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Private and public timber production: How markets and political institutions matter☆

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ABSTRACT

The aim behind this paper was to find a logical explanation for the simultaneous existence of public and private timber enterprises based on an individual, subjective benefit-cost weighting made in the context of different institutional arrangements. In the section on modeling, the effects of the separation of forest ownership and forest management, and of private and public ownership sharing are studied. The main difference between public and private timber enterprises relates to the exit clause. Whereas public timber production is characterized by a strong exit clause, in the case of private timber enterprises the individual stockholder can exit almost without constraint. The strong exit clause in public enterprises increases the liability as technique for hedging the risks of timber production. This becomes more pronounced the greater the degree to which the public fiscal decision is separated into a production and a liability decision. The reason for this is that where there is a higher degree of public decision making an unconstrained majority rule applies, which also leads to a transfer of liability to a minority. Another factor is that the limited time perspective involved in public choices does not outperform the advantage of lower interest rates associated with public timber production. The strong exit clause in public timber enterprises also provides an opportunity for the forest manager to increase the forest rotation length. The paper concludes with some remarks on how the results obtained from the simple public choice model employed in the study are applicable to a representative democracy.

1. Problem setting and a note on the method

Observations show that in democratic states public timber production represents a considerable part of overall timber production. At the same time, the production of timber by public forest enterprises is often deemed to be inefficient. Are we really to assume that individuals act irrationally when making the choice among different institutional arrangements?

As institutional arrangements such as public and private timber production are not fallen from heaven - in democratic states they are the result of voluntary agreements among individuals - we must ask why individuals choose to adopt inefficient institutions for the production of timber.

Individuals choose between different institutional arrangements, with the aid of an individual, subjective weighting of the benefit-costs relation, so as to achieve their own objectives. This gives rise to the following question: under which circumstances is the public production of timber of greater net benefit to these individuals than the private production of timber? The focus of this paper will be on providing the answer to this question.

In this paper I suggest a logical derivation of the existence of different institutional arrangements as a result of individual benefit costs weighting, as explained in detail in Buchanan (1999a). The analysis presented in this paper does not sketch any historical development of public and private forest enterprises. Rather the method applied is a conceptually comparative evaluation of alternative institutional arrangements from the perspective of the individuals involved.

Although the public production of private goods can be widely observed in the economies of modern democratic states (e.g., Hinds et al., 2004: 286 et seq.), I have selected timber production because of its suitability in demonstrating the dichotomy of market and political institutions (Buchanan, 1999b), and for its inherently entangled character (Wagner, 2010).

An important part of the world's timber is exchanged through markets. However, as outlined above, timber is produced and supplied through both private and public enterprises. Some of the private forest enterprises are large stock companies, where several thousand stockholders have pooled their resources to vast amounts. Given this 'publicness' of private ownership, what then is the meaning of publicly owned? I hope this paper contributes to a better understanding of the entangled nature of private and public institutions in democratic societies.

To provide a logical derivation of the circumstances under which public timber production is preferable to the private production of timber, a stepwise change to the pertinent institutions will be organized. The starting point of this paper is the Faustmann model (Faustmann, 1849),

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because it provides a well-developed economic analytical framework to study timber production with the help of the analysis of forest rotation lengths (Amacher et al., 2009; Amacher et al., 2011). The institutional environment is a perfect competitive market exchange with frictionless transactions in which the forest stand is managed directly by the private forest owner.

The second step of the analysis presented in this paper deals with the separation of the property rights bundle into a forest ownership and a forest management bundle of rights. The reason for this is that a main argument for the inefficiency of public enterprises relates to the discretionary power of the enterprise managers, which is assumed to be much higher in public than in private enterprises [cp. the summarized discussion in De Alessi (2004: 451)]. To isolate this separation from other institutional influences, I will analyze the effect of the described separation on the optimal rotation length. For a more refined analysis, I will extend the Faustmann model to a model in which the forest ownership and the forest management bundles of rights are separated among two individuals, the forest owner and the forest manager. The two individuals will, however, act within the institutional environment of a perfect competitive land and labor market, as in the case of the pure Faustmann model.

The analysis subsequently moves onto the problem of corporate actions. In this case the bundle of rights associated with ownership is shared among many different individuals. Therefore, in this third step, I will analyze shared ownership in the model of the private stock corporation. This will provide the analytical basis for the study of public ownership, which will take place in a fourth and final step.

I will study the institutions that form a private joint forest enterprise as a special case. One might assume that the joint enterprise is essentially an interim arrangement between the stock corporation and the public enterprise. The reader will discover, however, that this is not the case. The kinds of coordination problems solved with the help of the institutions in the case of the joint enterprise differ from those solved by the forest owners using the institutions of the public enterprise.

Applying this stepwise analysis, I expect to arrive at detailed insights into why individuals on occasion prefer public timber production and set-aside private timber production. In addition, I expect to find differences in the outcomes and that I will be able to trace these differences directly back to the impact of the prevailing institutional arrangements.

All of the models of institutional arrangements in the domain of timber production employed in this paper are highly stylized. However, I hope that I have selected the relevant components of the institutional arrangements and that I have suppressed all of those other parts exceeding the scope of my analytical interest.

2. Modeling

2.1. Separation of forest ownership and forest management

Usually the analysis of the optimal rotation length of a forest stand is based on the Faustmann model Eq. (1) and the corresponding FOC Eq. (2):

$$\mathrm{LEV}(T) = \mathrm{pf}(T)\left(e^{rT}-1\right)^{-1} \rightarrow \max_{T} \tag{1}$$

$$\mathrm{pf}'(T^o) = r\left[\mathrm{pf}(T^o) + \mathrm{LEV}(T^o)\right] \tag{2}$$

where LEV is the land expectation value; T is the rotation length; T^o is the optimal rotation length, p is the timber price; f is the timber volume; r is the interest rate (Amacher et al., 2009). This approach is valid for cases in which the forest stand is managed directly by the private forest owner.

Where the forest owner prefers to employ a forest manager, it is usually because he or she assumes that the forest manager possesses particular knowledge enabling that person to manage the forest in such a way that the trees grow faster.

Assumption 2.1. The growth of the trees is better under forest manager stand management than under forest owner stand management:

$$f_M(t) > f_O(t), \tag{3}$$

Where M means manager, O means owner.

Assumption 2.2. The knowledge of $f_M(t)$is assumed to be asymmetric, meaning that the forest manager knows $f_M(t)$ but not the forest owner. Otherwise there would be no need for the forest owner to employ a forest manager.

