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State-Level Forestry Cost-Share Programs and Economic Impact of Increased Timber Outputs: A South Carolina Case Study

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Abstract: Management of family forests in the United States has been long-influenced by public policies and programs that encourage active management on these private lands, especially afforestation of idle lands and reforestation of cut-over lands. Financial incentive programs to encourage family forest reforestation date back to the 1940s, and in the beginning were funded by the federal government. Beginning in the early 1970s, state governments, especially those with strong forestry-based economies, saw a need to offer their own incentives, primarily cost-share programs to increase forest productivity. These programs are considered to be successful, but little research addresses the value and increased timber supply that result from the state investment. Here, we use historical data from the South Carolina Forest Renewal Program (FRP), one of the oldest and well-established state forestry cost-share programs, to determine the incremental timber outputs generated. Marginal analysis was used to produce financial comparison between regeneration options that include cost-share and those that do not. Annual funding for the FRP is currently $1,000,000 and in the long-run five dollars of economic impact is created for each dollar invested, and over a half million tons of additional wood is added to the annual timber supply.

Keywords: forestry incentive programs; state forestry cost-share programs; family forest owners; nonindustrial private forest; reforestation; South Carolina

1. Introduction

Management of family forests in the United States has been long-influenced by public policies and programs that encourage active management on these private lands, especially afforestation of idle lands and reforestation of cut-over lands [1]. There are about 310 million ha of forestland in the United States and roughly 35% of that is owned by individuals and families, or family forest owners (FFOs) [2]. FFOs are crucial to maintaining sustainability of the nation's forests and for their contribution to timber supply [3]. Family forests are subject to forest parcelization (a temporal process where large tracts tend to become smaller as owners die and estates are broken up). Smaller-sized holdings will lead to reduced economic viability and less active forest management on many of these ownerships [4]. Financial incentive programs to encourage better management on family forests date back to the 1940s and were mainly motivated over concerns of "poor" forest management on many family forests, a strong focus on sustained-yield forestry as a management tool, and increased timber supply from better-managed family forests [5,6].

Many states offer a variety of forestry incentives that vary from direct cost-share, property tax assessment adjustments, tax credits, and tax deductions. In the past, the emphasis was on encouraging

reforestation, but the focus now is broader towards increased forest sustainability [7]. Beginning in the early 1970s state governments realized the importance of reforestation to their economies and considered federal incentive programs to be insufficient to the need, resulting in state-level cost-sharing for reforestation and other practices. Most of these programs are administered by the state's forestry commission or agency, require a forest management plan, and have very specifically defined approved forestry practices (with reforestation almost always included) [8]. Cost-sharing rates are most commonly around 50%, but can be as high as 90% [9]. While increased forest productivity is usually the focus of these programs, forest sustainability issues that consider more than timber have become increasingly important, and the issues that tend to be stressed are retention of forest and agricultural land uses, protection of riparian areas and wetlands, wildlife habitat, and water quality [9].

The notion was to increase forest productivity on the state's forests by making investment in reforestation more financially attractive. Cost-sharing reduces the high front-end costs involved in reforestation and also increases the forest owner's rate of return [9]. Severance taxes are commonly used to fund the programs, often supplemented by state appropriations. Forest industry is generally supportive of the programs, even with the severance tax [10]. Since state funding is involved, and that follows the ebb and flow of state economies, the number of state cost-share programs does ebb and flow also. States with strong forest-based economies tend to have long term, stable programs [11]. One comprehensive study identified 19 state-level forestry cost-share programs, concentrated in the southern pine belt and Midwest [9]. These programs are now well-established and continue to make significant contributions to state timber supplies.

State-level forestry cost share programs, such as all publicly-supported financial incentive programs, have generated interest on the "rate of return" produced by improved forest management and increased reforestation [12–16]. South Carolina has a long-established state funded cost-share forestry incentive program that provides an excellent opportunity to evaluate the financial effectiveness of this forest policy tool [9]. We report on an analysis of that program and the contribution it makes to the state's economy. Our approach centers on estimating incremental timber supply produced by the cost-share program and extending that to expected increases in contribution to the state's economy.

2. Literature on Forest Cost-Share Programs

2.1. History and Research on State Cost-Share Programs

State forestry incentive programs emphasizing cost-share have been widely supported over time in most southern states that have established them, especially in those states with economies that depend on timber [17]. Over the last 75 years these programs have developed as a crucial tool to encourage reforestation and active forest management. Early forestry research established that, short of forest regulation of private forest lands, forestry incentives would be needed to ensure the financial returns necessary to convince FFO's to take the "risk" of planting trees [5,18–20]. Numerous research studies have shown the importance of forestry incentive programs to maintaining forest productivity on family forest lands and ensuring an adequate timber supply to support the state's forest industry [11–24].

Not all agree that cost-sharing makes good social sense and the literature covers both sides of the arguments for and against forestry incentives. Those that support it argue that long-term timber supply will be positively impacted, resulting in cheaper forest products and a stronger economy [22,25]. Beyond timber, the incentives should also have positive impacts on wildlife habitat, water quality, recreation, and aesthetics [3]. The two most common arguments against cost-sharing for reforestation is that some forest owners may delay forest regeneration when funding is not available and that some reforestation supported by cost-sharing would have been accomplished without the incentive [26–34]. While the social benefits of forestry incentives can be argued, they have been shown to be effective in their primary goal of increasing forest productivity and research supports positive benefit/cost ratios for the programs [35]. However, variables influencing investment behavior by FFOs

(such as personal income, interest rates, stumpage price expectations, and substitution of public for private capital) make it difficult to project timber outputs expected from forestry cost-share funding [36].

