FUND SUBSTITUTION AND THE PUBLIC COST SHARING OF PRIVATE FOREST INVESTMENTS IN FINLAND 1983-2000

Mikael Linden[*]
Department of Business and Economics
University of Joensuu
&
Jussi Leppänen[**]
Finnish Forest Research Institute

Abstract. A model of public cost sharing of private forest investment is proposed to describe substitution between private financing of investments and public investment assistance. Substitution depends on the curvature conditions of forest investment function on forest stock. When the second order investment effects are close to zero or when they do not exist the funding substitution will not take place. Simultaneous econometric model for private and public funding with forest incomes, forest income taxes, interest rates, investment scale, and market wood price expectations as exogenous variables is estimated. The model estimation with Finnish regional data in period 1983-2000 rejects the substitution alternative. A 10% increase in private investment funding increases public funding demand with same rate but a 10% increase of public funds increases the private funds supply 2.4%. Significant income effects are found only for private funding. In northern Finland scale effects are large for public financial assistance. Interest rate and price expectation effects are negative.

*) University of Joensuu, Department of Business and Economics, Yliopistokatu 7, Box 111, FIN-80101, Joensuu, Finland. email: mika.linden@joensuu.fi

**) The Finnish Forest Research Institute (METLA), Unioninkatu 40A, FIN-00170 Helsinki, Finland. email: Jussi.Leppanen@metla.fi.

I. Introduction

In many countries non-industrial private forestry (NIPF) has special political arrangements in order to fulfill social demands and objectives. Traditionally silvicultural and forestry infrastructure improvement investments and increasingly environmental objectives are promoted. In Finland, the traditional forestry financing policy has been based principally on cost-sharing, where public financing has been allocated to those NIPF owners, who also are investing given own share of investment costs.

Since 1960's, increasing investments into forestry has been seen as a growth factor for Finnish economy (see Juurola et al. 1999). In addition to projected increase in future timber supply, financial assistance to silvicultural investments and infrastructure building has indirectly supported technological development for more extensive harvesting. This has benefited welfare especially in those rural areas, where forest industrial plants are located.

Public cost-sharing instruments have been many and extensive. Financial assistance for NIPF owners have been given in forms of grants and soft loans. Financing zones defining the cost-sharing measure-level percentages have been employed in order to alleviate timber production profitability differences inside the country. This means, northern Finland with lower growth and yield and longer rotations has received greater share of cost-sharing than southern Finland. Also site productivity taxation instruments have been employed in promoting NIPF owners investments. All these financial instruments have been supported with technical assistance, of which forest work planning costs are considered directly grants for NIPF owners, and information costs like advisory services and forest planning as costs of extension.

Today, all NIPF owners are eligible for cost-sharing, if measure-related assistance conditions are fulfilled. In past decades, also forest owner income characteristics and forest estate size restrictions have also been employed in cost-sharing eligibility. Although social status restrictions were alleviated in time, it was not earlier than with Forest Improvement Law of 1987, when only characteristics of eligible supporting work target mattered for cost-sharing eligibility of NIPF owners.

The beneficiaries of public financing, NIPF owners have been since long time practically only agricultural producers, living in rural areas. However, since 1970's these connections have been in major change. Today, farmers own only 33 percents of forest area and their share of forest owners is even less, 22 percents. These shares are still decreasing. Due to high average age (57 years) and proportion of retired forest owners (37%), majority of NIPF owners still live in rural areas, but the next forest ownership generation will be in greater shares living in urban areas. (Karppinen et al. 2002)

Cost-sharing results seem to have been succesful, if time-series of investment total financing shares are regarded (see e.g. Finnish Statistical Yearbook of Forestry 2003). However, the focus of the present study, NIPF owners investment behaviour indicated by these time series has not been properly analysed.

The purpose of this paper is to analyse non-industrial private forest owners' investment behaviour with regard to public cost-sharing opportunity. The research questions can be set as follows: First, if public agent desires to increase certain forestry investments of NIPF, how this cost-sharing input will increase total supply of forest owners' own investment funding share? In this context, it must be kept in mind, that a great deal of NIPF investments are carried out outside the cost-sharing policy, and substitution between private and public funding may take place. Second, which is the opposite case, if private agent, a NIPF owner, desides to invest into forestry, how much he/she will demand for public cost-share funding? This also depends much on the availability of public funds and possible restrictions set in the funding policy.

