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RESEARCH PAPER

The Increasing Importance of Small-Scale Forestry: Evidence from Family Forest Ownership Patterns in the United States

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Abstract The state-level distribution of the size of family forest holdings in the contiguous United States was examined using data collected by the USDA Forest Service in 1993 and 2003. Regressions models were used to analyze the factors influencing the mean size and structural variation among states and between the two periods. Population density, percent of the population at least 65 years of age, percent of the population residing in urban areas, per capita income, income inequality, and per capita private forestland were found to be significantly correlated with the structure of landholding size. This paper suggests that the number and proportion of small-scale family forest owners in the United States are both increasing due to the increasing importance of non-timber amenities to forest landowners.

Keywords Non-industrial private forests · Seemingly unrelated regression · Ordinary least squares regression · National Woodland Owner Survey · Parcelization

Introduction

Economic analysis of forest management decisions has traditionally concentrated on decisions related to harvesting rotations, using the Faustmann optimal economic

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rotation model. In those studies, landholding sizes are generally assumed to be fixed. However, the factors that affect landholding size and how landholding size changes with socio-economic circumstances are important issues that have not been fully investigated. Small-scale family forestry is becoming more common in both developed and developing countries, yet the reasons why small-scale forestry is becoming more important have not been investigated adequately. This paper uses data from the United States to examine the structural variation of forest landholding size among the states. It argues that the economic efficiency of small-scale forestry has resulted primarily from increasing non-timber amenities of the forests.

Currently, there are an estimated 248 M ha of forestland in the contiguous United States (Smith et al. 2004). Nearly two-thirds, or 157 M ha, are privately owned and two-thirds of this land, or 105 M ha, is owned by 10.3 M families and individuals (Butler and Leatherberry 2004). The number and relative importance of family forest owners varies considerably across the country. The north has 46% of the family forest owners in the USA, the south has 42%, and the west has 12%.

The distribution of size of family forest landholdings has been undergoing dramatic change. The number of family forest owners in the contiguous United States increased from 9.3 M in 1993 (Birch 1996) to 10.3 M in 2003 (Butler and Leatherberry 2004). Research also suggests that both the share and total acreage in small parcels (less than 20 ha) have increased in the last 10 years (Butler and Leatherberry 2004). DeCoster (1998) noted that if this trend continues, nearly 95% of the nation's private forestlands will be owned by individuals with less than 40 ha by 2010. It is widely believed that the average size of family forest holdings in the USA is shrinking through a process called parcelization. However, most of the evidence has been anecdotal, rather than from empirical research.

Forest parcelization is the process of taking a contiguous parcel of land owned by a single owner and dividing it among two or more owners. This process should not be confused with forest fragmentation, which is the process of division of the *physical* forest resource into smaller parcels (rather than the ownership of the forest). To assess and analyze parcelization, previous research (e.g. Mehmood and Zhang 2001) has examined mean landholding size. If the structure of the landholdings has a statistically normal distribution and the shape of the distribution does not change, the mean is a useful indicator; otherwise, the mean can be misleading. For example, it is possible for parcelization and consolidation to co-exist without change in the mean (Ripatti 1996, Zhang et al. 2005).

The study reported here has similarities with that of Mehmood and Zhang (2001). However, the 1978 and 1994 data used by Mehmood and Zhang are not fully comparable because the 1978 data included forest industry land and the 1993 and 2003 data are limited to family forest owners. It is therefore argued that the data used here are more appropriate for analyzing parcelization. Although the analysis may provide some insights about change across time, as Mehmood and Zhang did, the primary focus is on variation across states. The main contribution of this study is the investigation of changes in the structure of landholding sizes (i.e. the share of family owners by size of forest landholdings), rather than only average landholding sizes.

Analyzing parcelization for family forest owners in the USA is highly challenging because of the lack of transition probability matrices of transfers from and to other ownership types (e.g. forest industry and government agencies) and gains and losses of forest land (e.g. from agriculture and to development). As an alternative, this study examines variation in the structure of family forest holdings among states. Even though spatial variation could differ greatly from time trends, the findings do explain variations between states and shed light on causal, or at least correlated, factors. If states with higher population densities and higher incomes have smaller holding sizes, it can be surmised that these factors are correlated with parcelization, and other states will likely face similar trends if populations grow and incomes increase in the future.

