Discount Rate and Harvest Policy: Implications for Baltic Forestry

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Abstract
The free market economy, to which East European countries are increasingly being exposed, implies that classical budgeting techniques in the form of the Faustmann approach present themselves as the tools of choice for forest investment analysis. One implication is that the choice of a proper discount rate (*r*) must be made as part of the basis for formulating a harvest policy. The paper discusses this choice in the light of practice as well as theory, and, using Lithuania as a case, examines the potential economic and political impact of softening the current restrictions on forest management.

A review of the debate on discounting in forestry is provided. A statistical analysis of the relation between reported *r*s and internal rates of return (IRR) from numerous studies on forestry investments reveals a strong correlation between *r* and IRR. Possible explanations are provided. Analysis reveals that application of any positive *r* will significantly change forestry practice in Lithuania. Setting r = 3 per cent, slow growing species are to be replaced by fast growing species, and rotation periods should be substantially shortened. The standing volume of (over-) mature forests is about 160 million m^3, as compared with the currently harvestable volume of about 40 million m^3 according to the minimum allowable rotation age. The macroeconomic perspectives of cashing some of the mature forest for the small transition economy are discussed, taking into account the effects of externalities of forests. Consequently we suggest an alternative formulation of the normal forest.

Finally, based on these considerations, a real *r* of 0-2 per cent is suggested for State forestry in Lithuania. A post-tax *r* of 2 per cent is advocated for private forestry, with potential project specific deviations downward to 0 or upward to 4 per cent. It is stressed that discount rate is viewed as one of important decision parameters and due regard should be given to non-timber forest outputs, social and institutional settings and other factors.

Keywords: transition economy, Lithuanian forestry, economic analysis, discounting.

1. Introduction

Since the Faustmann formula became widely recognised, the discount rate (r) has been an important variable in forest investment analysis. Soil expectation value (SEV) is the basic criterion for optimising silvicultural regimes, sequential choice of management units for various silvicultural activities, joint optimisation of timber and non-timber outputs, etc. Forest investment analysis continues to be based on the Faustmann formula, though often in modified forms which account for risk, uncertainty, and externalities, and allow more flexible treatment of various parameters in different time periods, e.g. Chang (1998). There is an enormous number of studies demonstrating the high dependency of silvicultural decisions on the r. However, few studies discuss which r is the most appropriate, and the rate used often differs from one study to another even if the economic conditions are similar.

This creates confusion among forestry scientists and practitioners in East European countries where forestry research experiences a swift shift in its content and objectives, especially as regards forest economics. Traditionally, forest science and silviculture have focused on biological aspects, while economic objectives were expressed indirectly, e.g. maximising the volume of certain timber assortments (so-called technical maturity) when deciding on optimal rotation ages. Financial criteria such as net present value or forest rent were not used in the central planning economies.

Transition to the market economy implies that forest investment analysis becomes part of decision making in the State and especially in private forestry. Forest economics based on Faustmann-like principles suggests itself as the common tool of practice and progresses to an important subject within the forestry curriculum in East European countries. Yet the choice of discount rate remains an unexplored issue. Estimation of a suitable discount rate is not a trivial task when the experience of decision making under market economy conditions is absent. The matter is further complicated as the importance of non-timber forest benefits gradually increases. Relying on the experience of countries with long forestry tradition under market economy and on the socio-economic and environmental aspects of forestry in transition economies, this paper aims at analysing the effects of the discount rate with focus on appropriate use of modern economic methods in Baltic countries, with Lithuania as a case.

2. Learning from experience

2.1 A review of theoretical arguments

While the choice of *r* is a new topic for East European forestry, it has for decades been an issue of fierce debates in economic literature. A brief review of some frequently used arguments is worthwhile before analysing the effect of a particular *r*.

Three notable groups can be separated: Advocates of the forest rent school, the soil rent or opportunity cost advocates, and a large group trying to find a steady ground for some compromise between the recommendations of the two other schools.

The origins of the 'forest rent' school are found in classical German forestry. The concept of time preference hardly had any relevance in developing the theory of the normal forest. Defenders of forest rent reject the idea of discounting in forestry. No time preference is assumed and simply the average annual cash flow is maximised. Various arguments have been raised against discounting, such as ethical indefensibility (Ramsey 1928), depletion of natural resources (Clark 1973), and intergenerational equity (Hampicke 1991).

In theory, if not always in practice, the forest rent criterion was substituted by the soil rent criterion in many countries. Within the soil rent school, the opportunity cost of capital has been favoured as a criterion for ensuring efficient allocation of resources in forestry, e.g. Row et al. (1981). Some forest economists obtain lower than conventional discount rates, while still using the traditional opportunity cost of capital criterion. Holten-Andersen (1990) presents analyses of the Danish bond market for the period 1819 to 1987. Taking into account the Danish income taxation system it is concluded that the long-term real interest rate lies in the range from 2 to 4 per cent on pre-tax basis and from 0 to 3 per cent on post-tax basis. Analyses of returns on corporate bonds in the USA (1960-1978) led Row et al. (1981) to recommend a 4 per cent *r* to be used in investment analysis in the US Forest Service. Such rate well explains the behaviour of forest investors in the Pacific Northwest region of the USA, but it fails for Southern USA where rotation ages of 25-35 years for loblolly pine suggest that rates of 7 to 8 per cent are used (J.D. Brodie, pers. com., 1999). Opportunity cost of capital should not be that different between various regions of the USA. Some prominent economists contend that in long-term physical investments such as forestry the *r* should be high due to the related risks and uncertainties (Samuelson 1976) and the loss of liquidity (Kronrad and de Steiguer 1983).