This paper is organised as follows. In Chapter II, background literature and a theoretical model is presented. In Chapter III, we introduce time series on Finnish NIPF owner investments, values of public and private cost-shares, the econometric model for analysing the demand for and supply of cost-sharing parts; and finally the results of the econometric model. Conclusions and discussion are followed finally in Chapter IV.

II. The economics of public cost sharing of private forest investments

II. 1. Background

Economic theory often treats economic subsidies and aid as harmful and distorting. In general equilibrium setting it is hard to defend Pareto efficient subsidies. The second best solutions are typically found. In partial setting subsidies can be motivated by positive externality, scale and allocation effects. Typically regional or industry specific employment and investment subsidies are introduced to promote more even economic growth and development. Theoretically investment subsidies are shown to be more efficient than employment subsidies (Flam et al. 1983, Fuest and Huber 2000). However, in non-competitive market conditions non-harmful factor substitution and incentive effects of subsidies can be eloborated (Holden and Swales 1995, Pennings 2000). The case of direct public fund subsidy or aid to private investment funding is not much analysed case. Wren (1996) shows that fund substitution depend crucially on the elasticity of investment with respect to the user cost of capital in the without–subsidy position, and on the nature of any amount and rate constraints on the assistance contract. The position of full substitution is hard to defend, but the case of partial substitution is relevant.

In forest economics the number of detailed papers on forest investment cost-share programs have been few. The general economic effects of public aid on forest investments and cuttings were analyzed, both theoretically and empirically, by Linden and Leppänen (2003a). Public financial assistance has clear positive investment incentive effects among the Finnish NIPF owners. In Linden and Leppänen (2003b) the substitution between private funding of investments and public aid was analyzed in details. In some special cases complementarities were not ruled out. Model predictions were tested with aggregate data from Finland in years 1963-2000. Some substitution of assisted private funding for non-assisted private funding was found. Boyd (1984) shows that the financial assistance part of the cost sharing program to forest owners affects capital improvement more than the decision to harvest mature timber. However, the investment effects of cost sharing programs are positive. De Steiguer (1984) finds, using panel data from USA southern states in period 1964-1979, that government cost-sharing payments do not affect the private autonomous tree planting expenditures of NIPF investors (see also Brooks 1985, Royer 1987 and Cohen 1983).

II. 2. The Model

Since the forest investment are costly and slowly maturing the socially optimal level of investments is not warranted. The relative low return of forest capital (i.e. the forest trees and land) makes alternative investment projects more attractive than wood production. Small or fractioned woodlot areas create also disincentives for larger infrastructure investments. In order to sustain the socially optimal level of wood supply the government must finance the private forest investors. Generally the incentive structure has been one wherein, once the private forest owner starts his forest investment project, the government will in selected cases support and partly cover the financial costs.

Assume that forest owner can increase and improve his forest stock S with investments and forest management in forest capital. In this context we define forest capital input as methods which improve the forest stand and soil. This type of investments include preparation for natural and artificial regeneration, seeding and planting, tending of seedling stands, forest fertilization and forest drainage. Some investments reduce harvesting costs, e.g. construction and improvement of forest roads.

Abstracting from stock growth and other input effects for sake of simplicity we assume that stock is a concave production function of capital K input (investments), i.e.

$$S = f(K), \quad \text{with}\, f_K > 0 \text{ and}\, f_{KK} < 0.$$

The price of investment goods q is given to the forest owner. The financing of investment in forest capital is undertaken with private funds R and government assistance program that has two parts: a lump sum transfer B and fixed share rate rule αR where $0 < \alpha < 1$. The forest owner can choose a combination of levels of B and R. The cost sharing programme has a fixed upper limit $\bar{W}$: $B + \alpha R \le \bar{W} < R$. Thus, the provided cost sharing is always less than the private funding of investment project. The sharing rule contains an incentive structure for the forest investor since assistance is ruled out if $R \le \bar{W}$. For example if the sharing rule is $B + 0.25R \le 100$, and private funding is only 50 without the rule, then the investor rises his share with the rule at least to 100 and his optimal assistance is $75 + 0.25\text{x}100 = 100$. The total investment is now 200. However if the private funding without the sharing program is already at the level of 200 then the investor may choose $50 + 0.25\text{x}200 = 100$, i.e. his lump sum assistance is less than in the above case with less private investment. This is hardly a optimal case since he/she can get the maximum assistance with less private funding. The example shows the difficulties involved with the cost sharing programmes. Fixing the lump sum assistance at the some level for every investor will not solve the problem since maximum assistance is always obtained only with one value of private investment.