The paper first reviews the existing literature on forest parcelization and closely related topics. Drawing on this information, an economic rationale for holding size is presented, followed by the specification of a landholding size econometric regression model and data sources used to test the model. Empirical results are then reported. Finally, the results of the analysis and their implications for family forest owners in the USA and other countries are presented.

Literature Review

Previous studies relating to the size of landholdings have often centred on community well-being (e.g. Gilles and Dalecki 1988; Swanson 1988; Labao and Michael 1991). Most studies conclude that the persistence of small-scale farms is positively related to social well-being (e.g. Goldschmidt 1978). Only a handful of studies have explicitly examined the detrimental aspects of declining farm size. Schmitt (1991) and Allen and Lueck (1998) used transaction cost theory to explain the proliferation of family farms and the resistance to large-scale farms in Europe and North America. Allen and Lueck (1998) showed that seasonality and random shocks are the main features that distinguish family farms from 'industrial' forms of landownership. When farms are successful in mitigating the effects of seasonality and random shocks to output, farm organization gravitates towards factory-type processes and large-scale farms.

In the case of forestry, there have been a number studies of relationships between strength of local forest industry and community well-being. These studies have found that concentration of forestland ownership is negatively related to community well-being (Fortmann et al. 1991; Sisock 1998; Bliss et al. 1998). A key difference, however, is that, unlike farm owners, forestland owners are increasing in number. Thus research on forest land ownership change is critical. Research in Finland by Ripatti (1996) was the first study, and is perhaps still the most comprehensive study, of the causes of forest parcelization. The study by Mehmood and Zhang (2001) was one of the first empirical examinations of the causes of forest parcelization in the USA. These authors found that death rate, urbanization, income, regulatory uncertainty and financial assistance for landowners all have significant impacts on the change in average holding size in the USA. But this study only examined change in mean landholding size and did not examine change in the overall structure of forest landholdings.

Gobster and Rickenbach (2003) suggested that economics, demographics, values and motivations, globalization and new technology, natural capital and forest policies are the primary drivers of forestland parcelization. DeCoster (2000) suggested that parcelization is driven by social, political and economic forces that consistently under-tax and over-serve developed areas, while over-taxing and under-serving rural land owners, including family forest owners.

Using transaction cost theory, Zhang et al. (2005) proposed an explanation for the increasing number of small non-industrial private forest ownerships in the USA. The major argument was that the higher transaction costs of non-timber amenities from forests, along with increasing demand for these services, increases the number of people who own smaller forest holdings.[1] As non-timber values increase, forestland is more likely to be owned by individuals to provide for their personal consumption of non-market amenity goods and services. This argument was supported with some historical evidence. The current paper approaches this question from a different perspective, using cross-regional evidence and statistical analysis to demonstrate the increasing importance of small-scale forestry and suggest some factors that might be behind changes in landholding size.

Theoretical Framework

Small-scale forestry is affected by substantial transaction costs and poorly developed markets for commodities and services. In developed countries, especially post-industrial countries, there is an increasing demand for consumption of non-timber goods and services from forests (amenity, recreation and wildlife) by growing urban populations, as opposed to the production value of forests for timber. Mather (2001) reviewed how forestry practices and policies in Europe and North America have changed as the importance of forest amenities has increased relative to timber production.

Forestland tenure and holding size change largely in response to changing transaction costs (Zhang 2001; Zhang et al 2005). For example, from the 1950s to the 1980s the forest industry purchased large areas of timberland, but the industry began to sell timberland in the 1990s in part because of a change in transaction costs (especially the reduction of transaction costs of wood markets) along with disadvantageous taxation and capital costs. Consequently, the wood processing industry is changing from in-house supplies of wood from industry-owned timberland to acquisitions from other timber owners through markets. In a similar manner, in cases of forest industry-owned timberland, silviculture can be either conducted in-house or through outside contractors (Wang and Van Kooten 2000). Using in-house silviculture or harvesting saves the transaction costs of hiring outside contractors but adds to internal administrative costs, while contacting-out the activities saves the administrative costs but increases market transaction costs.

[1] The logic of this argument is that people who use timberlands frequently (e.g. as hunting lease, bird watching, or simply enjoying the peace and or amenities) would be better off (in terms of saving transaction costs) by owning the timberland than purchasing the services owned by someone else.

