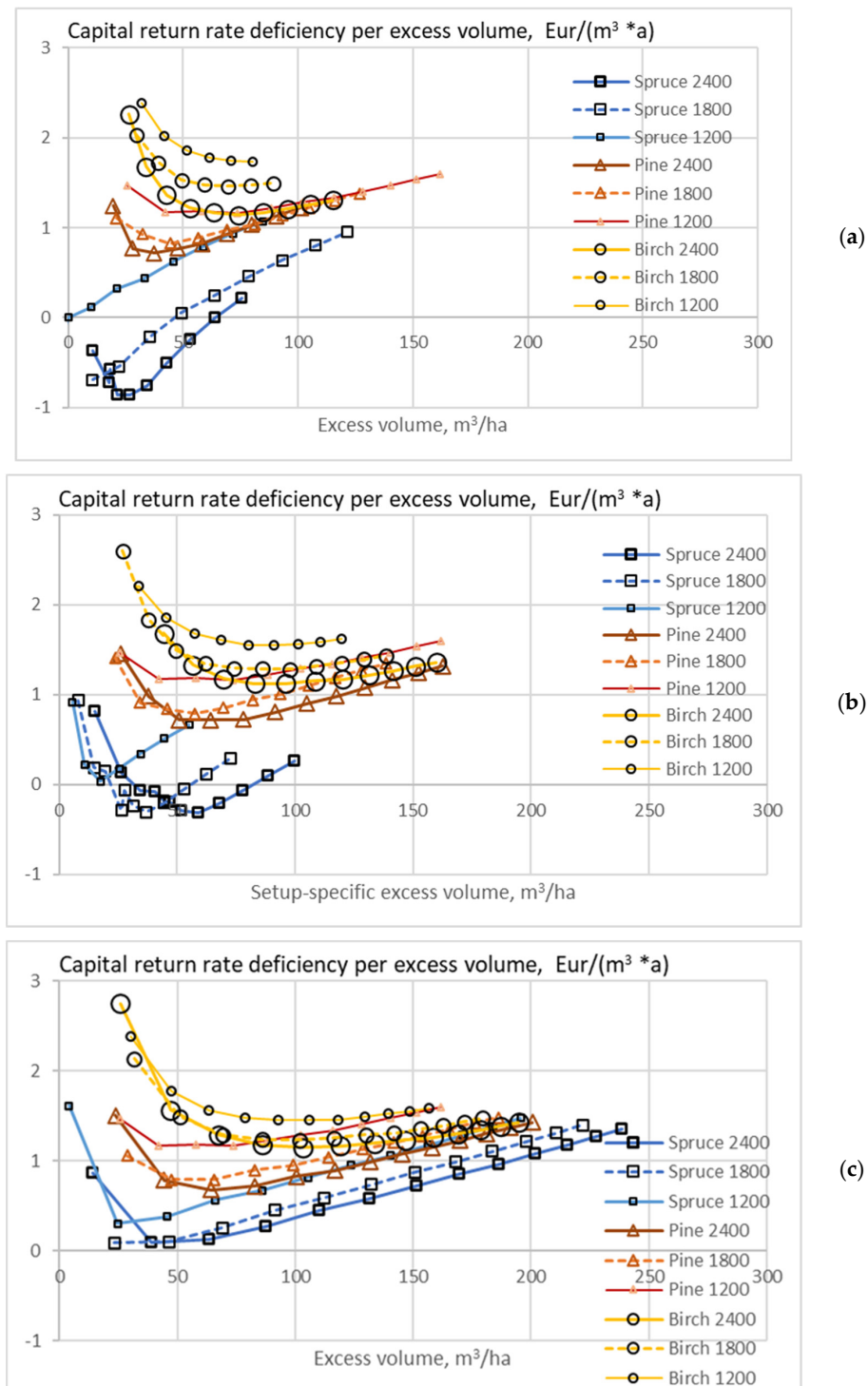


Figure 17. The expected value of capital return rate deficiency per excess volume unit on stands of different initial sapling densities, with inflated bare land value, as a function of excess volume, when the growth model is applied as early as applicable, without any thinning restriction (a), in good-quality trees of at least 238 mm of diameter only removed in thinning (b), and without any commercial thinning (c). The expected value of capital return rate and stand volume from spruce stands with 1200 saplings per hectare is taken as the common reference.

If cash flow is created by timber sales only, the proportional capitalization premium deteriorates with harvesting, and the capital return rate becomes linearly scaled according

to Equation (12). However, exploiting the real estate market may, at least partially, prevent the deterioration of the premium. Implementation of this is far from straightforward, and Equation (11) must be considered as a rough and possibly optimistic approximation. The utilization of the premium in the real estate market likely requires significant changes in forest management, which is discussed in detail in forthcoming studies.

The presented quantitative results depend on the magnitude of the capitalization premia. The premia used in this study were somewhat arbitrary but based on recent observations from the Nordic Region [13,15,17], including very recent observations by the author: Large, productive forest estates appear to change owners at 150% of fair forestry value determined by professionals—a recent approximation in the press has been 150 to 200% [55]. Correspondingly, the quantitative results reported are probably within a valid range, and the financial continuity problems demonstrated are real. On the other hand, with vertical integration driving the inflation of estate prices in many developing countries [29], inflated bare land value may be closer to reality. In the latter case, financially optimal procedures are affected, but no financial discontinuity appears.

It is still worth considering whether there are some fundamental grounds for proportional goodwill in market prices. There may be. First, the present value of income (or value) from the following rotation can be discounted to the present time. Secondly, income from several future rotations can be described in terms of a geometric series. The result is a coefficient of value multiplication, often in the order of the observed “goodwill” magnitude. Such coefficient depends only on the applied discount rate and rotation length—the value increment is proportional. Does this change the problematics regarding continuity problems? No, it does not. Harvesting deteriorates value.

Figures 16 and 17 indicate that a significant excess volume can be produced at the expense of a monetary capital return rate deficiency in the order of one to two Euros/excess cubic meters per annum. This can be easily compensated by a carbon rent derived from European carbon emission prices valid at the time of writing [7,8,46,56]. On the other hand, such compensation is needed to achieve a large-scale increment in carbon sequestration. It has been recently shown that the carbon stock can be increased without deteriorating the wood supply for forest-based industries [7].

5. Conclusions

It was shown that proportional goodwill in capitalization induces linear scaling of the financial return, without any contribution to sound management practices. However, there is a financial discontinuity, as harvesting deteriorates goodwill. Such deterioration might be partially avoided by entering the real estate market. Conversely, a capitalization premium set on bare land as a tangible asset would increase timber storage and carbon sequestration. Observations indicated that the proportional goodwill is closer to reality within the Nordic Region, resulting in continuity problems.

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