Changing environmental attitudes, and the imposed image of barely profitable forestry venture, probably were the most important forces inducing the influential group of compromise seekers. Justification of special, low discount rates for forestry has been fastened with new arguments, in addition to those employed by advocates of forest rent. For example, Leslie (1989) insists that there is no empirical evidence of using high, industrially competitive interest rates in forestry and that such rates favour forest plantations instead of natural forest management practices. However, there is no clear answer to the question of how the desired low rates of 2 to 4 per cent should be obtained to reduce the revealed subjectivity of the choice. Controversial arguments were raised for justifying the social *r* that became a substitute for the conventional *r* in socioeconomics of natural resources. Social time preference rate and social opportunity cost have both been advocated as appropriate criteria for determining *r*. Pearce and Turner (1990) support the neo-classical view that the social time preference rate should be higher than the pure time preference rate of interest, “since future societies are likely to be richer than current ones” (p. 213). Argumentation for the social opportunity cost tends to place the social *r* within “Faustmann ranges”, as it resembles the desire for the efficient allocation of resources. Yet, many economists in natural resource management and in forestry specifically argue contrariwise: The social *r* should be lower than the private *r* due to market imperfection and presence of externalities.

Harou (1984) suggests that previous experience of social *r* or presentation of net present values at different *r*s to decision makers, can help for determining the social discount rate. The upper and lower bounds might be obtained using the average of resulting internal rates of return (IRRs) and the average of used *r*s, respectively. Furthermore, the social opportunity cost is involved for correcting the resulting net present values to account for the displacement of private investments. Time has shown that neither Harou’s nor other methods for deriving the social *r* have found considerable application in practical forest investment analysis. This is not surprising, knowing the burden of required information combined with the fragility of assumptions (Price 1988).

Zinkhan (1988) represents the group of economists adopting the Capital Asset Pricing Model (CAPM). He finds that required rates of return in forestry projects are lower due to the risk reduction benefits. This effect is obtained via negative correlation between returns from forest investments and the returns of an aggregate stock market index. While it may be argued that forest owners do not hold the market portfolio or any other highly diversified portfolio, it should still be stressed that in many cases a forest is itself a somewhat diversified portfolio. The use of several tree species and the production of different roundwood products, as well as non-wood products like hunting, can result in a considerable risk reduction.

Thorsen (1999) analyses prices for spruce, oak and beech assortments in Denmark 1912-1992. He finds that correlation between prices of roundwood from the different species is considerably less than 1, implying that reductions in risk may be obtained. Furthermore, the coefficient of variation of prices is significantly lower for high-grade products than for pulpwood products for all three species. This suggests a relatively lower *r* for forest stands producing high-grade products due to the reduction in the risk premium, but the amplitude of this reduction remains to be discussed. Klemperer et al. (1994) argue that risk premiums for forestry investments should be lower, as the long-term nature of forest production implies unreasonably low certainty equivalents for expected values of forestry investments if the risk premium is fixed at a moderate level. Thus, taking risk into account will not necessarily increase discount rates in forestry above that observed in other economic sectors and may even, depending on the actual nature of the risk in the specific case, be considerably lower.

Some authors yet argue for the use of risk free interest rates in investment analysis, as Price (1993) does in his comprehensive and challenging work on discounting. With the help of numerous examples, Price demonstrates flaws associated with traditional arguments - based on opportunity cost of capital and human time preference on consumption. Finally, the overall practice of conventional discounting is questioned, as "track of values through time is not generally a negative exponential" (p. 344). Although calling for caution, this assertion cannot help much in solving our problem: which *r* is appropriate for forest investment analysis in Eastern Europe. However, it is acknowledged that the *r* is only one out of a group of parameters and criteria for decision making and the common effect of introducing an *r* may be blurred, e.g. due to restrictions in the form of sustainability in a technical and economic sense.

Summarising the debate on discounting, the most commonly used arguments for a certain *r* are presented in Figure 1. It may be concluded that neither these arguments, nor the examples of discount rates applied in various countries and regions provide a straightforward answer to the question of choosing an *r*.