Economic analysis finds that optimal holding size occurs when net marginal utility is equal to marginal cost (the market price of forestland plus holding costs, including taxes, management costs and risk). Over time, owners will adjust their holding sizes in response to changes in input and output prices (Zhang et al 2005).

To further explain, Fig. 1 represents the behavior of a family forest owner whose primary objectives are not related to timber production. In Fig. 1, marginal cost refers to forestland price and holding costs. The forestland price is fundamentally the present value of all future value generated from timber production and non-timber products and services. Forestland price is determined by joint market forces. Buyers are price takers, or must make their decision based on the price offered to them. An increase in price, for example from P_0 to P_1, will decrease the average holding size and increase the number of owners.

The marginal value of timberland is the utility or benefits owners receive. The utility curve shifts according to owners' preferences. The two utility curves represent either one owner's preferences at two different times or two owners' preferences at the same time. Assuming U_0 and U_1 represent current and future utility respectively, the different shapes imply that the family forest owner represented by U_1 place greater weight on non-timber values than the owner represented by U_0. A shift from U_0 to U_1 can be caused by changes in owners' incomes or related changes in preferences (for example, changing public awareness and increases in perceived value of forested environments). The utility curves are not parallel because marginal non-timber values may increase relatively faster than timber values as income increases. Intuitively, the land value for timber production is not subject to the owner's income but rather is largely due to management skill and scale. But amenity values are dependent on the owner's income since significant costs prevent the emergence of the market. When income increases, the marginal value curve of timberland shifts up. Therefore, the shape of the weighted total marginal value curve

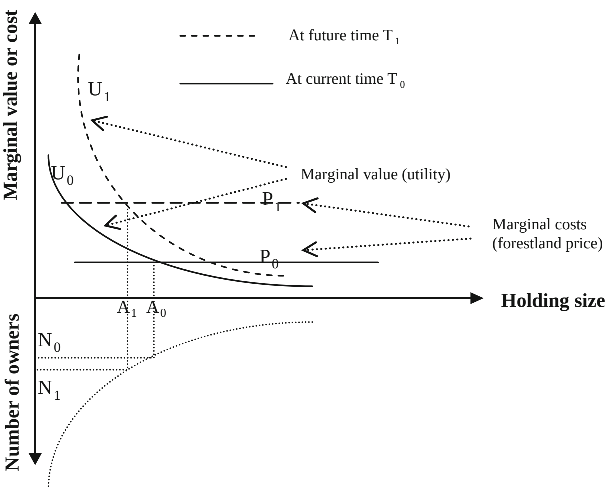

Fig. 1 Shrinking holding size and increasing number of small family owners

varies. The concave shape of the curve is consistent with the findings of other research (e.g. Butler and Leatherberry 2004).

The optimal landholding size for a family forest owner is the holding size for which marginal value is equal to marginal timberland price. An increase in the number of people with small holdings occurs when land becomes more costly, or in other words, when marginal timberland cost rises more sharply and holding larger tracts of land becomes less affordable. Under these circumstances (increasing number of wealthy people creating a demand for the non-wood value of forests and increasing costs), as Fig. 1 indicates, the landholding size will become smaller. Although larger numbers of people with more wealth are owning forestland, a substantial rise in forestland values in the past decades means that they can only afford smaller amount of land. As a consequence, the total number of small family forest owners increase from N_0 to N_1.

When the primary ownership objective is timber production, the optimal holding size is likely based on the efficiency of timber production (Fig. 2). Holding sizes tend to be larger because of technological advances that favour larger scale of operations for forest management. Of course, the ultimate choice of size of forest holdings will be mitigated by capital and land availability.

Socio-economic and biophysical conditions determine possible management objectives as well as timber and non-timber values. Therefore, there should be observable relationships between the distribution of forest land holding sizes and the biophysical characteristics of the forest land and the socio-economic characteristics of the forest landowners. Following Mehmood and Zhang (2001) and Pan et al. (2007), an empirical analysis has been conducted of these factors. For this analysis, it is hypothesized that holding size is a function of a group of variables representing the factors that ultimately determine the holding size.