Generally the positive incentive effects of cost sharing programmes are valid only if the level of subsidy $\bar{W}$ is high enough, i.e. the positive incentive effects for investment dominates in average. However, this is not warranted as the following analysis based on the optimal investment conditions will show.

The private funding is provided by the loan markets with interest rate r. The cost sharing rule entails still that forest owner can choose an optimal mix of B and R in order to maximize the net gain of his investment project subject to cost sharing rules, i.e.

$$\max_{B,R} f(K) - C(R,B)$$

$$s.t. \quad qK = B + (1+\alpha)R$$

$$0 \le B + \alpha R \le \bar{W}$$

$$R > \bar{W}.$$

$C(B,R)$ is a convex or a linear cost function of provided public and private funds. Naturally $C_B = s \ge 0$, $C_R = r > 0$ with $r - s > 0$ and $C_{RR} = r_R \ge 0$. The marginal private cost of public funds is close to zero for the private investor but the marginal cost of private funds is positive. If the private lenders are risk averse the private interest rate incorporates a risk premium which increases with private funding costs $(r_R > 0)$. If $C_{BB} = s_B$ exists, this means that the private marginal cost of public funding is increasing with level of funding. The assumption is reasonable, when the increasing part of the auditing and monitoring cost of public funding is paid by the private forest owner. Typically $s_B = 0$ and $C_{BR} = C_{RB} = 0$. In the following the analysis is conducted using only the assumption $C_{BR} = C_{RB} = 0$.

The Lagrange of the problem is

$$L(B,R) = f([B+(1+\alpha)R]/q) - C(B,R) + \lambda[\bar{W} - B - \alpha R]$$

The first order conditions are

$$\begin{cases} \partial L/\partial R = \dfrac{1+\alpha}{q} f_K - C_R - \alpha\lambda = 0 \\ \partial L/\partial B = \dfrac{f_K}{q} - C_B - \lambda = 0 \end{cases}$$

$$\begin{cases} \partial L/\partial \lambda = \bar{W} - B - \alpha R \geq 0 \\ \lambda[W - B - \alpha R] = 0 \end{cases}$$

The forest owner uses all cost sharing funds because the involved marginal cost is close to zero, i.e.

$$C_B = s \geq 0: \quad \lambda = \frac{f_K}{q} - s > 0 \text{ and } \bar{\mathrm{W}} - B - \alpha R = 0.$$

Solving for λ from the first order conditions give

$$\frac{(1+\alpha)}{q} f_K - C_R - \alpha\left(\frac{f_K}{q} - s\right) = 0 \ .$$

Noting that $C_R = r$ the optimal investment rule is

$$f_K = q(r - \alpha s) < qr$$

i.e. marginal product of forest investment equals the assisted user cost of investment. Note that $f_K < qr$ means higher level of investments than without the public cost sharing.

In order to analyse the comparative static effects between private funding and forms of public funding the optimal investment condition $f_K = qr - q\alpha s$ is first totally differentiated holding q and B fixed

$$f_{KK}\frac{R}{q}d\alpha + \frac{(1+\alpha)}{q}f_{KK}dR = qC_{RR}dR - qsd\alpha$$

$$\Rightarrow \qquad \frac{dR}{d\alpha} = -\frac{(f_{KK}R + q^2 s)}{(1+\alpha)f_{KK} - q^2 C_{RR}} < 0 .$$

Rising the share rate α means less private investment if $s = C_B$ is close to zero and the level of private funding R is high. Note that rate of private risk premium $C_{RR} = r_R > 0$ has a lowering effect on funding substitution. If investment effects on forest stock are linear $(f_{KK} = 0)$ and $s \geq 0$ then

$$\frac{dR}{d\alpha}\Big|_{f_{KK}=0} = \frac{s}{C_{RR}} \geq 0$$

and funding substitution will not take place.