If we specify f(t) in Eq. (1) we get:

$$\mathrm{LEV}_O(T) = \mathrm{pf}_O(T)\left(e^{rT}-1\right)^{-1} - W^* \rightarrow \max_{T}, \tag{4a}$$

$$\mathrm{LEV}_{SE}(T) = \mathrm{pf}_M(T)\left(e^{rT}-1\right)^{-1} - W_M \rightarrow \max_{T}, \tag{4b}$$

and in the equilibrium we have:

$$\mathrm{LEV}_{SE}(T) = \mathrm{LEV}_O(T), \quad \text{with } W^* < W_M \tag{4c}$$

The notations in Eq. (4a) mean: $\mathrm{LEV}_O(T)$ is the LEV for the case in which the forest stand is managed directly by the private forest owner; $\mathrm{LEV}_{SE}(T)$ is the LEV where forest ownership and management are separate (SE); W is the present value for a perpetual, annually constant wage stream[1] with $W = wr^{-1}$; W^* is the present value of market equilibrium wage rate; W_M is the present value of the market wage rate of the forest manager.

W_M carries for both the demand and supply market information on labor and the present value of the investment in the specialist silvicultural knowledge that results in $f_M(t)$. A higher or lower W between different labor inputs carries nothing more than a difference in the investment made to obtain specialist knowledge. Thus, W^* equalizes the differences in the knowledge investments, measured in present value terms; for example, for a three wage rate case:

$$W^* = W_l - K_l = W_m - K_m = W_h - K_h \tag{5}$$

where l stands for low level; m for medium level; h for high level; and K is the present value of the investment in knowledge (cp. Stiglitz, 1985, which offers important insights into the equilibrium wage distribution by using a quit rate function as an example).

For the case of the forest manager we get

$$W_M = W^* + K_M, \tag{6a}$$

so that in the equilibrium we have

$$K_M = \mathrm{LEV}_{SE}\left(T^o_{SE}\right) - \mathrm{LEV}_O\left(T^o_O\right). \tag{6b}$$

It should be clear that the forest manager maximizes neither $\mathrm{LEV}_O(T)$ nor $\mathrm{LEV}_{SE}(T)$ because any kind of LEV is the capitalized income of the land owner, not the income of the forest manager. The income of the forest manager is the fixed annual wage the forest owner pays as part of the labor contract.

The fixed annual sum does not mean, however, that the forest manager has no opportunity to maximize his annual wage income by varying the rotation length. On the contrary, the higher the rotation

[1] Clearly there are different wage schedules that a forest owner can apply. From the huge body of literature produced since the very beginning of the study of forest economics [cp., e.g., di Paprica (1789): 29)] we know that a rotation length dependent wage schedule is difficult to implement. Consequently, the wage paid is normally entirely independent of the rotation length and paid at a fixed annual rate.

length the lower the amount of time in terms of labor that the forest manager needs to manage a single forest stand.

A short rotation length implies a large harvest and regeneration area. In consequence the forest manager is mainly occupied with managing/organizing the harvest and the regeneration. For instance, I assume a forest manager that is responsible for an area of 1000 ha of an equal age distributed forest with a rotation length of 10 years. In this case, the annual harvest and regeneration area amounts to 100 ha. If the rotation length of the same forest is 100 years, then the annual harvest and regeneration area is only 10 ha.

This means that at a higher rotation length the forest manager can manage a larger forest area, has more time for additional business or has more leisure time. All three of these opportunities amount to the same in an equilibrium state.

Therefore, the forest manager's rotation length problem can be formulated as follows:

$$W(T_M) \rightarrow \max_{T_M}.; W'(T_M) > 0, W''(T_M) < 0 \quad \text{thus } T_M^o \rightarrow \infty. \tag{7}$$

However, the forest owner employs the forest manager only under the condition Eq. (4c).

Eq. (6b) shows that the forest manager has no margin with respect to choosing a rotation length. If the forest manager selects a rotation length other than T_{SE}^o, the forest owner cannot fulfill his or her obligations and if, in turn, the forest owner does not pay W_M he or she will not find a forest manager to employ. As a consequence, $LEV_{SE}(T_{SE}^o)$ determines completely the manager's optimal rotation length.

Let me summarize: first, the separation of forest ownership and forest management in a private forest firm follows from information asymmetry with respect to $f_M(t)$. Second, this separation leads to different objective functions of the forest owner and of the forest manager, which generates a coordination problem. Third, the individuals solve the coordination problem with help of market exchange, whereupon the competition hampers any power which can evolve from information asymmetry.

2.2. Shared private ownership

In the preceding we assumed the forest owner to be one individual. Now let us continue our investigation on the basis of ownership split into many securitized shares, a forestry corporation with many stockholders.

At first one might think that the existence of many stockholders could serve to hinder the operational control of the forest manager. However, the unrestricted salability of stocks without the prior approval of other stockholders moves the control problem from principal agent to market coordination, which enables effective policing (Alchian and Demsetzt, 1972: 788, Fama and Jensen, 1983: 312).

Normally, for purposes of risk diversification, stockholders spread their assets across many different firms and will, therefore, "not be interested in directly controlling the management of any individual firm" (Furubotn and Richter, 2008: 390 et seq.). They compare only the dividends provided by the different stocks on the stock market and select for their portfolios those stocks paying out the highest dividends. Finally, competitive equilibrium leads to:

$$LEV_S(T_S^o) = D^* \tag{8}$$

where D is the present value of a perpetual annual dividend stream as a sum of all stockholder dividends and S stands for stockholder.

This ongoing comparison of the different stocks and of the transfers over a very short period of time to low transfer expenditures exerts pressure on the forest manager to adopt management towards meeting the interests of the stockholders. The forest corporation's stock prices carry information on forest management decision making with respect to the realization of $LEV_S(T_S^o)$ for the stockholders. Therefore, the competition on the stock market incentivizes the forest manager to realize $LEV_S(T_S^o)$ (cp. Fama and Jensen, 1983: 313).

The stock market also offers opportunities for takeover. If the forest manager does not achieve $LEV_S(T_S^o)$, the forest corporation's stock prices fall. The stocks move to those stockholders who assume that the substitution of the current forest manager by another would lead to an increase of the LEV by using the full knowledge of the other forest manager (cp. Fama and Jensen, 1983: 313). The forest manager's maximum problem Eq. (7) becomes:

$$L = W(T_M) + \lambda[LEV_S(T_S^o) - LEV_S(T_M) \rightarrow \max_{T_M,\lambda}, \tag{9}$$

which means that T_M^o is completely determined by T_S^o, thus $T_M^o = T_S^o$. The forest manager has no room for any optimization.