It is hypothesized that, as population increases, more forest and agricultural land will be converted to residential and commercial uses (Nagubadi and Zhang 2005). Therefore population density influences demand and price for forest land. Changes in the spatial distribution of the population, such as urbanization, could also be expected to affect the structure of forest holding sizes. People living in cities, suburbs or urban-rural interfaces have different goals for their land than rural

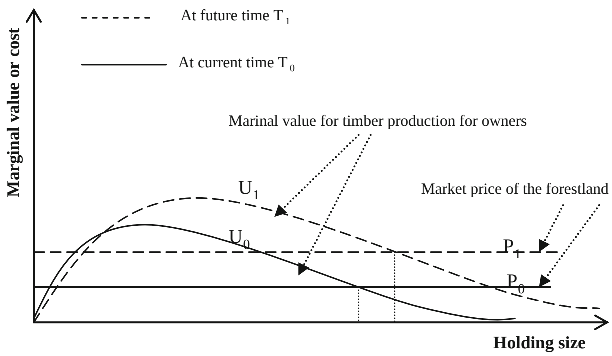

Fig. 2 Holding size versus cost of timberland for timber production

people. They are more likely to own land as part of their house site or for recreation purposes, and less likely to have timber production as a major objective.

Demographics and economic factors may also be associated with changes in holding size (Gobster and Rickenbach 2003). For example, an aging population might result in more land transfers, subsequent parcelization, and hence an increase in the number of smaller holdings. Income levels and number of retirees may affect the utility function and owners' demands for various mixes of products and services from their forestland, and thereby influence the distribution of forest landholding size. As income increases, living in or around the forest has become a growing lifestyle choice (DeCoster 1998). Distribution of income may also be an important determinant of land property size. Several researchers (e.g. Sisock 1998; Pan et al. 2007) have found the Gini index, which quantifies income disparity, to be a significant predictor of parcelization and consolidation. Private forestland availability may also affect average holding size and holding size structure.

To put all these variables together, models have been hypothesized of the form:

$$Y_m = \alpha + \beta_1 POPD + \beta_2 OLDP + \beta_3 URBAN + \beta_4 INCP + \beta_5 GINI + \beta_6 PFP + \varepsilon \tag{1}$$

$$Y_i = \alpha + \beta_{i1} POPD + \beta_{i2} OLDP + \beta_{i3} URBAN + \beta_{i4} INCP + \beta_{i5} GINI + \beta_{i6} PFP + \varepsilon_i \tag{2}$$

where Y_m is the mean holding size in a state (ha), and i represents the category of holding size (small, medium and large). Equation 2 has three sub-equations: Y_i is the percentage of family forestland in holdings between 1 and 19 ha (i = small), the percent of forestland in holdings between 20 and 199 ha (i = medium), and the percentage of forestland in holdings 200 ha or larger (i = large); POPD is population density (number of persons per square mile); OLDP is the percentage of the population who are at least 65 years of age; URBAN is the percent of the population living in urban areas; INCP is per capita income ($US 1000); GINI is the Gini index of income disparity; and PFP is the average holding size (ha/owner). The data sources for these variables are listed in Table 1.

Research Method and Data

Ordinary least square (OLS) has been used to conduct the regression for Eq. 1, which has average holding size as the dependent variable for the panel data (two periods for all states). Seemingly unrelated regression (SUR) has been used to jointly estimate the equations represented by Eq. 2. SUR is used because the explanatory variables that affect the share of forestland are the same for the three models (small, medium, and large). This method allows individual shares of forestland and residual variances to differ across the models. An advantage is that heteroscedasticity across equations is explicitly incorporated, thus strengthening the testing of joint hypotheses (Binder 1985). Varying levels and log transformations are explored for these equations.