The effects of lump sum assistance on private funding is analysed in similar fashion, but now α and q are hold fixed and

$$f_{KK}\frac{dB}{q}+\frac{(1+\alpha)}{q}f_{KK}dR = qC_{RR}dR - q\alpha C_{BB}dB$$

$$\Rightarrow \qquad \frac{dR}{dB} = -\frac{(f_{KK}+q^2\alpha C_{BB})}{(1+\alpha)f_{KK}-q^2C_{RR}} < 0.$$

The result is close to above with share rate but the substitution between B and R now does not depend on the level of R. Thus $dR/d\alpha < dR/dB$. Note that when $f_{KK}=0$ the funding substitution disappears

$$\frac{dR}{dB}\Big|_{f_{KK}=0} = \frac{\alpha C_{BB}}{C_{RR}} > 0.$$

The analysis so far has been based on the assumption that the cost share rule is binding, i.e. $\lambda[\bar{W}-B-\alpha R]=0$ with $\lambda>0$. Next we analyse the fund substitution case with non-binding rule $B+\alpha R<\bar{W}$. The case is a plausible alternative in this context, since quite often forest owner lacks incentive for forest investments or simply because in many cases any larger forest investment possibilities do no exist. The forest owner may also have income constraints that lowers his private investment possibilities. In all these cases the forest owner participate only partly in cost sharing program or he/she may do not participate at all in it. There are also evidence, which may partly support this kind of behaviour in Finland, since in many years some public funding is left over, i.e. all public funds targeted to support and boost the private forest investments are not used.

In this case the analysis of the first order conditions is

$$\begin{cases} \partial L/\partial R = \dfrac{1+\alpha}{q}f_K - r = 0 \\ \partial L/\partial B = \dfrac{f_K}{q} - s = 0 \end{cases}.$$

The funding substitution formulas are now for R and α

$$\frac{d\alpha}{q} f_K + \frac{(1+\alpha)R}{q^2} f_{KK} d\alpha + \frac{(1+\alpha)^2}{q^2} f_{KK} dR = C_{RR} dR$$

$$\Rightarrow \qquad \frac{dR}{d\alpha} = - \frac{(qf_K + f_{KK}(1+\alpha)R)}{(1+\alpha)^2 f_{KK} - q^2 C_{RR}}.$$

For R and B we get

$$\frac{1}{q^2} f_{KK} dB + \frac{(1+\alpha)}{q^2} f_{KK} dR = C_{BB} dB$$

$$\Rightarrow \qquad \frac{dR}{dB} = - \frac{(f_{KK} - q^2 C_{BB})}{(1+\alpha) f_{KK}} < 0.$$

The sign of $dR / d\alpha$ is not generally certain, but under assumption $f_{KK} = 0$ we obtain

$$\frac{dR}{d\alpha}\Big|_{f_{KK}=0} = \frac{f_K}{qC_{RR}} > 0\,.$$

The analysis above has shown that the funding substitution outcome is not always valid case when public financial support to forest owners increases. Irrespectively of binding of public cost sharing constraint the public support increases private funding on investments if the stock effects from investments are almost linear $(f_{KK} \approx 0)$ and if marginal costs of public and private funding are increasing with the funding levels ($C_{RR} > 0$ and $C_{BB} > 0$).

III. Econometric analysis

III. 1 Data and model specification

Our panel data consists of regional observation of 19 Forestry Board districts in Finland in years 1983-2000. In 1996, an forestry organisational reform took place changing the regional areas, and new 13 Forestry Centre regions were converted to preceding districts. Following variables are used:

PRIVfunds = private total costs of forest investments (million euros)

PUBfunds = government investment grants and loans to private forest investors (million euros)

INCOME = private forest owners' income from wood selling measured as a value of timber sales contracts (million euros)

i = nominal interest rate of commercial bank loans (%)

HECT = total forest area affected by forest investments (in hectares)

Pe = one period ahead market price expectations (euros/m3 over bark)

Corresponding observations, except for the interest rates, for these variables are obtained from Finnish Statistical Yearbooks of Forestry, published by Finnish Forest Research Institute. The price expectations were derived from time series models of regional stumpage market prices. The conducted theoretical analysis above does not allow for any detailed formal model how the private and public funding of private forest investments are related to each other. However the derived theory implications can be tested with following two equation system describing the supply of private investment funds and demand for public funds

Supply of private funds

$$PRIVfunds = f(\underset{(-)}{PUBfunds}, \underset{(+)}{INCOME}, \underset{(-)}{i}, \underset{(+)}{HECT}, \underset{(+)}{Pe})$$