As a consequence, effective control over the forest manager is achieved by the unrestricted transferability of the forest corporation's stocks rather than by trying to control the outcomes of forest management or the forest manager directly. Thus the cost of controlling the forest manager tends toward zero. The stockholders require no information with respect to a forest growth function (cp. Alchian and Demsetzt, 1972: 788, Alchian, 1998).

There has been wide discussion of the problem the poor observability of the LEV implies for stockholders. The forest manager can pretend to generate a $LEV_S(T_S^o)$ by transforming timber and land assets into financial assets. The transformation of timber assets is then achieved by depleting the timber volume and the transformation of land assets by site degradation.

This kind of problem occurs where Eq. (3) is inverted, namely where $f_M(t) < f_O(t)$. In this case the forest stockholders assume, that there is a better growth function than is possible with the specific silvicultural knowledge of the forest manager. This situation also fails to provide equilibrium. Equilibrium can only be achieved with the correction of $f_O(t)$, so that $f_M(t) = f_O(t)$. This problem may be relevant in real forestry. As the process of adaptation from disequilibrium to equilibrium can take decades, it cannot be analyzed by employing (static) equilibrium analysis.

2.3. Addendum: joint ownership

The institution of the forest stock corporation whereby stocks can be bought and sold without the approval of any other stockholder, and so reducing the cost of exiting the corporation to zero, is undesirable under other circumstances (cp. Alchian, 1998: 1037; Congleton and Vanberg, 2001: 148; Zinkhan et al., 1992). In such situations, capital contracts include a provision making exits more difficult. Examples include registered stocks and partner interest shares.

A difficult exit procedure leads simultaneously to more intensive engagement by the owners in the collective decision making processes of such a joint enterprise. Each owner of the joint forest enterprise must expend certain resources, such as in making preparations for meetings or engaging with forest management issues for the purposes of joint decision making. In this way participation becomes as difficult as exiting, and decision making costs increase together with exit costs. We can, therefore, summarize the exit and the decision making costs as only one cost component, C_{em}, the present value of the summarized exit and decision making costs.

Although we have $C_{emS} < C_{emJ}$, the equilibrium must hold:

$$LEV_S(T_S^o) = LEV_J\left(T_J^o\right) \tag{10}$$

where J means joint. However, when we observe Eqs. (1) and (10) what does the difference in C_{em} equalizes the two LEV-equations?

I argue, in accordance with Alchian (1998), that an assumed change from a stock corporation contract to a joint enterprise contract protects

ownership-specific knowledge. Each owner adds an element of knowledge to the joint enterprise that cannot easily be substituted by other individuals. This is the very reason for the provision in the contract making exits more difficult.

When seeking to identify this specific knowledge we should avoid the pitfall of mixing specific silvicultural knowledge with specific ownership knowledge.

Assumption 2.3. In the joint forest enterprise we also operate on the basis of a separation between forest ownership and forest management. This means that none of the owners of the joint forest enterprise possesses silvicultural knowledge. The specific knowledge possessed by the forest owners is in fact the knowledge of which of the many thousand possible land properties is most suitable for management as forest land.

This knowledge derives mainly from watching the prices on the land markets. Zinkhan et al. (1992: 145) added to these different aspects of the acquisition of forest land, such as geographical knowledge, site productivity, terrain, size and ownership characteristics of available land tracts, their connectivity and so on. The forest owner, therefore, is the expert of selecting the right properties for management as forest land whereas the forest manager is the expert required to manage the forest land in the right way. This, however, leads to:

$$f_{MOJ}(t) > f_{MOS}(t), \tag{11}$$

and equality in Eq. (10) can hold. MOJ in Eq. (11) means manager-joint-owner and MOS means-stock-owner

Where no specific knowledge of the characteristics of the land is necessary, the forest owner can switch to a pure stockholder. This means that she becomes an expert in comparing timberland investments with other financial investments (cp. Zinkhan et al., 1992: 158 et seqq.).

In the equilibrium state we will get $D_S^* = D_J^*$, which leads to:

$$LEV_S(T_S^o) - W^* = LEV_J\left(T_J^o\right) - W^* - C_{emJ}; \quad \text{with} \quad C_{emS} = 0 \tag{12}$$

Under consideration of Eq. (12), the maximum problem of the forest manager Eq. (9) becomes:

$$L = W(T_M) + \lambda\left[LEV_J\left(T_J^o\right) - LEV_J(T_M) - LEV_S(T_S^o) - C_{emJ}\right] \rightarrow \max_{T_M,\lambda} \tag{13}$$

As above, T_M^o is completely determined by the exogenous parameters of $LEV_S(T_S^o)$, $LEV_J(T_J^o)$, and C_{emJ}. In this case also, the forest manager has no room for any optimization; he must achieve (T_J^o).

C_{emJ} depends not only on difficult exit conditions stipulated in the capital contract of the enterprise but also on the number of owners N of the joint forest corporation. The properties of this decision making (dm) costs function are $C'_{dm}(N)>0, C''_{dm}(N)>0$.

Where N is large, the decision making costs can be reduced by delegating decision making to the forest manager. From this it follows that $C_{emJ}>C_{emd}$, where d means delegation of decision making to the forest manager. If we assume delegation to mean full delegation, and that the forest manager is only one individual, then full delegation means that $f_{MOJ}(t)$reverts to $f_M(t)$ and the joint ownership specific knowledge is eliminated. Thus, full delegation becomes an oxymoron. Rather the existence of an optimal owner group size becomes obvious, whereupon the FOC will be $f_{MOJ}'(N)p = C_{dmJ}'(N)$.

2.4. The public ownership model in a direct democracy

Now let us study public timber production with the help of the direct democracy model. Clearly this is a very strong reduction of the complexity of politics in modern democracies.

Independent of the many variations, the public choice in modern representative democracy is also the result of choices made by the many different individuals within a society. We like to analyze how individuals achieve their own ends with the aid of democracy; and exactly this research interest is the reason for the simple model of direct democracy because in a representative democracy the results of public decision making must be traced directly back to the choices made by the individuals. As a consequence, the application of the simple direct democracy model also retains much of its explanatory power for representative democracy.

In the direct democracy model the forest enterprise is owned by all citizens of a political unit (nation, state, municipality, etc.). They can rid themselves from their shares either by moving to another political unit or by collective voting for a collective exit with the help of a collective decision making rule (maybe by majority rule). Collective exit in this case means, for instance, liquidating or selling the whole enterprise. The difference compared to a private enterprise from the preceding section is that an exit for a single owner is impossible (except by leaving the jurisdiction). This means that an exit is a collective good in a double sense: first, individual exit is impossible, only the exit of all owners together is possible; and second, this collective exit is the result of a collective decision to exit. Therefore, the exit of a single owner is much more restricted than in a private corporation. Thus,

$$C_{emS} \ll C_{emDD} \;\; \forall \;\; N_S = N_{DD},$$

where DD means direct democracy.