Table 1 Description of variables and data sources

Variable	Description	Data sources
MEAN	Average holding size	Birch (1996), Butler et al. (2005)
SMALL	Percent of forestland in holding size less than 20 ha (%)	Birch (1996), Butler et al. (2005)
MEDIUM	Percent of forestland in holding size between 20 and 200 ha (%)	Birch (1996), Butler et al. (2005)
LARGE	Percent of forestland in holding size larger than 200 ha (%)	Birch (1996), Butler et al. (2005)
POPD	Persons per square mile	U.S. Census Bureau (2000, 1990)
OLDP	Persons 65 years old and over	U.S. Census Bureau (2000, 1990)
URBAN	Percent of urban population	U.S. Census Bureau (2000, 1990)
INCP	Per capita income ($1,000)	U.S. Census Bureau (2000, 1990)
GINI	Gini index of family income	Volscho (2004)
PFP	Per capita private forestland (ha)	Smith et al. (2004)

To conduct the regressions of Eqs. 1 and 2, the data were collected in 1993 (for more information, see Birch 1996) and 2002–2004 by the USDA Forest Service (for more information, see Butler et al. 2005). The data from 2002–04 are simply interpreted as year 2003. Data from the 1978 national study of private forest owners as described in Birch et al. (1982) could not be used because of figures were not reported for size of holding for family forest owners.

The USDA Forest Service Forest Inventory and Analysis program conducts the National Woodland Owner Survey (NWOS), which is the nation's survey of forest owners. On a recurring basis (previously conducted every five years, but now annually), the survey collects data from a random sample of forest owners across the United States to obtain information about their forestland, ownership objectives, forest use, forest management practices, sources of information, concerns and issues, and demographics. The NWOS uses remotely sensed imagery to determine whether each of a random set of sample points across the United States is forested. For the forested points, ownership information is collected from property tax offices and other public sources. These forest owners are sent a postal questionnaire as the primary data collection instrument, and telephone interviews are used to increase response rates. More detailed information on the data collection and processing procedures are described in Birch (1996) and Butler et al. (2005).

The data set used in this study has 92 observations for 46 states and two points in time (1993 and 2003). Four states—Hawaii, Nevada, Alaska, and Idaho—are excluded from the analysis due to either missing data or too few observations. Table 1 describes the dependent and independent variables and data sources. For each state, landowners are placed into six size classes: less than 4, 4–19, 20–39, 40–199, 200–399, and more than 400 ha. Means have been calculated as the weighted average size by states.

Forest holdings are further collapsed into three groups based on previous research, data availability, and the objective of an approximately uniform distribution of the sample among the groups. Accordingly, the percent of forestland in holdings less than 20 ha was used to indicate owners with smaller holdings and, presumably, non-timber ownership objectives. An increase in the percentage of forestland in this group is considered an indicator of forest parcelization. The group of owners with holdings between 20 and 199 ha was labeled medium, and the group with owners of holdings of 200 ha or more was labeled large. The specific break points are arbitrary, but are judged to be appropriate for measuring the structure of forestland holdings.

Socio-economic variables including POPD, OLDP, URBAN, and INCP were obtained from the US Census Bureau for 1990 and 2000 (US Census Bureau 1990, 2000). Data for the Gini index on income disparity was drawn from Volscho (2004). Per capita private forestland area is used as a proxy for private forestland availability and was obtained from Smith et al. (2004).

Population, Social Welfare, Urbanization and Family Forestland Holding Size

As indicated in Table 2, the mean holding size is largest in the South (21 ha), followed by the West (14 ha) and the North (11 ha). About 90% of the family forest owners in the United States own less than 20 ha, for a total amount of one-third of family forestland.

From 1993 to 2003, the average size of family forest holdings decreased marginally (by 1%), but the share of small and large holdings increased by 4% and 13% respectively and the share of medium sized holdings decreased by 8%. This is consistent with the findings of Ripatti (1996) and the argument made by Zhang et al. (2005) about average holding size change. It highlights the importance of examining the structure of forest land ownership, because this change would not have been evident through an analysis of average holding sizes only.

Table 3 presents the estimated OLS (for the mean) and SUR (for structure) models. The impacts of individual variables can be compared directly because the coefficients have an interpretation as the elasticity of a log-form model. Overall, the independent variables explain the four dependent variables measuring forestland holding structure quite well, with R^2 values between 0.40 and 0.61. All of the independent variables have showed the expected sign of relationship with the dependent variables.

As expected, the significance of the coefficient for the population density variable is consistent with the literature in that, as it increases, the mean size and share of large holdings decreases and the share of small holdings increases. It is likely that population density is a determinant of the holding of small parcels. As population density increases and area of forestland remains fixed, the demand for forestland increases and drives the conversion from larger land owners who are more interested in timber production to small owners who are more interested in non-timber activities, such as aesthetics and privacy (often associated with a home site) and recreational opportunities like hunting.