Demand for public funds

$$PUBfunds = g(\underset{(+)}{PRIVfunds}, \underset{(-)}{INCOME}, \underset{(+)}{i}, \underset{(+)}{HECT}, \underset{(-)}{Pe})$$

The signs under the variables indicate the effects of variables on the endogenous variables. The model treats both the private and the public funding of forest investments as endogenous variable. The level of supply of private funds *PRIVfunds is* partly determined by the public funding since this is the target of public cost sharing programs. However, the theory predictions derived above indicate that fund substitution is the most expected alternative, i.e. increase in public share of funding decreases supply of private funds. The demand for public funds, *PUBfunds,* is also endogenous since the level of public funds distributed by the state is conditioned by the increased level of private investment. In this case we can not assume that private funds are substituted for public funds. Note that this result does not either contradict our theory implications.

Incomes obtained by the forest owners in form of wood selling have a positive effect on supply of private funding of investments. However, the income effect on public funding is assumed to be negative. High forest incomes reduce the need of public investment support. The total forest area affected by forest investments is the scale variable in the system. Large investment areas imply increasing investment funds. However, the financing of investment with bank loans has a negative effect on investment, i.e. high loan interest rates decrease the supply of private investment funds. The commercial interest rate effects on public funding are positive indicating the effects of increased costs of private funds. The price expectations of stumpage market prices increase the private investment funds since next period's incomes are expected to higher than in current period. Increasing expected incomes allows for larger investments and less public support.

Next we assume that the above system can be linearized and the following fixed regional effects panel model of demand for and supply of investment funds is estimable with least squares methods

$$PRIVfunds_{it} = a_{0i} + D1 + D2 + D3 + a_1 PUBfunds_{it} +$$

$$a_2 INCOME_{it} + a_3 i_{it} + a_4 HECT_{it} + a_5 Pe_{it} + \varepsilon_{it}$$

$$PUBfunds_{it} = b_{0i} + D1 + D2 + D3 + b_1 PRIVfunds_{it} +$$

$$b_2 INCOME_{it} + b_3 i_{it} + b_4 HECT_{it} + b_5 Pe_{it} + \eta_{it}$$

$i = 1, 2, \ldots, 19$ (regions) and $t = 1, \ldots, 18$ (1983-2000).

Regional specific fixed effects a_{it} allow for regional differences in fund supply and demand. ε_{it} and η_{it} normally and independently distributed errors.

The estimated equations include three dummy variables that describe price agreements and forest tax changes during the analysed period. The dummy variables are defined as

D1 = dummy variable for collective timber price agreements in period 1979-1990
D2 = dummy starting in year 1993 for transition in forest income taxation system
D3 = regional percentages of alternative forest tax formulas adopted since year 1993.

The Finnish tax system for NIPF owners changed in 1993. The forest owner was forced to choose, in the transition period of 1993-2005, between the old system based on the owned forest area (site-productivity tax) and the new system based on the income from wood selling (wood sales profit tax).

All the nominal price variables were changed to real prices by dividing them by the cost-of-living index. Interest rates $(100 x i)$ were adjusted with the inflation rate to obtain real interest rates. All variables except interest rate and dummies D1-D3 were logarithmically transformed.

The model system above is estimated with instrumental variable method (2SLS) since both equations include an endogenous variable as explanatory variable. Using OLS method would lead to inconsistent and biased parameter estimates. Note that the above model is in the structural model form. The reduced form of model entails that the total effects of exogenous variables are affected by the feedback effects of endogenous variables. The reduced form is obtained in following way (abstracting from fixed regional and dummy effects)

$$\begin{bmatrix} 1 & -a_1 \\ -b_1 & 1 \end{bmatrix} \begin{bmatrix} PRIVfunds \\ PUBfunds \end{bmatrix} = \begin{bmatrix} a_2 & a_3 & a_4 & a_5 \\ b_2 & b_3 & b_4 & b_5 \end{bmatrix} \begin{bmatrix} INCOME \\ i \\ HECT \\ Pe \end{bmatrix}$$

$\Rightarrow$

$$\begin{bmatrix} PRIVfunds \\ PUBfunds \end{bmatrix} = \begin{bmatrix} 1 & -a_1 \\ -b_1 & 1 \end{bmatrix}^{-1} \begin{bmatrix} a_2 & a_3 & a_4 & a_5 \\ b_2 & b_3 & b_4 & b_5 \end{bmatrix} \begin{bmatrix} INCOME \\ i \\ HECT \\ Pe \end{bmatrix}$$

Next we estimate the model using all the regions at same time and separate models for Forestry Board districts in southern and northern Finland. All exogenous variables including dummies are used as instruments. However the equation identification needs that at least one exogenous variable must be excluded from each equation. The excluded variable has to be different in each equation. This means that some of coefficients in vectors $a' = (a_2....a_5)$ and $b' = (b_2....b_5)$ must be zero (for more details, see Greene 2000, chapter 16).