In the literature produced by both the economic and the political sciences there exists a huge body of research on the exit and voice (collective decision making) problem. Dowding et al. (2000) reviewed the relevant literature based on the seminal work by Hirschman (1970). Usually an easy and fast exit from the stock corporation leads to various important advantages for the individuals involved, as summarized by Alchian and Demsetzt (1972: 787–789) and Alchian (1998: 1032). In simulations of three-person prisoner dilemma games, Congleton and Vanberg (2001: 165) showed that the possibility of exit leads to escape from dysfunctional teams, which increases the benefits of cooperation.

Strong exit clauses on the other hand lead to increased free-riding, reducing the benefits of cooperation. Greater ease of exit also leads to stable, long-term enterprises because an easy exit procedure operates as a sorting mechanism in the long run. Although these results relate to the joint enterprise they are instructive for the stock cooperation, too. Beyond the protection of special knowledge in the case of joint enterprises, it is not easy to find advantages at strong exit clauses. One example was provided by Gehlbach (2006). He formally modeled the exit and the voice, dividing individuals into leaders and citizens. Without any kind of leadership, which is assumed in our model of direct democracy, Gehlbach's model leads to the conclusion that strong exit clauses are effective only where the individuals are split into two groups, the citizens and the leaders (Gehlbach, 2006).

This gives rise to the question why potential forest enterprise owners (the citizens of a political unit) arrange such a strong exit constraint voluntarily? We cannot expect that every citizen within the political unit has the same specific ownership knowledge as in the joint enterprise, which must be protected by such a strong exit clause. For the purposes of this study we need an economic logic fully consistent with the competitive equilibrium theory. Therefore, we must assume that:

$$LEV_S(T_S^o) = LEV_{DD}(T_{DD}^o). \tag{14}$$

Which part of the Faustmann model Eq. (1) satisfies Eq. (14)?

This is a difficult question. De Alessi (2004: 450–452) summarized the discussions of the reasons for the existence of public enterprises. He referred to different reasons: individual tastes for governmental ownership, patronage, failure to understand how markets work, and limitations of the market system. He concluded that public enterprises are less efficient by market standards than their private counterparts.

Other reasons often concluded for the existence of public enterprises are the so-called historical reasons: public enterprises producing private goods and selling these on the markets cannot derive directly from an individual subjective benefit-cost weighting but rather stem from historical developments.

Let us suppose for a moment that the public forest enterprise fell from heaven. Let us also suppose that $LEV_S(T_S^o) > LEV_{DD}(T_{DD}^o)$. This being the case, there is no reason to have a public forest enterprise; but why do the citizen owners not vote for a collective exit? It is easy to see that arguments of this kind merely shift the analytical problem but cannot answer the question. What we need is an answer based on economic logic and which fulfills the equilibrium condition Eq. (14).

My suggestion is that the relevant difference among the private forest stock corporation and the public forest enterprise is the degree and the kind of liability, subject to the condition that the citizen owners own mortgageable property that can be used as collateral.

Liability plays an extraordinary role in investments; and the production of forest timber is an outstanding candidate for liability. The long time period between the bought factors of production (forest land, expenditures for forest regeneration and pre-commercial thinning) and the sold timber provides much space for changes in products and prices (interest rates included) so that the return can fail, and liability results. (von Mises, 2007: 289–294).

It should be clear that r, W and C create obligations for the forest owners to different contract partners and p contains receivables (cp. also Deegen et al., 2011: 356 et seq.). Obligations and receivables substantiate claims to future payments which, concerning their maturity in future, are inherently uncertain. Therefore, contracts on future obligations require hedging in cases in which obligations cannot be met. The safeguard is property, which in our case is the forest land. Without property, contracts on future obligations are impossible (Stadermann, 2006: 74).

Stock corporations are powerful organizations which generate huge amounts of liable capital combined with very high liquidity. In the stock corporation, liability is limited to the assets of the corporation, which constitute the source of the liable capital. Therefore, the limited liability places a constraint on the volume of contracts on obligations. In cases where the corporation likes to exceed the limited liability, it needs liable capital from outside. And exactly this can be arranged by public enterprises.

The advantage here is not the amount of liable capital but the opportunity to exceed the liability out of assets of the enterprise. The difference among the stock corporation and the public enterprise, therefore, is characterized by the difference in the limitations of the liabilities. While in the stock corporation the liability is limited to the assets of the corporation, the maximum liability of the public enterprise achieves the total amount of the future incomes of all citizens of the political unit (Stadermann, 2006: 149 et seqq., 270), cp. Fig. 1.

In the extreme case, the citizen owners of the public enterprise are responsible with all of their income and assets, independently of the assets used in the public forest enterprise, and this non-enterprise asset volume of all owners is really the 'lender of last resort'. Often the non-enterprise liable asset volume is much higher than the enterprise asset volume.

Now we can insert the exceeded liability of the public forest enterprise into the Faustmann model Eq. (1). A direct input is impossible because the liable property is not a component of the Faustmann model. Some researchers work with borrowing constraints (e.g., Tahvonen et al., 2001). Another option is to consider the liability in the rate of interest: the high liability in the public forest enterprise leads to a lower interest rate than in the stock corporation.

Unfortunately, the complicate exit from the public forest enterprise leads to another important difference among the stock corporation and the public enterprise that also affects the interest rate. This is the liquidity. Whereas the high degree of liquidity of the single stock in a stock corporation is always taken as given, the degree of liquidity of the individual shares in a public enterprise is strongly hampered. It is exactly this low liquidity that produces an opposite effect on the interest rate: the low liquidity of the public forest enterprise leads to a higher interest rate than for the stock corporation.

Assumption 2.4. Therefore, only in the case where the seeker and the supplier of capital have valued the increase in the liability of the public enterprise as being greater than the decrease in liquidity does the equilibrium Eq. (14) hold.