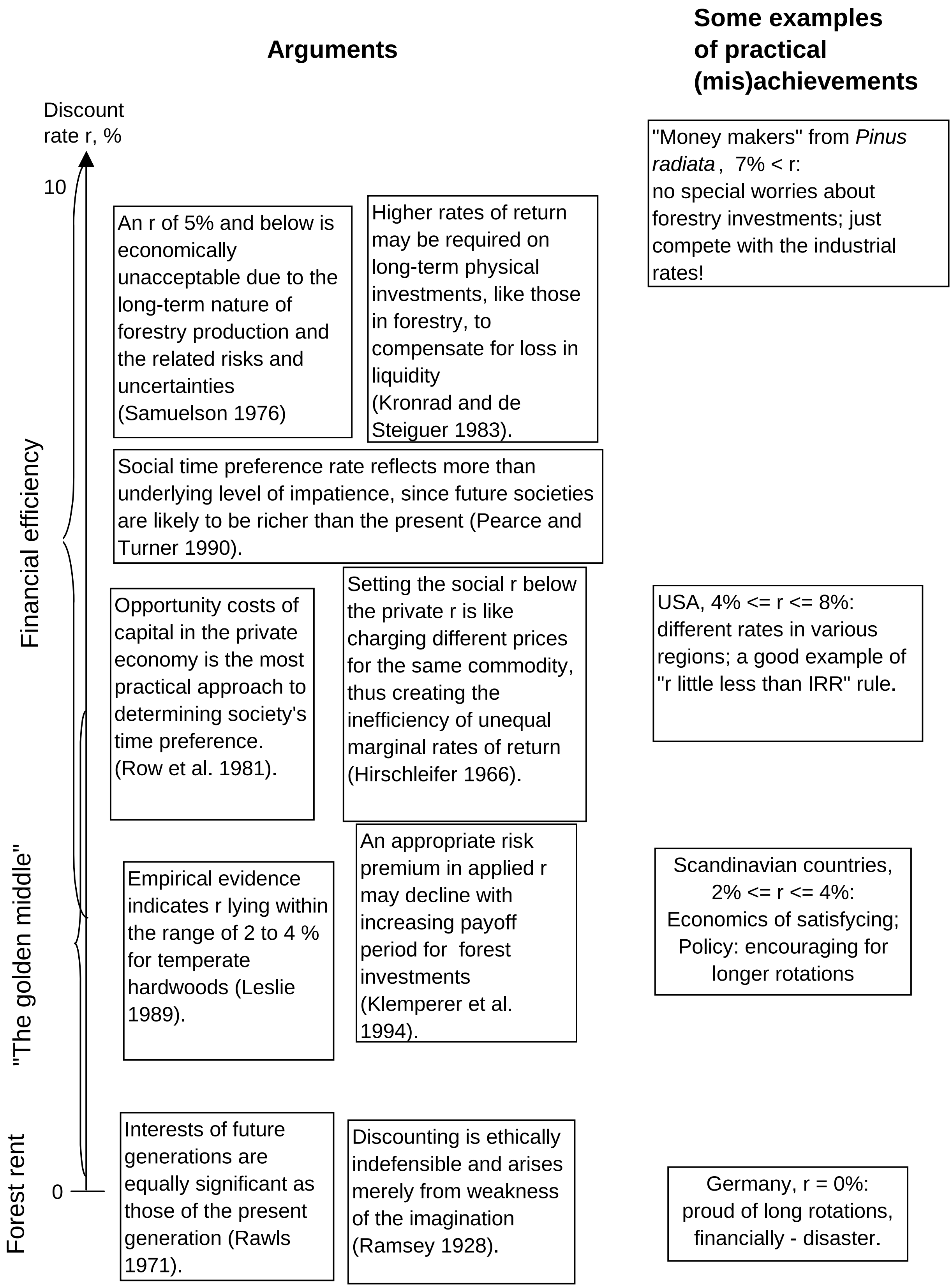


Figure 1. Searching for the “best” discount rate in forestry.

2.2 A review of practice

Undoubtedly, the literature points to a number of important considerations to be made when deciding on discount rates. Consensus on a single specific recommendation is not achieved and we now turn from the theoretical arguments towards an evaluation of practice, as it reveals itself in numerous applied forest economic studies in the literature.

The discount rates used in applied studies are as varying as one would expect, given the above disagreements on theoretical considerations. Reviewing the literature, we found that the use of a high *r* seems to coincide with cases where the IRR is high due to growth conditions and prices. To test the hypothesis that the applied *r* depends on the internal rate of return, various studies on forest investment analysis have been selected. The main criterion for the inclusion of a study in our analysis is a statement of IRR and an *r*. An average value of *r* and/or IRR is derived when several levels of *r* and/or IRR are presented in a study. The studies comprise a wide range of growing conditions, including low profitable Norwegian forests and high earning plantations in the tropics and the temperate areas of the Southern Hemisphere (sources indicated below Figure 2).

Figure 2 summarises the estimated relation between the calculated IRRs and the used *r*s. There is an overwhelming evidence (two-sided p-value < 0.0001) that the slope term of the linear regression for the mean response of *r* to IRR is different from zero. The 95 per cent confidence interval: 0.286 to 0.649. When the studies were confined to projects yielding an IRR of less than 10 per cent, the *r* used was on average 19 per cent lower than the IRR (Figure 3).

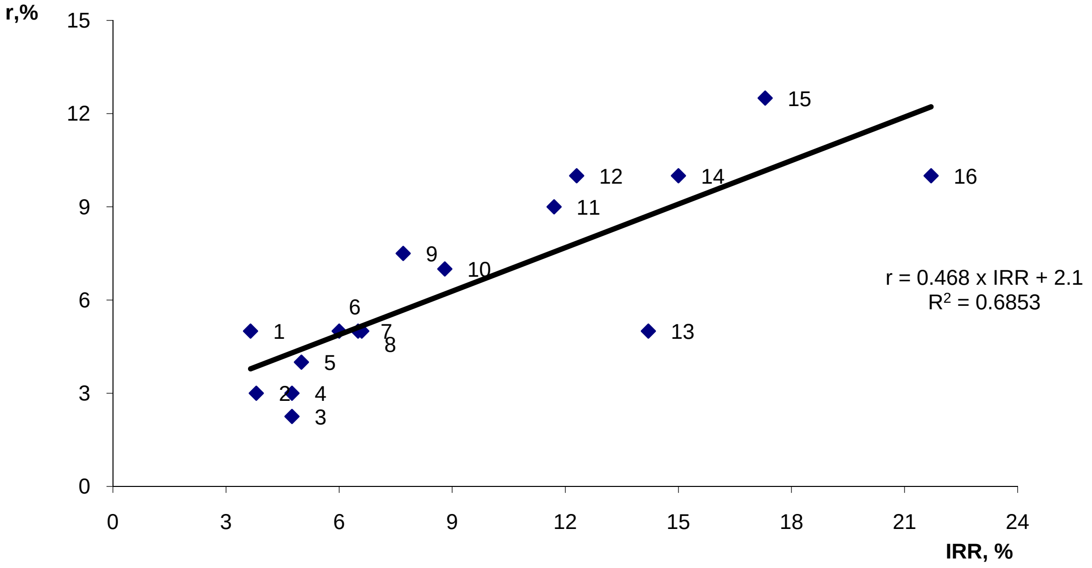


Figure 2. Relationship between *r* and IRR in selected studies. Sources: 1 - Niskanen et al. 1996; 2 - Braekke et al. 1994; 3 - Naurois and Buongiorno 1986; 4 - Holten-Andersen 1990; 5 – Hytönen and Aarnio 1998; 6 - Bailey 1986; 7 - Lea 1984; 8 - Willis and Garrod 1992; 9 - Kurtz et al. 1984; 10 - Tarrant et al. 1983; 11 - Nuronwu 1987; 12 - Tewari and Singh 1984; 13 - Niskanen et al. 1996; 14 - Tarp 1994; 15 - Tewari and Singh 1984; 16 - Marothia 1988.