Our findings show that the percentage of the population older than 65 years has a positive effect on the share of medium and small holdings, but a negative effect on the share of large holdings. It is likely that advancing age portends an increase in the

Table 2 Mean holding size and structure of family forest holdings by state, 2003

Region, state	Mean (ha)	Small (%)	Medium (%)	Large (%)
North				
Connecticut	5.72	55	43	2
Delaware	4.48	80	10	10
Illinois	10.39	46	47	6
Indiana	8.34	51	45	4
Iowa	9.02	46	51	3
Maine	15.12	29	53	18
Maryland	5.12	51	40	9
Massachusetts	3.83	56	40	4
Michigan	11.25	48	45	7
Minnesota	18.53	33	62	5
Missouri	19.48	29	59	13
New Hampshire	11.41	36	49	15
New Jersey	5.34	77	19	4
New York	11.61	43	52	5
Ohio	8.83	60	35	5
Pennsylvania	11.92	45	46	9
Rhode Island	4.59	65	35	0
Vermont	30.40	23	66	10
West Virginia	17.64	27	62	11
Wisconsin	16.13	31	63	6
North average	11.46	47	46	7
South				
Arkansas	14.51	23	58	19
Alabama	19.64	22	40	38
Florida	7.74	38	41	21
Georgia	15.20	24	44	32
Kentucky	13.33	32	57	10
Louisiana	32.05	23	41	36
Mississippi	40.23	14	48	38
North Carolina	14.70	38	46	15
Oklahoma	49.53	14	63	24
South Carolina	16.58	25	51	24
Tennessee	13.47	35	46	18
Texas	18.83	30	49	21
Virginia	16.07	33	51	16
South average	20.91	27	49	24
Rocky Mountain				
Arizona	12.92	33	33	33
Colorado	12.58	26	33	41
Kansas	10.00	45	50	5

Table 2 continued

Region, state	Mean (ha)	Small (%)	Medium (%)	Large (%)
Montana	109.96	6	44	50
Nebraska	11.02	34	36	30
New Mexico	29.77	11	11	79
North Dakota	10.84	39	46	14
South Dakota	14.36	35	42	23
Utah	17.36	15	33	51
Wyoming	58.03	6	36	58
Rocky mountain average	28.68	25	37	38
Pacific Coast				
California	20.74	21	37	42
Oregon	14.17	38	34	28
Washington	8.24	51	33	16
Pacific coast average	14.38	36	35	29
National average	18.06	36	44	20

Source: USDA Forest Service (Birch 1996, Butler et al. 2005)

Table 3 Regression results on factors influencing forest landholding size and distribution

Variable	Mean coeff. (S.E.)	Small coeff. (S.E.)	Medium coeff. (S.E.)	Large coeff. (S.E.)
Constant	6.752^{***} (2.277)	-4.943^{***} (2.224)	-5.716^{***} (1.642)	13.510^{***} (3.555)
POPD	-0.271^{***} (0.040)	0.193^{***} (0.039)	0.032 (0.028)	-0.398^{***} (0.062)
OLDP	0.045 (0.059)	0.100^{*} (0.057)	0.177^{***} (0.042)	-0.229^{**} (0.094)
URBAN	0.678^{**} (0.301)	-0.800^{***} (0.295)	-0.796^{***} (0.219)	1.903^{***} (0.463)
INCP	−0.196 (0.162)	0.030 (0.159)	0.066 (0.117)	-0.467^{*} (0.250)
GINI	0.425 (0.858)	−1.220 (0.839)	-1.677^{***} (0.621)	6.223^{***} (1.326)
PFP	0.306^{***} (0.059)	-0.279^{***} (0.058)	0.061 (0.043)	0.352^{***} (0.090)
R^2	0.61	0.53	0.40	0.60
N	92	92	92	90

Note: *, ** and *** denote significance at the 10%, 5%, and 1% levels

transfer of larger holdings through inheritance, and parcelization is associated land going to multiple heirs or being subdivided for development. For obvious reasons, the percentage of population older than 65 years has a strong correlation with increased death rates and previous studies have shown that death rate is correlated with smaller holdings (DeCoster 1998; Mehmood and Zhang 2001).