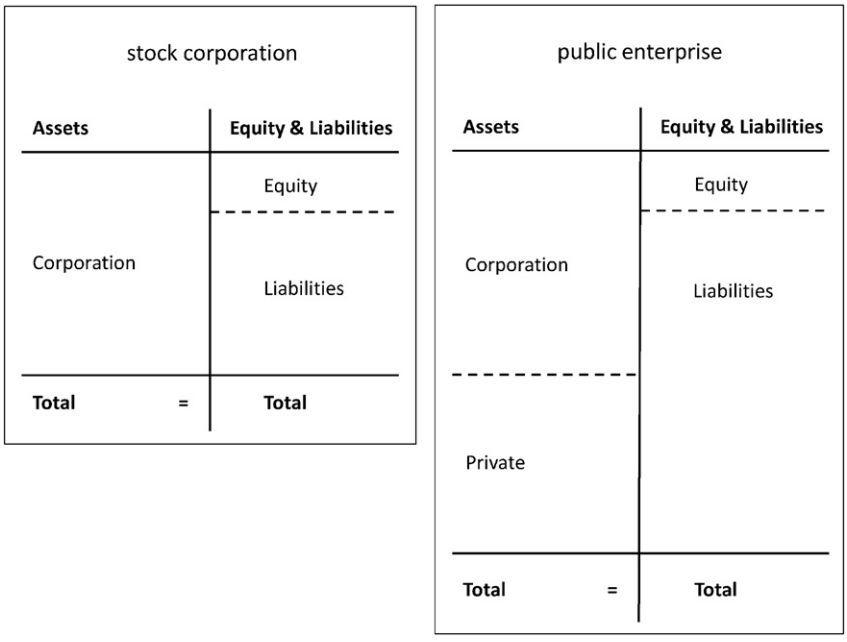

Fig. 1. The difference of liability among the stock corporation and the public enterprise: while in the stock corporation the liability is limited to the assets of the corporation, the maximum liability of the public enterprise achieves the total amount of the future incomes of all citizens of the political unit.

Thus,

$$r_S > r_{DD}. \tag{15}$$

Under this assumption, it is clear that:

$$LEV_S(T) < LEV_{DD}(T) \quad \forall \quad T. \tag{16}$$

Furthermore, the comparative static analysis shows that the optimal rotation length is linked negatively to the interest rate (e.g., Johansson and Löfgren, 1985: 83, Amacher et al., 2009: 27).

Considering Eqs. (15) and (16) it thus hold that

$$T^o_S < T^o_{DD}. \tag{17}$$

Inequality Eq. (15) does not mean a departure from the equilibrium assumption. Under consideration of the liability premium, Eq. (15) is consistent to

$$r_S - PL_S = r_{DD} - PL_{DD} \tag{18}$$

where PL is the liability premium.

To highlight the differences in the LEV models among the stock corporation and the public enterprise more clearly Eq. (14) is presented in more detail:

$$\begin{aligned} &pf_M(T^o_S)\left(e^{r_S T^o_S}-1\right)^{-1} - W_M \\ &= pf_M(T^o_{DD})\left(e^{r_{DD} T^o_{DD}}-1\right)^{-1} - W_M - C_{emDD} \end{aligned} \tag{19}$$

From Eq. (19) a margin can be identified:

$$G \equiv LEV_{DD}(T^o_{DD}) - LEV_S(T^o_S),$$

where G stands for margin according to Eq. (19). From this arises the question as to who earns this margin.

To answer this question we must bear in mind that a large N leads to the free-rider effect. This effect occurs only in the public forest enterprise and not in the stock forest corporation, even if we assume that $N_S = N_{DD}$. As I mentioned above, every stock owner compares the dividends paid out by different stocks continuously so that a competitive equilibrium evolves, cp. Eq. (8). The advantage for the stock owner stems from an ability to exchange with ease her stocks for those stocks with the highest dividends. The citizen owners of the public forest enterprise on the other hand have no incentive to do so. Even if the citizen owners were aware of the different dividends, they cannot exchange their shares because of the strong exit clause. This strong exit clause renders continuous observation of the dividend markets fruitless. The citizen shareholder has no opportunity for a smooth exchange and, therefore, his incentive to watch the 'dividend' generated by his public forest enterprise share runs to zero so long as $G > C_{emDD}$. However in cases of $G \leq C_{emDD}$ the outcome of this is that every single owner of the public enterprise becomes uninformed with regard to $LEV_{DD}(T^o_{DD})$. In the best case scenario, the citizen can only observe D_S without information costs. As a consequence, the forest manager is the candidate to earn G.

However, it should not be forgotten that the forest manager acts in the competitive labor market with W_M. Therefore, he cannot increase the wage rate. All he can do is extend the rotation length at the point at which $LEV_{DD}(T_{DD}) = LEV_S(T^o_S)$. Hence, the maximum problem of the forest manager becomes:

$$L = W(T_{DDM}) + \lambda\left[LEV_{DDM}(T_{DDM}) - LEV_S(T^o_S)\right] \rightarrow \max_{T_{DDM},\lambda} \tag{20}$$

The FOC is characterized by:

$$\frac{\partial L}{\partial T_{DDM}} = W'(T_{DDM}) - \lambda LEV'_{DDM}(T_{DDM}) = 0 \tag{21a}$$

$$\frac{\partial L}{\partial \lambda} = LEV_{DDM}(T_{DDM}) - LEV_S(T^o_S) = 0 \tag{21b}$$

On account of $\frac{W'(T_{DDM})}{LEV'_{DDM}(T_{DDM})} = \lambda$ and $W'(T_{DDM}) > 0$ then $\lambda > 0$ and Eq. (21a) has constraint power. Eq. (21b) leads directly to a horizontal constraint line $LEV_S(T^o_S)$ on the T-LEV(T) diagram, Fig. 3, which determines completely the manager's optimal rotation length. The forest manager has no margin within which he can choose. Considering Eq. (16) and Eq. (7), we can directly conclude that $T^o_S < T^o_{DDO} < T^o_{DDM}$, where DDM denotes the forest manager in the public enterprise of a direct democracy and DDO designates the citizen shareholder of the public enterprise.

2.5. The results summarized

Table 1
The results of the modeling of the institutional situation relative to the rotation lengths summarized.

Institutional situation	Rotation length relations
Separation of forest ownership and forest management	$T^o_{FPO} \gtrless T^o_{SE}$
Private forest stock corporation	$T^o_{FPO} \gtrless T^o_{SE} = T^o_S$
Private forest joint enterprise	$T^o_M = T^o_J \gtrless T^o_{DDM}$
Public forest enterprise	$T^o_S < T^o_{DDO} < T^o_{DDM}$

Table 2
Summary of the exit costs *C*, liabilities *l* and interest rates *r* of the investigated institutional arrangements.