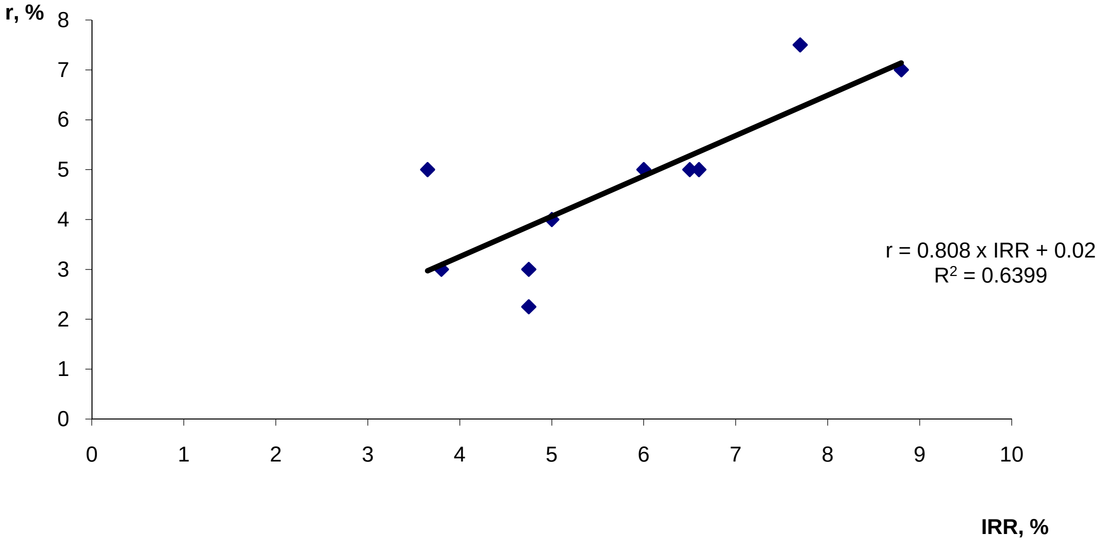


Figure 3. Relationship between *r* rate and IRR, when IRR < 10%.

What does this evident association between the *r* and the IRR imply? At least two possible explanations present themselves.

First, it may reflect the presence of substantial risk premiums in some forest production regimes. As discussed above, high discount rates are often used when evaluating fast growing tree species in monoculture plantations, kept in short rotations and aimed at the production of wood for pulp and paper. Such forest regimes do not benefit from the risk reductions related to the use of different species in the forest portfolio. Furthermore, these regimes aim at producing low-grade products where price variations are typically higher. For such risky investments to be undertaken, expected returns must be higher than for less risky forestry investments. This will result in higher (expected) IRR and the use of higher *r*s for project evaluation. However, it is doubtful that the differences in risk premium are as high as the variation of *r*, as shown in Figures 2 and 3.

The second explanation does not comply with traditional arguments. Investors and analysts simply choose an *r* close to the IRR. The result is that net present values are in general positive, but never unreasonably high. This conclusion is supported by the fact that many authors refer to the chosen *r*s as those most frequently used in forestry practice, e.g. Braekke et al. (1994). Conclusively, growing conditions and prices, but not the opportunity cost of capital, are the decisive factors when choosing an *r* for use in forest investment analysis. The rationality of this approach is, however, doubtful.

3. Impacts of discount rates - the Lithuanian case

3.1 Economic estimations

In this section we describe the potential impact on Lithuanian forests and economy of adopting different *r*s and the classical Faustmann approach to forest investment analysis.

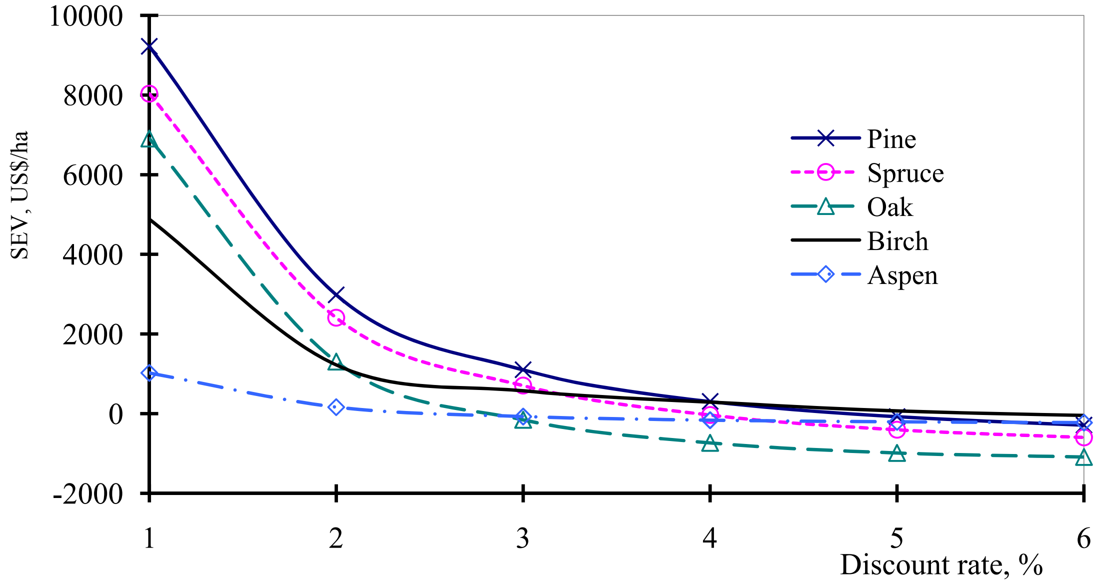


Figure 4. Relationship between the SEV and the discount rate on the site of type o*xalidosa*.