III. 2 Results

The models are first estimated with fixed effects OLS without the endogenous variables on the right hand side. This gives us some preliminary information concerning the importance of postulated exogenous variables. The results in Table 1 show that model estimates are well-determined and most of parameter signs are as expected. The collective price agreements in period 1979-1990 (dummy D1) had positive investment funding effects. However the introduction of wood sales profit taxation alternative starting in 1993 (D2) seems to lower the funding in forest investments but the coverage of this new tax system (D3) has a positive impact on investment funds. However the total tax effects are positive and they are stronger on demand for public funds than on supply of private funds. The causes of opposite signed tax effects is analysed in details in future research work.

Table 1. Fixed effects LS-estimates for models of private funds (PRIVfunds) and public cost sharing funds (PUBfunds) of investments in Finland. 342 observation: N=19 forest board districts, T =18 years 1983-2000

Exogenoues Variable	*PRIVfunds* estimate t-value	*PUBfunds* estimate t-value
$D1$	0.295*	0.269
	(3.06)	(1.57)
$D2$	–0.664*	–0.923*
	(–2.92)	(–2.35)
$D3$	1.101*	1.341*
	(3.17)	(2.34)
INCOME	0.236*	–0.088*
	(22.67)	(–4.77)
i	–0.137*	0.031
	(–2.52)	(0.24)
HECT	0.318*	1.302*
	(10.54)	(24.34)
PE	–0.264*	–0.071
	(–2.29)	(–0.39)
R^2	0.778	0.662
fixed effects $\chi^2(18)$	181.09	53.86
$p-value$	(0.00)	(0.00)

**) statistically significant at 5% level*

Private forest incomes increase the private funds supply with rate of 0.24% but lower the demand for public funds. However the exact elasticity value of latter (-0.088) is not significant in economic terms. The negative interest rate effects on private funds are not negligible since a 10% increase in commercial loan interest rates decreases private funding with 1.4%. Interest rate effects lack statistical significance on public funds. Investment area (variable HECT) effects are large especially on the public funds demand. A 10% increase in invested area increases public funding with 13%. The corresponding elasticity for private funding is only 3.2%. The difference between these estimates is interesting. Private investment may be more cost-effective than public financed investments. The difference may reflect also the fact that alternative forms of investment funds are used in different purposes. Higher price expectations on stumpage market prices decrease the supply of private funding on investment. The reason for the found negative effect may lie in the regressive investment behaviour of private forest owners. Investments are financed only with realized incomes, not with expected incomes. No effects are found on public funding. Thus the proposed positive income effect is rejected.

Generally, results in Table 1 are promising since many variables enter in equations with statistical significance and have proper economic interpretation. The coefficient of determination, R^2, is reasonable high for both equations. No autocorrelation or hetero-skedasticity were found in residuals. Tests for no fixed regional effects are rejected in both equations. Thus regional differences exist in forest investment funding. Regional dummies were positive in private funding equation but they were negative in public funding equation.

In the next stage we estimate the two equation model system with 2SLS method because the endogenous variables are now included on the right hand side of equations. The equation identification needs that some variables are excluded from the models. In this context, we exclude variable *HECT* from equation for *PRIVfunds* and variables *i* and *Pe* from equation for *PUBfunds.* Also the dummy variables *D1-D3* were excluded from the latter equation since in the preliminary estimation non-exclusion caused some estimation instability. Note that all exogenous variables were included in instrument set.

Table 2. Fixed effects 2SLS-estimates for models of private funds (PRIVfunds) and public cost sharing funds (PUBfunds) of investments in Finland.