Exit costs	$C_{emS} \ll C_{emDD} \quad \forall \quad N_S = N_{DD}$
Liabilities	$l_S < l_{DD}$
Interest rates	$r_S > r_{DD}$

3. Discussion

Individuals pool their resources because they assume that corporations provide an efficient means of achieving their individual objectives (cp. Vanberg, 1995: 10–36). In section two I analyzed two different types of corporate timber production. I used on the one hand the stock corporation as a stylized model of private timber production; and on the other the model of direct democracy to represent purely public timber production. The aim was to discover step by step the reasons why individuals sometimes prefer public over private timber production.

I suggested a model where the individuals agree collectively on a strong exit clause, which hampers any kind of individual exit and leads to a comparative advantage of public timber production by means of the extension of liability. This extension allows for risk capital to be accrued at a lower interest rate than in the private forest stock corporation.

3.1. Formulation of hypotheses

The lower interest rate to which a public forest enterprise is subject affects the profitability of timber production strongly because profitability is extremely sensitive to the interest rate, as in all long-term production processes. If the suggestion of extended liability in the public production of market goods is correct, then we can formulate a hypothesis that can be tested empirically: we expect public production mainly in branches of long-term production and in those risky branches where the total enterprise assets are insufficient to hedge the liability.

The hypothesis is valid only for capitalist states in which public production plays a subordinate role to privately organized production.

As public production becomes a more important part of the whole economy, the less applicable the argument of extended liability becomes because the same property belonging to the citizens can only be mortgaged once.

The assumption on the extension of liability in public timber production is not merely an empirically testable hypothesis in its own right, it also directly allows for certain hypotheses to be drawn on the differences between public and private forest timber production. The finding presented in section two that the optimal forest rotation length adopted by stock corporations is always shorter than in public enterprises is an empirically testable hypothesis. However, when testing the hypothesis, a clear distinction must be made between private forest stock corporations and private forest enterprises in which the forest is managed directly by the forest owner. As the analysis in section two showed, no testable hypothesis on the optimal rotation length can be deduced for the latter type of forest enterprise. However, where the forest property rights are separated into ownership rights and a forest management bundle of rights, the result of the analysis allows again for the deduction of an empirically testable hypothesis.

The derivation of hypotheses requires that a distinction consistently be made between public timber production and joint timber production, as joint timber production does not allow for an empirically testable hypothesis to be deduced analytically. Although the problems of coordination among the forest ownership bundle of rights and the forest management bundle of rights appear similar in the joint and in the public enterprise, the reasons for these problems are different. Whereas the exit impediment in the joint enterprise is for the protection of specific knowledge, in the public enterprise it is to secure a high degree of liability.

3.2. Limited time perspective in public choice

The lower interest rate identified for public timber production than for its private counterpart stands in certain contradiction to the analysis by Brennan and Buchanan (2000: 85–89). They derived for collective choices (social) discount rates systematically higher than the rate of time preference of the individuals in their private spheres. The basic reason for this stemmed from the inability of the individual in a collective choice situation to place a high probability on the prospect that the collective will decide in favor of the continuation of long-term production in future collective choices. The individual will find it difficult to use a repeated series of collective procedures to maintain long-term production. This is a strong argument and contradicts the assumption that public timber production could be more efficient where the collective is able to avail of a lower interest rate, as I assumed in the preceding analysis. To explain and illustrate the two effects, I would like to work with an example related to Brennan and Buchanan (2000: 87–89) and with a diagram related to Brennan and Buchanan (2000: 88, Fig. 5.1).

Suppose that the individual evaluates at time t_0 public timber production relative to private timber production. The interest rate for private timber production should be 0.05 and that for public timber production should, subject to the liability advantage, be 0.03. I assume the optimal rotation length for private production to be forty years with a stumpage value of 10,000 €/ha. The rotation length for public timber production is assumed to be fifty years with a stumpage value of 12,000 €/ha. The evaluation problem and the numbers applied are depicted in a decision tree diagram, Fig. 2.

To calculate the net present values (NPV) let us work with a single rotation model but not with the Faustmann model Eq. (1). This is only to simplify the explanation. For purposes of illustration the NPV results suffice.

The NPV for public timber production is 2678 €/ha compared to € 1353 /ha for private timber production. Consequently, the individual will choose public timber production.

Now let us introduce the argument posited by Brennan and Buchanan (2000: 87–89). The two calculated NPVs will be realized where the

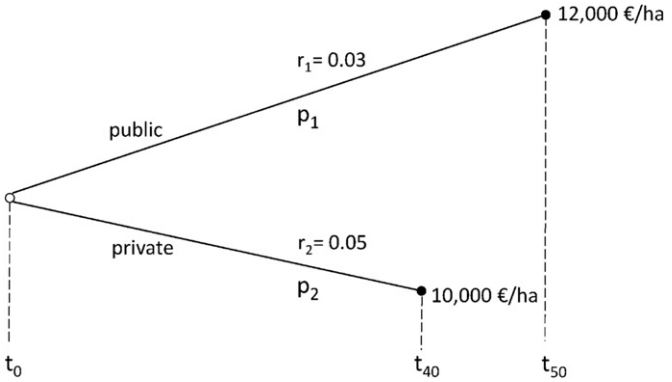

Fig. 2. Decision tree diagram for the evaluation of public and private timber production where the interest rates and the probability that the individuals are involved.

individual has full control over the forest property over the entire rotation length. However, this is only the case for private timber production. In the case of public timber production the individual is only one voice among many. This means the individual must estimate whether the other individuals involved will proceed with timber production over the next fifty years. The individual could come to the conclusion that the other individuals will stop public timber production before the optimal rotation length is reached. The individual will estimate a probability p_1 for no collective unplanned termination of timber production. This probability will be much lower than one, because the individual has no way of knowing what the other individuals, who may prefer public timber production at t_0, might choose in future collective decisions made over the long production period. By contrast, the probability of no unplanned termination of private timber production will be close to one, because there are no exit constraints in stock corporations, so that individuals can come and go without any threat to the continuity of the corporation.

If the probability of individual no unplanned termination p_2 equals one and p_1 in our numerical example is lower than 0.505, the individual will opt for private timber production even though the NPV is less than that for public timber production.

As a consequence, the Brennan-Buchanan argument for public timber production moves the expected NPV in the opposite direction to the lower interest rate. Therefore, the result of the analysis for the combined effect is ambiguous. This leads to a higher improbability of public timber production than the pure interest rate effect led us assume.

Now let us return to the Faustmann model Eq. (1) and let us introduce the probability of no unplanned termination according to the Brennan-Buchanan argument. The analysis of the expected LEV for the case, where the probability is depending on the rotation length (cp. Amacher et al., 2009: 275 et seqq.), tells that the optimal rotation length of the public forest enterprise is now closer to the optimal rotation length for private timber production.