Using results from Brukas and Brodie (1999b), we present standard SEV calculations for different values of *r*. The timber growth models by Kuliešis (1993), pine assortment tables (Kenstavicius 1987), observed timber prices (CFME 1998), and actual costs of silvicultural activities served to calculate forest rent and SEVs for eight tree species on all site types. Real prices were assumed to remain constant and present regimes of intermediate stand treatments were taken as a basis for defining the timing and intensity of thinning. The obtained results are exemplified with SEVs on site type *oxalidosa*, which represents soils of normal humidity and moderate fertility (Figure 4).

Figure 4 serves for finding the optimal choice of tree species as a result of the chosen *r*. Oak can compete with coniferous species only when the forest rent criterion is applied (estimated forest rent for oak, pine, and spruce is about $US 130 /ha/year). Pine and spruce yield superior SEVs when the *r* lies between 1 and 3 per cent. Between 3 and 4 per cent, birch starts outpacing conifers and earns positive returns, until the *r* reaches the IRR at 5.6 per cent. Such IRR for Lithuanian conditions is achieved only on few sites where birch has the highest productivity. On typical sites of the species, IRRs for pine, spruce, and birch lie between 3 and 5 per cent. Thus, choosing *r*, e.g. 4 per cent, implies that the choice of species should on many soils change towards fast growing species like birch and away from the slower growing oak and pine species. Actual implementation of such a shift should, however, take into account that changes in supply in the long run, brought about by changes in choice of species, will perhaps change prices and hence profitability of the different species. Hence, adjustment in choice of species should be less dramatic than Figure 4 seems to suggest at first glance. The limitation of the applied cost and price data (CFME 1998) is acknowledged as well. Furthermore, the previously mentioned effects of risk reduction through a diverse species composition should be taken into account, and so should the production of valuable externalities, a point to which we return below. Finally, the cash value of, e.g. a normal oak forest is much higher than that of a normal birch forest – also implying a higher potential for, e.g. optimal income smoothing.

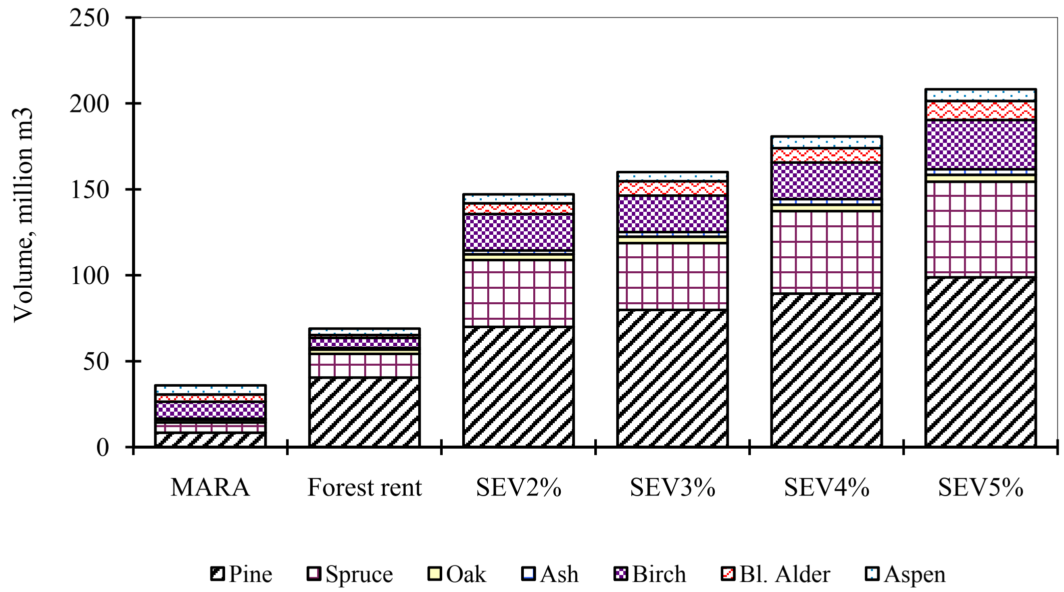
Table 1. Comparison of current minimum allowable rotation ages in commercial forests and optimal timber rotations on typical sites.