Urban population versus rural population refers to the share of urban and rural residents. The percentage of a state's population that lives in an urban area, an appropriate identifier of urban versus rural states, has a significantly positive relationship with the mean size and share of large holdings, but is negatively related to the shares of medium and small holdings. This finding indicates that, other things being equal, population concentration in cities is positively correlated with large forest land holdings. This contradicts findings from pervious studies (Befort et al 1988; Mehmood and Zhang 2001). The results indicate that, for states with higher percentages of urban population, overall mean holding size is larger.

Income per capita has a significant negative relationship with the share of larger holdings, which is in agreement with the literature (e.g. Goldschmidt 1978; Mehmood and Zhang 2001). The estimate for the income variable indicates that, as income increases, people devote more money to non-timber activities. However, this result should be considered preliminary; the shares of medium-sized and small holdings show the expected signs, but neither of the coefficients is statistically significant.

It is interesting to note that income inequality, which is measured by the Gini Index, has a significantly positive impact on the share of large holdings, but a significantly negative impact on the share of medium-sized holdings. This implies that income inequality is a driving force for large landholdings. A plausible interpretation is that states where income inequality is greatest have smaller shares of small and medium holdings and a greater proportion of larger holdings, a reflection of rurality. These results should be considered with caution because the negative impact of small holding sizes is not significant.

Not surprisingly, per capita private forestland area had significant positive impact on mean family forestland holding size and share of large holdings, but a negative impact on the share of small holdings; it also has a positive, but statistically non-significant, impact on the share of medium-sized holdings. This finding suggests that per capita forestland is a driving force behind large landholdings, which are more likely when forestland is abundant and in less populated regions. A possible explanation is that, with increasing availability of private forestland, the possibility of owning larger parcels increases.

Conclusion and Discussion

The results of the statistical analysis indicate that population density, percentage of older people, percentage of urban population, per capita income, income variation, and per capita private forestland correlate with structural differences in the sizes of family forest holdings. These results strongly support the hypothesized link between the variables and the structure of forestland, and help explain why some states have relatively higher numbers of smaller family forests. For example, higher population density, aging population and per capita income are associated with more small family forest owners (i.e., more owners with smaller parcels), whereas percentage of urban population, income variation and per capita private forestland are positively associated with larger holdings.

To understand the impact of percentage of urban population on overall mean holding size, suppose two states have the same population density, one being highly urbanized and another highly rural. The average holding size in an urbanized state is likely larger than in a rural state where the population is more evenly distributed across the state. It is likely that more people own land in the rural state while in the urbanized state a smaller number of people living in rural areas own larger parcels. This is counter to conventional thinking – most people think that urbanization will increase parcelization. But in fact, urbanization is not necessary population growth but more about spatial changes in population.

Due to data limitations, it has not been possible to address directly the process of parcelization. But the statistical results reveal some general trends associated with family forestland holdings. Family forestland under current circumstances is tending to shift from medium-sized holdings to smaller parcels that are primarily used for non-timber purposes. The results suggest that growth in population causes parcelization when measured either by the average holding size or as share of small holdings, but urbanization measured by the share of population which lives in cities does not. These results indicate that states with a higher share of urban population, all else equal, are more likely to have larger average holding sizes and larger proportions of forestland in large holdings.

Parcelization, or an increasing number of small owners with smaller parcels, is often presumed to be related to forest fragmentation, but this may not always be the case. Examining the structure of forest holding size instead of the mean has proved a useful step towards understanding the drivers of parcelization. A further research step would be to develop transition matrices that include transitions between sizes of family forest holdings along with gains and losses to and from other types of land uses.

The USA is not unique in being subject to forestland parcelization. As countries in Asia become wealthier, similar changes can be expected. Harrison et al. (2002) observed, 'throughout the world, there appears a trend to move from industrial forestry towards landholder-based forest management and community forestry and small-scale (often referred to as 'smallholder') forestry is of growing importance.' There are important policy implications of this change; hence it is an important research topic.