Finally, the Brennan-Buchanan argument demonstrates the importance of a strong exit clause because this clause counteracts an unplanned collective termination of timber production and reduces the power of the Brennan-Buchanan argument. On the other hand, individuals can reduce the individual liability with fiscal institutions independent of the contract on public timber production. In such cases the Brennan-Buchanan argument becomes more relevant again.

3.3. Fiscal institutions as liability redistribution

In the section on ‘public ownership’ I described the main difference among the forest stock corporation and the public forest enterprise as being a difference in the limitation of liability: whereas in the case of the stock corporation liability is limited to the corporation's total assets, the liability of the public enterprise is extended to assets beyond those

possessed by the enterprise. I mentioned the private property of the citizen owners and referred, therefore, to these citizen owners as 'lenders of last resort'.

When we compare private unlimited corporations with stock corporations we find that the former invest in less risky projects than the latter. Unlimited liability bears a note of caution given the danger of individual bankruptcy. Thus, if we observe an extension of liability surpassing the volume of enterprise assets then we should expect a drop in the willingness to take risks. However, in the section on 'public ownership' I postulated the opposite: the citizen owners exchange the risk premium on the interest rate with liability extension. The question arises: why do we observe contrasting risk-liability action in privately and in publicly owned unlimited forest enterprises? This can be explained by the impact of fiscal institutions that limit and redistribute the liability.

The description above of the citizen owners of the public forest enterprise as 'lenders of last resort' does not generally mean that the liability for the public forest enterprise includes all of the non-enterprise assets of the citizen owners. Typically, the citizen owners constrain their liabilities by means of fiscal institutions such as tax rules and constraints on eminent domain. (Buchanan 19999c: 215–226) This means that the fiscal institutions of a political unit determine the total liability of the citizen owners.

Usually the fiscal institutions separate the decisions on public production from the decisions on liability. We should understand that the liability of the public enterprise will be limited by taxes, eminent domain and other regulations. These decisions are usually entirely uncoupled from decisions on public production. Public decisions on taxes and such follow other rules, apply other criteria and involve other preferences than those applying to public decisions on public production. The separation of these two fiscal spheres allows the individual citizen to vote for more public timber production and for less individual liability at the same time, and this is one of the main differences to the forest stock corporation. When buying a stock, the individual decides simultaneously on the amount of liability. In the worst case the individual loses the entire value of the stock, but never anything more. Therefore, the purchase decision and the liability decision is but one decision. Contrary to the market place, in the public square, the 'purchase' decision and the liability decision are two separate decisions. (Buchanan, 1999c: 87–96) Precisely this separation of fiscal decision-making is the source of the extension of liability in combination with more risky production.

However, as long as the unanimity rule is applied in public decision-making, the two separate decisions should lead to a similar result as in the private unlimited corporation: the extension of liability leads to less risky public timber production than in the case of limited liability. On the other hand, the application of an unconstrained majority rule opens up the opportunity to distribute the liability of public timber production in such a way that only the minority is liable for the obligations. If an individual knows his degree of taxation, his exposure to eminent domain etc., then he votes consistently in favor of public production. If a majority is taxed less, then that same majority will vote for a liability extension with the aid of public timber production. In other words, public timber production as an extension of liability will only evolve if an unconstrained majority rule leads to a form of taxation such that only a minority is responsible for the liability. (cp. Buchanan and Tullock, 1999: 190–199, Tullock, 2005: e.g. 209, 247).

The discussion here gives rise to an empirically testable hypothesis: political units with unconstrained majority rules have more public forest enterprises then political units with procedural and domain constraints on political authority (Buchanan and Musgrave, 2000: 107–128).

3.4. Discretionary power of the forest manager

De Alessi (2004: 451) concluded that managers of political enterprises have more discretionary power than managers of comparable private enterprises due to a lack of information on economic performance and less incentive for owners to monitor managers. Therefore, in section two of this paper the separation of ownership and management was studied. I obtained the same result. The forest manager within the public enterprise has more discretionary power than his colleague in a private enterprise. In this case he uses this discretionary power for the extension of the rotation length. Thus, in the public enterprise the observed forest rotation length is longer than the rotation length of the LEV-maximum. The reason for this is the strong exit clause for forest owners and a resultant free-rider problem.

Exactly this institution is the source of moral hazard of the forest manager. As we have seen in the modeling section of this paper, moral hazard does not stem from the separation of the property rights into an ownership and a forest management bundle of rights. As long as the competitive markets work the forest manager cannot move the rotation length to the direction of his own individual optimum. The coordination problem between the owner and the forest manager is solved satisfactorily by the conditions of the competitive market. In the case of the public forest enterprise it is the strong exit clause and not the separation of forest ownership and forest management that provides opportunities for the forest manager to extend the rotation length. This again gives rise to the question of why citizen owners agree to such a strong exit clause.

When developing empirical tests it should be clear that not every divergence between the optimal forest rotation lengths in the private stock corporation and the public enterprise is brought about by the discretionary power of the forest manager. As we have seen, the optimal rotation length in the public enterprise is always longer than in the private stock corporation. Only the liability premium of the public enterprise will be transformed into longer forest rotation lengths. Therefore, it would be difficult to distinguish empirically between the two components of the increase in the forest rotation length. It is exactly this difficulty of the citizen owner to watch the right r_{DDO}. What she can do is watch $r_S$and conclude that r_{DDO} must be less than r_S, but without knowing by how much. This inaccuracy in watching the right interest rate is the source of the discretionary power of the forest manager enabling him to extend the forest rotation length towards his own individual optimum, cp. Eq. (7).

The forest manager in the public forest enterprise can adopt rotation lengths longer than the optimal rotation length to maximaze the LEV in the direct democracy (T^{o}_{DDO}) by manipulating the LEV function. Two possibilities for the manipulation of LEV functions are offered in the public choice literature (e.g. Mueller, 2003: 359–385). The manager can either manipulate the costs of timber production or create special goods and services.

One of the most successful stories to shroud costs in forest enterprises is that of an interest rate close to zero, or a special forestry interest rate (e.g., Moog and Bösch, 2013): $0<r_{DDM}<r_{DDO}$, where r_{DDM}refers to the interest rate manipulated by the forest manager. With the help of this interest rate manipulation the public enterprise forest manager shifts the 'satisfactory' optimal forest rotation length in the direction of his own preferred optimal rotation length, Fig. 3.

Another technique for manipulation often referred to in public choice literature is the creation of goods. Although this technique is essentially applicable only in state bureaucracies, where the outcome is never really attributed to a value by the consumer, it may also be detected in public forest corporations.