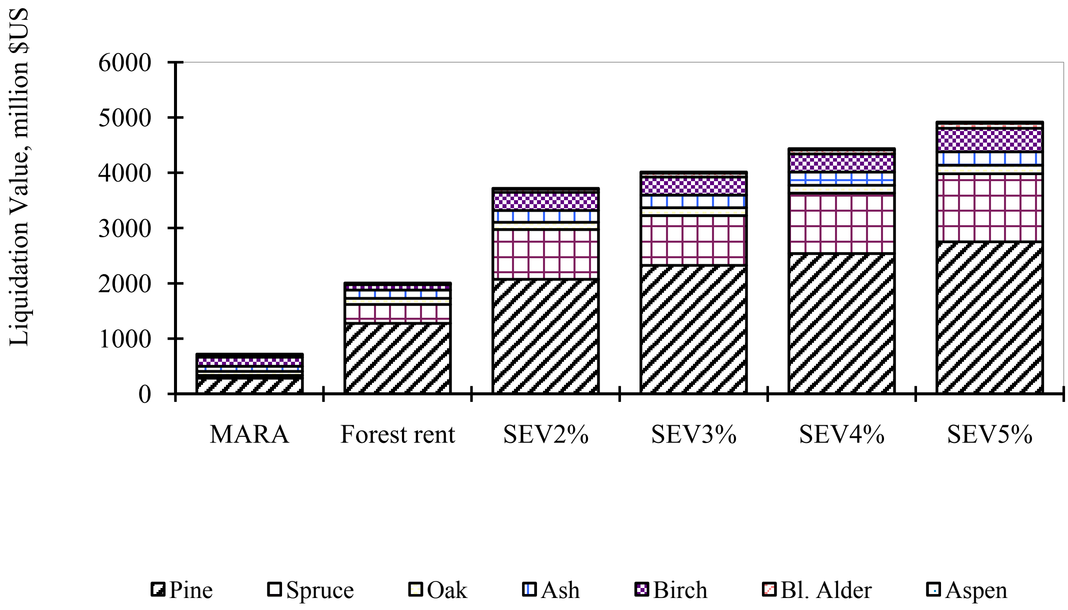
Tree species	Minimum Allowable Rotation age	Optimal rotations				
		Forest rent	SEV, 2%	SEV, 3%	SEV, 4%	SEV, 5%
Pine	101	80	65	60	55	50
Spruce	81	75	65	65	60	55
Oak	121	95	75	70	70	65
Ash	101	90	70	65	60	60
Birch	61	70	55	55	55	50
Black Alder	61	75	60	55	55	50

Table 1 demonstrates the effect of *r* on rotation ages in Lithuanian forestry in case the Faustmann criterion is applied. Discounting with rates from 2 to 5 per cent would not radically change rotation ages for fast growing tree species such as birch and black alder. The contrary result is obtained for slower growing broadleaves and conifers, covering more than 60 per cent of the forest land. An *r* as low as 2 per cent results in a decrease in optimal rotation ages of 15 years for spruce and up to 45 years for oak.

Figure 5. Standing volume in mature forests.
Note: MARA – minimum allowable rotation age.

Figure 6. Liquidation value of mature forests.





3.2 The political dilemma

Values accumulated in Lithuanian forests are remarkable in the scale of the present economy. If an *r* of 2 per cent is chosen, the value of mature forests makes up about 35 per cent of the Lithuanian Gross Domestic Product (GDP), which amounted to US$ 10.73 billion in 1998. If, say, two thirds of this capital is released during the next 10 years, it could annually increase the GDP by 2-3 per cent directly. Add to this the multiplier effect of reallocating the capital tied up in old forest stands to more productive uses. Despite the roughness of the estimation, the potential of boosting the transition economy is apparent. To further stress the need for careful consideration of future harvest policy, it can be noted that current annual Lithuanian harvest levels amount to approximately 5 million m^3, less than half the annual increment of approximately 12 million m^3. Thus, capital build-up in roundwood is continuing at an impressive pace.

Lithuania and many other East European countries still suffer from the aftermath of the USSR and its collapse. The economies are rather weak and there is a profound shortage of capital for investment in projects, which can help Lithuania and other East European countries meet their high aims for growth in GDP. There is no doubt that the future generations of the East European nations will be richer than the current ones. Following the arguments of Pearce and Turner (1990) this implies that social discount rates should be higher than the simple time preference, putting an upward pressure on the *r* in forestry. Thus, the people and politicians of Lithuania and the other East European countries should be aware of the choice they face: Insisting on the current restrictive rules for rotation ages and harvest patterns implies that less hospitals, roads, infrastructure and schools can be built. On the other hand, softening the restrictive rules and increasing harvests implies a reduction in the production of externalities such as recreation values.

Hartmann (1976) showed that in the presence of externalities rotation ages should perhaps be higher than otherwise. The implicit assumption is that forest stands produce positive values other than roundwood, often non-market values, and that this production increases with stand age. There is a general consensus that this is indeed correct.

However, so far little attention has been given to the question of substitution between stands. It is reasonable to assume that, as the amount of old stands increases, the marginal value of the benefits supplied decreases. The following revised Faustmann model takes this into account.

$$J(T) = \frac{-C + \int_0^T e^{-rt} g_i(t, A(0,t), \ldots, A(T_{\max}, t))dt + e^{-rT} V_i(T)}{1 - e^{-rT}} \qquad (1)$$

Here $J(T)$ is the net present value of the i'th single stand, including the value of externalities as expressed in the function $g()$. C is regeneration costs, t is stand age and time, $T \in]0;T_{max}]$ is the rotation age, $A()$ is the area within each age class at the different time points and $V(T)$ is the value of the timber stock. The first-order condition for maximum of $J(T)$ becomes:

$$V_i'(T) + g_i(t, A(0,t), \ldots, A(T_{\max}, t)) = r(V_i(T) + J_i(T)) \qquad (2)$$

Note, that this condition must be solved simultaneously for all stands in the area considered. Typically, we expect $\partial g/\partial t = g_t > 0$, implying that externality production increases with age. This tends to increase the rotation age. However, we will also expect that $g_{A(t', t)} < 0$, i.e. as the area of an age class increases, the marginal benefit of externalities produced by a stand t decreases. Furthermore, if all age classes have the same area it seems reasonable to expect that $g_{A(T\max, t)} < .. < g_{A(t, t)} < .. g_{A(0, t)} < 0$. The interpretation is that the marginal value of externalities for the stand in focus is affected more by (changes in) the area of old stands than (changes in) the area of young stands.