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References

Allen DW, Lueck D (1998) The nature of the farm. J Law Econ 41(2):343–386

Befort WA, Luloff AE, Morrone M (1988) Rural land use and demographic change in a rapidly urbanizing environment. Landsc Urban Plan 16(4):345–356

Binder JJ (1985) Measuring the effects of regulation with stock price data. Rand J Econ 16(2):167–183

Birch TW (1996) Private forestland owners of the United States, 1994. USDA For Serv Northeast For Exp Stat Resour Bull NE-138, Delaware, OH

Birch TW, Lewis DG, Kaiser HF (1982) The private forest-land owners of the united states. U.S. Department of Agriculture, Forest Service. Resour Bull WO-1. Washington DC

Bliss JC, Sisock ML, Birch TW (1998) Ownership matters: forestland concentration in rural Alabama. Soc Nat Resour 11(4):401–410

Butler BJ, Leatherberry EC (2004) America's family forest owners. J Forestry 102(7):4–14

Butler BJ, Leatherberry EC, Williams MS (2005) Design, implementation, and analysis methods for the National Woodland Owner Survey. U.S. Department of Agriculture, Forest Service, Northeastern Research Station, Newtown Square, PA. Gen Tech Rep NE-GTR–336, p 43

Decoster LA (1998) The boom in forest owners—a bust for forestry? J Forestry 96(5):25–28
Gilles JL, Dalecki M (1988) Rural well-being and agricultural change in two farming regions. Rural Sociol 53(1):40–55
Gobster PH, Rickenbach MG (2003) Private forestland parcelization and development in Wisconsin's Northwoods: perceptions of resource-oriented stakeholders. Landsc Urban Plan 69(2/3):165–182
Goldschmidt W (1978) As you sow: three studies in the social consequences of Agribusiness. Montclair, NJ, Allenhead, Osmun
Harrison S, Herbohn J, Niskanen A (2002) Non-industrial, smallholders, small-scale and family forestry: what's in a name? Small-scale Forest Economics. Manage Policy 1(1):1–11
Fortmann L, Kusel J, Kawamura Y, Olson M, Danks C (1991) The effects of forest control and use on county well-being. In: Jonathan K, Louise F (eds) Well-being in forest-dependent communities, vol 1. Berkeley, California: Department of Forestry and Resource Management, University of California, Berkeley, pp 49–67
Labao LM, Michael DS (1991) Farming patterns, rural restructuring, and poverty: a comparative regional analysis. Rural sociol 56(4):565–602
Mather AS (2001) Forests of consumption: postproductivism, postmaterialism, and the postindustrial forest. Environ Plann C Gov Policy 19(2):249–268
Mehmood SR, Zhang D (2001) Forest Parcelization in the United States. J Forestry 99(4):30–34
Nagubadi RV, Zhang D (2005) Determinants of timberland use by ownership and forest type in Alabama and Georgia. J Agric Appl Econ 37(1):173–186
Pan Y, Zhang Y, Butler BJ (2007) Trends among family forest owners in Alabama, 1994–2004. Southern J Appl Forestry 31(3):117–123
Ripatti P (1996) Factors affecting partitioning of private forest holdings in finland: a logit analysis. Acta Forest Fenn 252 (monograph)
Sisock ML (1998) Unequal shares: forest land concentration and well-being in the rural Alabama. Master Thesis, Auburn University. Auburn
Smith WB, Miles PD, Vissage JS et al (2004) Forest resources of the United States, 2002. US Department of Agriculture, Forest Service, North Central Research Station, St. Paul, MN. Gen Tech Rep NC-241
Swanson LE (1988) Agriculture and community change in the U.S. Boulder. Westview Press, CO
US Census Bureau (1990) Census 1990 data for the United States http://factfinder.census.gov/servlet. Viewed 1 Aug 2006
US Census Bureau (2000) Census 2000 data for the United States http://factfinder.census.gov/servlet. Viewed 1 Aug 2006
Volscho TW (2004) Gini Index of Family Income by U.S. County, 2000. University of Connecticut, Dept of Sociology: http://vm.uconn.edu/~twv00001/counties.htm. Viewed 15 July 2006
Wang S, van Kooten GC (2000) Forestry and new institutional economics: an application of contract theory to forest silvicultural investment. Ashgate, Aldershort
Zhang Y (2001) Economics of transaction costs saving forestry. Ecol Econ 36(2):197–204
Zhang Y, Zhang D, Schelhas J (2005) Small-scale non-industrial private forest ownership in the United States: Rational and Implications for forest management. Silva Fenn 39(3):443–454