Exogenoues Variable	*PRIVfunds* Whole country N=19, T=18 estimate t-value	*PUBfunds* estimate t-value	*PRIVfunds* Southern Finland N=15, T=18 estimate t-value	*PUBfunds* estimate t-value	*PRIVfunds* Northern Finland N=4, T =18 estimate t-value	*PUBfunds* estimate t-value
PUBfunds	0.244*		0.245*		0.190*	
	(10.32)		(9.18)		(3.92)	
PRIVfunds		1.232*		1.051*		0.943*
		(6.20)		(3.65)		(1.75)
*D*1	0.230*		0.206*		0.243*	
	(2.58)		(1.96)		(2.21)	
*D*2	–0.417*		–0.515*		–0.043	
	(–2.26)		(–1.78)		(–0.38)	
*D*3	0.683*		0.831*		0.061	
	(2.52)		(2.01)		(0.16)	
INCOME	0.258*	–0.378*	0.256*	–0.340*	0.295*	–0.311*
	(23.06)	(–7.42)	(19.80)	(–5.33)	(12.78)	(–1.68)
i	–0.138*		–0.087		–0.285*	
	(–2.38)		(1.15)		(–4.21)	
HECT		0.912*		1.003*		0.819*
		(11.49)		(8.17)		(8.34)
Pe	–0.247*		–0.141		–0.511*	
	(–1.94)		(–0.89)		(–3.46)	
R^2	*0.748*	*0.529*	*0.685*	*0.599*	*0.863*	*0.324*

**) statistically significant at 5% level*

Table 2 gives the results from instrumental method estimation for the panel models that include all Forestry Board districts. Separate models were estimated also for southern Finland (15 districts) and northern Finland (4 districts). Some differences in investment behaviour among private forest owners are expected in southern and northern Finland. The climate and soil conditions are quite different in these regions. Also the age structure of the forests are different. In southern Finland trees on average reach their financial maturity much younger than in northern Finland. The public share of investment funding is also higher in the north.

The results in Table 2 for exogenous variables are quite close the ones found in Table 1. above except for the negative income effects on public funds demand are now significant in economic terms also. The parameter estimates are now close to –0.35. The tax effects on private supply of funds are not found in northern Finland. The price expectations and interest rate effects on private funds are larger in northern Finland than in southern Finland.

The most striking result concerns the funding substitution hypothesis. The results reject the hypothesis. Table 2 shows that no substitution is found. Private and public funding of investments are related to each other complementary. However the relationships between them are not symmetric. The elasticities of public funds in private funds supply equation lie between values 0.19-0.25 but the private fund elasticities of public funds demand are between values 0.94-1.24. Thus a 10% increase in private investment funding increases public funding demand with same rate but 10% increase of public funds increases private funds supply in average only with 2.4%. The latter result is partly understandable also from the point that private funding share is twice as large as the public share The effects are somewhat higher in southern Finland than in northern Finland. The found elasticities values and endogeneity of both funding forms mean that if exogenous causes for investment are not allowed for, the investment funding would die out.

Regional differences are not great between the forms of investment funding but some greater disparities are found among the exogenous variables, when the model results above are converted in the reduced model form. Table 3 gives the reduced form parameterisation with whole country, southern and northern Finland estimates. The reduced income effects on public funds demand are insignificant regardless the region analysed. Income effects on private funding supply are quite similar across the regions. 10% increase in private forest incomes increase the private funding on investment with rate of 2.3% in southern Finland and 2.9% in northern Finland. The reduced interest rate effects are more significant in northern

Finland and the effect are more severe with public funding. Investment area effects on public funding are especially large in northern Finland. The reduced price expectations effects are

Table 3. Reduced form estimates for exogenous variables

	INCOME	*i*	*HECT*	*Pe*
Whole country				
PRIVfunds	0.237	–0.197	0.318	–0.353
PUBfunds	–0.085	–0.243	1.304	–0.435
Southern Finland				
PRIVfunds	0.233	–0.117	0.331	–0.189
PUBfunds	–0.095	–0.123	1.351	–0.199
Northern Finland				
PRIVfunds	0.287	–0.347	0.189	–0.622
PUBfunds	–0.039	–0.327	0.998	–0.587

three times larger in northern Finland compared with findings in southern Finland. A 10% increase of price expectations decrease investment funding in average 6% in northern Finland. The reduced form estimates show that the investment funding in northern Finland is much more sensitive to exogenous interest rate and price expectation shocks than in southern Finland. Note that some uncertainty is contained in these estimates since some parameter estimates in Table 2 were quite imprecise.