Thus, having insignificant areas of old forest, the value of externalities from high age classes exceeds the financial value of felling forest in these classes, therefore stands have to be retained. When increasing the area of old stands, the marginal benefit of externalities decreases and the area should not be increased further once the first-order condition is fulfilled. In every age class we should stop felling when the equilibrium condition is satisfied. While an abstraction like (1) and (2) may represent a convenient expression of the problem, the crucial issue: determining $g()$, remains unsolved. However, formulating the problem as in (1) and (2) helps in putting focus on the true problem. While advocates of low discount rates often point towards the correlation of externality production with stand age, they seem to forget that the value of externalities is not independent of supply. Using low (or even zero) discount rates in a classical Faustmann formulation is likely to lead to inefficiency and excess supply of externalities. Inefficiency is also a likely outcome of using high discount rates in Faustmann calculations, as a shortage of externalities will result.

Relying on these observations, we suggest a redefinition of the classical theory of the normal forest, still honoured in East Europe. Along with the ideas embedded in equations (1) and (2) above, decision makers could pursue a (normal) forest structure using a financially rational *r*, while still maintaining sufficiently large areas of old forests to ensure a socially optimal production of timber and externalities (Figure 7). Such an ideal distribution of age classes could be called a “sustainable normal forest”.

4. Financial versus socio-economic considerations

Forests in central planning economies have for decades been managed according to strict regulations, which did not allow much flexibility when making important silvicultural decisions, e.g. choosing the length of rotation. Lack of managers’ experience as to forming their own perception of time preference in forest investments and absence of historical data on financial markets greatly restrain the justification of an appropriate *r* in the conventional manner. However, examination of impacts of various *r*s allows envisioning consequences of discounting.

The analysis in the previous section indicates possible outcomes for Lithuanian forestry, which can with some degree of confidence be extended to parts of surrounding countries: Latvia, Estonia, Poland, Bellorussia, and probably to the European part of Russia, at least at the “Baltic” latitudes. This becomes possible due to similar traditions of silvicultural practices (with some deviations in Russia), convergence of timber prices in the established international free market (Thorsen 1998), similar structure of silvicultural costs, etc. Firstly, it is interesting to examine the outcomes of the choice of r from a rational and purely financial viewpoint.

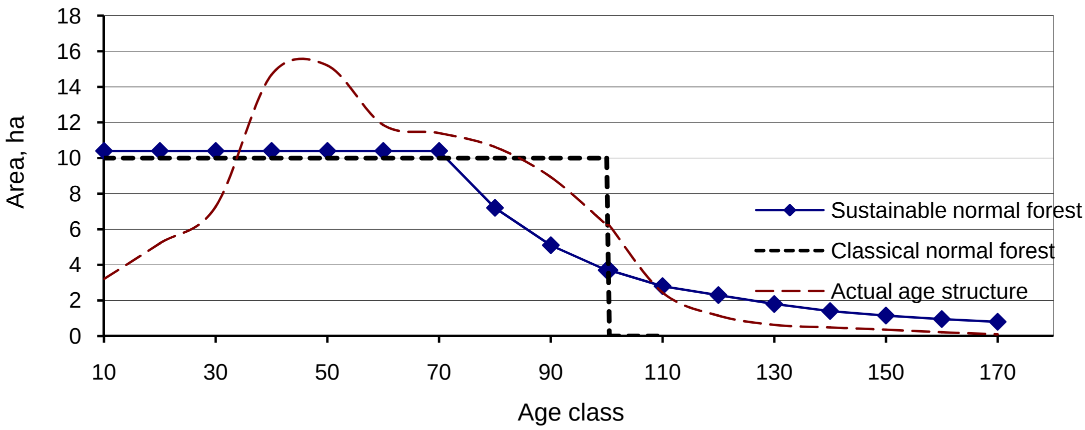


Figure 7. Sustainable normal forest versus the classical normal forest and the actual age structure of pine in Lithuania. All normalised to 100 hectares.
Note: Age class refers to the upper end of a decade, e.g. age class 10 represents stands of age 0 to 10.

The adoption of *r*s above 5 per cent would make forestry an unprofitable venture in the region east of the Baltic Sea. If political constraints were in such case replaced by pure financial optimisation, the rational outcome would be clearing of all stands older than 60 years and abandoning the bare land or, in the best case, converting it into agriculture. The latter outcome is hardly possible at the current stage of extensive agriculture.

Since calculations for all species and productivity classes yield an average IRR of approximately 4.3 per cent, the "*r* a little less than IRR" rule would imply an *r* of about 3.5 per cent. As shown earlier, an *r* of 3-4 per cent implies conversion of forests towards fast growing broadleaves. It would justify past and present forestry practices in the European part of Russia where coniferous forests have been over-harvested and large areas regenerated with fast growing soft broadleaves of low economic value (Nilsson and Shvidenko 1998). An *r* between 0 and 3 per cent would most likely justify the continuous management of coniferous species. The shift towards lower rotations would be an obvious outcome, in particular in the upper half of this range of *r*.

As discussed above it can be argued that capital tied up in State forests could be used for other, investments: schools, hospitals, environmental protection, energy-producing facilities or simply buying other real or financial, foreign or national assets. However, adopting a high *r* does not imply that a swift increase in harvest levels is optimal. This would most likely lead to a sudden decrease in timber price due to local excess supply. The timber market may approach the steady state in the long run (Brazee and Mendelsohn 1990, Thorsen 1998), but not all paths towards this state are optimal. Even with a high *r*, changes in harvest policies must take into account market reactions.