The most prominent example is the 'timber reserve' stockpiled as a safeguard against a 'timber famine' (Perlin, 1997; Simon, 1996: 153–160). Using the 'timber reserve' justification, the forest manager legitimates higher timber stocks, leading to longer rotations and a lower LEV in comparison to Eqs. (1) and (2).

3.5. Reasons for public timber production

Public timber production in a direct democracy means that all citizens of the political unit are liable for all contractual obligations. The liability of every citizen is not limited by the value of his or her

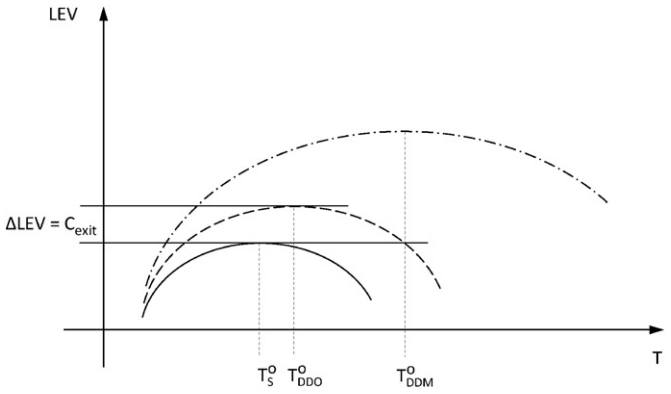

Fig. 3. The extension of the forest rotation length through the manipulation of interest rates.

individual share of the public enterprise but extends to their private incomes and assets. Also in this sense the citizens are the 'lender of last resort' for public timber production.

The liability extension described leads to a comparative advantage on the capital market because the public forest enterprise can mobilize a larger amount of debt capital, can borrow more risky capital or pay a lower interest rate for the same amount of capital as a comparable private forest stock corporation.

Although the liability argument is consistent with the concept of voluntary agreements made by individuals in public contracts, public timber production requires additional conditions. These are:

a) The public decision is separated into a decision on public timber production and a decision on the individual contributions to public liability.
b) Public decision making applies an unconstrained majority rule.
c) The application of this unconstrained majority rule leads to a transfer of liability to a minority.
d) The limited timeframe applying in public choices cannot outperform the advantage of lower interest rates associated with public timber production.

In other words, public timber production evolves only under a special institutional setting, the characteristics of which are described in a) to d) above. These conditions also provide an opportunity to formulate an empirically testable hypothesis: we can expect more public timber production as the four conditions a) to d) are fulfilled.

The development of modern financial markets over the last decades has led to a number of effective securities as dispositions to solve the liability problem. These financial instruments combine liability dispositions with a very high level of liquidity. The comparative advantage of public timber production should decline with the development of modern global capital markets. This should in turn lead to an increase in movements towards collective exits and the rededication of public enterprises producing market goods into public enterprises producing political goods such as public ecosystem or recreation services.

These two derivations correspond to observations made in modern democratic states over the last three decades. Privatization, and the extension of ecosystem services, are being discussed almost everywhere. For instance, Hinds et al. (2004: 286–287) gave an interesting overview of empirical results on the relative efficiency of public and private corporations. The discussion of timber production, multiple use forestry and the provision of ecosystem services by Nelson (1999, 2013: 11–12) can be read under the lens of the argumentation presented here. However, the paths of these arguments cannot be followed to their conclusion in this paper because the analysis here is focused on the public production of timber as a market good whereas the analysis of the public production of non-market goods exceeds the scope of this paper.

As I explained above, the extended liability in public timber production and the limited time perspective applying in public choices is ensured by a strong exit clause, which contains two elements. Firstly, only a collective exit from the public forest enterprise is possible; individual exit, as may occur in a private stock corporation, is impossible. Secondly, the collective exit is the result of a collective decision to exit.

The strong exit clause in the public forest enterprise not only ensures the liability and limits the time perspective; it also strengthens the discretionary power of the forest manager. Within the Faustmann model, the forest manager uses this discretionary power for those silvicultural management strategies that lead to some increase in the forest rotation length. Therefore, all of the differences among the silviculture adopted by a public and a private timber enterprise emerge from the use of different interest rates. Thus the Faustmann model analysis is full applicable for public forest enterprises in direct democracy, under the consideration that the public forest enterprises produce only goods exchanged at markets.

The source of this discretionary power is not the separation of forest ownership and forest management but the application of a special combination of rules for public decision making, as described in points a) and b) above. The key to improving the efficiency of public timber production within the political institutional arrangement lies in changes in the fiscal institutions and not in changes in the forest manager's employment contract or in implementing controlling tools in the public forest enterprise.

4. From the simple public choice model to representative democracy

It should be clear that all of the results and conclusions to this point derive from a simple public choice model of a direct democracy. This means that all individuals within a political unit are involved in public decision making, whereby each individual has exactly one vote.

Clearly this represents a very great reduction of the complexity of the political institutions in a representative democracy. The individuals in a representative democracy participate in the political processes in many different ways, with very different intensities. Furthermore, the institutions of a representative democracy attribute to the individuals within the society different weight. These lead to the typical classification of individuals as voters, members of political parties, representatives, bureaucrats and members of pressure groups. I expect that the various institutions of a representative democracy lead to different outcomes in public decision making than is the case in the model of a direct democracy.

For instance, Laband (2013) demonstrated with help of a stylized example how the results of an election differed between a direct and a representative election. This example prompts the question as to why the citizens agree with such 'unsatisfactory' results of representative democracy given the wishes of the 'real' majority. The answer to this question leads directly to the field of constitutional economics, which exceeds the scope of this paper.

If we understand representative democracy to be an efficient way for an individual within a large group to add their voice to public decision making, then the model of direct democracy provides the results of pure public decision making without any variation caused by the specific institutions of representative democracy. The model of direct democracy traces every public choice back to the direct choices made by the constituent individuals. The analysis of this simple model allows for general results and conclusions for every form of democracy. This is the concern of this paper.

Whether we apply simple models of direct democracy or more complex models of specific representative democracies, the issue is not that we understand democracy to be either simple or a set of complex institutional arrangements. The application of simple or complex models depends on the questions being asked. We can apply simple models to discern principles that are generally valid independent of the specifics of a certain democracy. To understand the specific

consequences of a concrete institutional arrangement, then we must work with more complex models. Using both kinds of model we formulate hypotheses that can be tested empirically. Whereas the simple models provide propositions that must be observable in every democracy, the complex models provide propositions that differ from democracy to democracy. The floor for further research in this direction is open.

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