IV. Conclusions

A model of public cost sharing of non-industrial private forest investment was proposed to describe the optimal choice between the private financing of investments and public investment assistance. The public support consisted of a lump sum transfer and fixed share rate rule of private funds. The NIPF owner optimized his private funding with respect to sharing contract. The government actions and choices were given as exogenous. The fund substitution depends on the curvature conditions of forest investment and funding cost functions. If the stock effects from investments are almost linear and if marginal costs of public and private funding are increasing with the funding levels, the fund substitution is not present. In more general cases substitution is present. The model does not allow for structural testing of fund substitution hypothesis, but helps us to interpret empirical results.

Simultaneous econometric model for private and public funding with forest revenue taxes, forest incomes, interest rates, investment scale, and market wood price expectations as exogenous variables was estimated. Finnish regional data in period 1983-2000 was used. The 2SLS estimation results rejected the substitution alternative. A 10% increase in private investment funding increases public funding demand with same rate but a 10% increase of public funds increases the private funds supply 2.4%. From budget expenditure point of view, also other instruments than public grants and loans increasing private funding are therefore worth of further research and development. Significant income effects are found only for private funding. In northern Finland investment scale effects are large for public financial assistance.

The results imply that government cost-sharing investment programmess have been incentive supporting. They have increased, not "crowded out", the private investments. Linden & Leppänen (2003a) showed also that cost-sharing has led to increased cuttings during the analyzed period. However, the question of opportunity costs and stocks effects of government funding remains to be analyzed. Thus, cost-benefit analysis and cost-effectiveness of cost sharing programs should be analyzed in more details before the final merits of government investment support programmes can be evaluated.

Acknowledgements

This paper has been prepared within the Evaluating Financing of Forestry in Europe (EFFE) project, carried out with the financial support from the Commission of the European Communities, DG Research - Quality of Life and Management of Living Resources Programme under the contract number QLK5-CT-2000-01228.

References

BOYD, R. 1984. Government Support of Nonindustrial Production: The Case of Private Forest. Southern Economic Journal 51: 89-107.

BROOKS, D.J. 1985. Public Policy and Long Term Timber Supply in the South. Forest Science 31: 342-357.

FLAM,H., PERSSON,T. & SVENSSON, L. 1983. Optimal Subsidies to Declining Industries: Efficiency and Equity Considerations. Journal of Public Economics 22: 327-45.

FUEST, C. & HUBER, B. 2000. Why Do Governments Subsidise Investment and not Employment? Journal of Public Economics 78: 171-192.

GREENE, W. E. Econometric Analysis, 5th ed. Prentice-Hall. NY.

HOLDEN, D.R. & SWALES, J.K. 1995. The Additionality, Displacement and Substitution Effcets of Factor Subsidies. Scottish Journal of Political Economy 42: 113-126.

JUUROLA, M., OLLONQVIST, P., PAJUOJA, H. & TOROPAINEN, M. 1999. Outcomes of Forest Improvement Work in Finland. Silva Fennica 33(3): 217-224.

KARPPINEN, H., HÄNNINEN, H. & RIPATTI, P. 2002. Suomalainen metsänomistaja 2000 [Finnish forest owner 2000]. Finnish Forest Research Institute, Research papers 852. 83 p. In Finnish.

LINDEN, M. & LEPPÄNEN, J. 2003a. The Impact Government Investment Assistance on Forest Investments and Timber Supply: A Theoretical and Empirical Analysis. In Helles, F., Strange, N. & Wichman, L. (eds). Recent Accomplishments in Applied Forest Economics. Kluwer Academic Publishers, Forestry Sciences Vol. 74: 167-179.

LINDEN, M. & LEPPÄNEN, J. 2003b. Effects of Public Financed Aid on Private Forest Investments: Some Evidence from Finland, 1963-2000. Scandinavian Journal of Forest Research 18: 560-567.

PICARD, P.M 2002. Optimal Employment Subsidies and Market Structures in Industries with Unemployment. Oxford Economic Papers 31: 352-362.

ROYER, J.P. 1987. Determinants of Reforestation Behaviour Among Southern Landowners. Forest Science 33: 654-667.

DE STEIGUER, J.E. 1984. Impact of Cost-Share Programs on Private Reforestation Investment. Forest Science 30: 697-704.

WREN, C. 1996. Fund Substitution and the Incentive Effects of Public Investment Subsidies. Scottish Journal of Political Economy 43: 534-548.