The above considerations largely rely on the rationality of a "profit maximiser". Such a purely financial approach hardly could be expected to be followed in public decision making in East European forestry. The common trend in contemporary forestry is an increasing weight on environmental forest benefits, yet these benefits are difficult to value in monetary terms, which is needed to estimate the best ways to increase the social welfare (Helles 2000). Under such circumstances, the decisions on use of forest resources increasingly become a subject addressed by politicians and economic considerations are often neglected.

In addition, we should not exclude institutional settings and public response to proposed actions. It is quite obvious that, say, a twofold or threefold increase in the amount of clear fellings would require a radical reallocation of financial and managerial resources in East European forestry agencies. As March and Olsen (1989) indicate, institutions embed historical experience into rules, routines, and forms that persist beyond the historical moment and conditions. This notion is highly relevant in our case. Such concepts as "maximisation of the increment of the most valuable assortments" are deeply entrenched in the thinking of East European forest managers. Simultaneously, public opposition to a sudden increase of fellings is easily predictable, only the exact consequences of the counteraction are unclear. Another Lithuanian example might serve to show the attitudes of parts of the public. Due to heavy windthrows and subsequent insect damage, the annual cut of timber in 1995 and 1996 was increased to almost 6 million m^3 from the usual 3-4 million m^3. Despite the fact that 6 million m^3 lies far below the total annual increment (12 million m^3), foresters were rewarded with epithets such as "an army of fellers" and "destroyers of Lithuanian forests" (Aleknonis and Jackoniene 1998). The professional self-understanding of Lithuanian foresters still suffers from this image and they are, therefore, likely to be reluctant to suggestions of increased harvesting levels.

High preferences for old forests might be the expression of considerable option and bequest values, but it is also related to direct use values. Cardinal non-monetary evaluations show that mature stands (according to current minimum allowable rotation age) of slow growing broadleaves and conifers have the highest recreational value

(Riepšas 1990), while premature stands of these species contain the highest summed protection value (Pauliukevičius and Kenstavičius 1995). The favouring of old forest is also dependent on the cultural-ethical values established in consciousness or even in sub-consciousness of humans. For example, an association of the word "forest" with the old sacred oak might seem an irrational argument, but it could be a partial explanation of the conservative standpoint of parts of Lithuanian Society whose world view, according to ethnologists, still includes features of the heathenish religion (Hauptmann 1980).

However, the application of any r from even a purely financial standpoint does not mean that identical financial rotation ages have to be applied in all forests. In fact, this is already excluded in Lithuania, where severe harvesting restrictions are imposed on 14.6 per cent of the total forest area. These restrictions reflect attempts to catch the positive externalities from forests, such as shelter for endangered species. Even if unable to exactly evaluate the production of positive externalities, policy makers need to somehow take them into account when designing forest policy.

Such attempts fit well into the above defined ideal age classes distribution called sustainable normal forest (Figure 7). It is emphasised that the imagined ideal distribution should not be a static conception. The area of older age classes were increased over time along with the increasing positive social preferences to environmental benefits from forests. The corresponding changes were easier accommodated if the actual age structure would shift towards the sustainable normal forest instead of being transformed into the classical normal forest with subjectively chosen rotation ages.

5. Implications for Lithuanian forestry

The above considerations prove the difficulty associated with the choice of discount rate in forestry of transition economies. On the one hand, transition to the market economy and adoption of modern methods of forest economics require that the choice is made and the magnitude of the discount rate affects the results of economic analysis in forestry. On the other hand, economic considerations are often overshadowed by subjective valuations, especially in the arena of public forest policy. Monetary evaluations of the positive externalities from forests are extremely uncertain in the present dynamic socio-economic and cultural-ethical context. The presented model (formulas 1 and 2) and proposed ideal age class distribution called "sustainable normal forest" (Figure 7) suggest a way in which an economically rational approach still may be applied as an integral part of the decision making in forestry.

As the externality value, the g-function in (1) and (2), is unknown we too suggest a fairly low r for State forestry in order to catch substantial amounts of the age dependent externality production. Hence, we suggest an r of less than or equal to 2 per cent for contemporary economic evaluations in East European State forestry. In some cases, application of the forest rent instead of SEV may be appropriate. It is noted that policy may establish additional constraints, e.g. on sustainability of production in both cases. Also, it is strongly emphasised not to ignore the values of non-timber and non-market outputs from forestry such as recreation, landscape, biological, historical, cultural, and environmental values. The r should be viewed as one among a number of decision parameters.

Compared to public decision making, private forest landowners usually put a larger weight on the maximisation of profits. In this case, the real interest rate, reflecting an opportunity cost of capital, might be a more suitable approach. We do not have the luck of being able to analyse long-term real *r*s, since such data are absent in East European countries. Our advice would be to look at Scandinavian countries: growth conditions are similar, and in the long term economic development is also likely to be similar. Forestry practices reveal that private investors apply *r*s from 0 to 4 per cent in Scandinavian forestry. The "*r* a little less than IRR" rule is not violated in this range either. Furthermore, the need for development of forest legislation is hereby underlined, with the purpose to achieve fulfilment of social targets also in the private sector. The above arguments for choosing an *r* for State forestry partially apply to private forestry too. As a compromise, we suggest using an *r* of 2 per cent. Country and project specifics may require shifting this rate downward to 0 per cent or upward to 4 per cent, but it could serve as a reference point for investment analyses for private forests in Eastern Europe.

An interesting subject for future research is the evaluation of possible paths toward sustainable normal forests in Lithuania, providing the greatest benefits for Society. The estimation of the optimal level of externalities probably would be the most challenging part of such research. Despite all the uncertainties it is beforehand obvious that a careful choice of *r*, in combination with environmentally balanced legislation, will be an important agent for sustainable development in East European forestry.

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