An econometric study of FFOs addressed their reforestation behavior [28]. The forest owner's decision on whether or not to reforest was very sensitive to reforestation cost, and, thus, to net reforestation cost after cost-sharing assistance. Regardless of financial position, forest owners were responsive to net cost in the reforestation decision. For forest owners with below average incomes and asset positions, cost-sharing would be a means to overcome capital limitations; for forest owners with high levels of income it could be a way to make an investment in reforestation competitive with other investment opportunities. Some substitution of public capital for private capital could occur in the latter group, but the study found that much of the capital was additive. Thus, cost-sharing was found to be a strong inducement to reforest, even among forest owners with no capital constraints [28].

The cost-effectiveness of federal forestry incentive programs has been the focus of research [37–43]. Early conservation incentive programs were primarily concerned with soil and water conservation, so the federal Forestry Incentives Program (FIP) that began in the mid-1970s was the first real opportunity to evaluate a program totally focused on forestry. A series of analyses found FIP to be cost-effective in terms of financial return and increased forest productivity. Performance was measured in terms of rate of return and increased timber yields. Research in South Carolina found that market demands for timber (stumpage prices) impacted forest owner perception of cost-effectiveness, but by most measures the program could be considered to be very efficacious [39].

Federal forestry incentive programs were limited in the amount of financial assistance that could be provided to FFOs. State forest policy officials were aware of the effectiveness of these programs in accomplishing reforestation and increasing forest productivity (and timber supply) and state-level forestry cost-share programs were developed to supplement the incentives available to forest landowners. These programs tended to be structured similarly and common characteristics were: (1) a primary objective of increased timber supply, based on USDA Forest Service [44] projections of a timber shortfall somewhere in the future; (2) funding usually from a severance tax on harvested timber, with a portion of funding from general state appropriations; (3) strong forest industry support for the programs; (4) generally all FFOs are eligible in the state, with minimum and maximum forest area limitations; (5) a common cost-share percentage of 50%, with a top reimbursement rate of 90%; (6) usually forest management plans are required for cost-sharing; and (7) eligible forest practices centering on tree planting, site preparation, and timber stand improvement [8].

2.2. South Carolina's Forest Renewal Program

South Carolina established a state-level cost-sharing forestry incentive program, the Forest Renewal Program (FRP), in 1981 to complement federal forestry cost-share programs [16]. The program has proven to be a popular reforestation option for FFOs. Since the beginning of forestry cost-share programs in South Carolina, over one-fifth of planted pine trees in the state resulted from these federal and state programs. FRP is representative of state-level forest incentive programs and will be the foundation of the cost-effectiveness analysis presented later in this article. It is administered by the South Carolina Forestry Commission (SCFC) and is jointly funded by an assessment on forest industries producing primary timber products and state appropriations [40]. Funding is 80% from the tax on roundwood and 20% from state appropriations. From 1983 to 1996, funding was $500,000 annually and in 1997 funding increased to $1 million annually. Most of the funding is allocated to reforestation, including site preparation. Timber stand improvement is also funded on natural stands [45].

The stated goal of the program is "to encourage tree planting on private lands to help ensure adequate future timber supplies," and, besides increasing woodland productivity, to also provide for other benefits, such as "clean air, clean water, and wildlife habitat". The ultimate goal is to stimulate the state's economy [46]. In general, all FFOs in the state are eligible to participate (individuals, group

partnerships, associations, trusts, and corporations are eligible, as long as they are not a public entity or engaged in the manufacture of wood products).

Forest management practices eligible for cost-sharing are site preparation and tree planting on previously forested or agricultural lands and timber stand improvement of natural or artificially-regenerated forests. There are restrictions and limitations: (1) a forest management plan is required and the practices must be completed in accordance with that plan; (2) funding is limited to roughly 40 ha of forest area; (3) specific forestry practices must occur on at least 4 ha of contiguous forest area; (4) all work must be completed within 20 months of funding; and (5) the funded land must be maintained in a forest condition for at least 10 years or until commercial harvest, or the funding must be repaid. The required forest management plan can be prepared by any forester, but must be approved by an SCFC forester and South Carolina registered foresters may offer professional assistance in implementation of forest practices [46].

3. Methods: Incremental Yields and Returns

The South Carolina Forest Renewal Program (FRP) tree planting accomplishments represent the primary added-value that results from forest industry and state investment in reforestation. Those program accomplishments represent forest area that was reforested with genetically improved loblolly pine growing stock; in addition the planted area can be expected to receive active forest management prior to harvest. In comparison, if that reforestation had not occurred, natural regeneration of a pine stand was the likely scenario. The difference in reforestation method (natural versus planted with improved growing stock) is a key assumption of our analysis. Our literature review identified arguments that both supported and disputed this assumption; however, the literature clearly tended to strongly support our assumption. In addition, several studies specifically addressed this issue and concluded that FFOs' response to cost-share programs does follow the scenario of our assumption [47–50].

The difference between natural forest stands and planted ones is well-suited to incremental or marginal analysis. The benefit expected from this cost-share reforestation program is the incremental forest yield on that forest area, as compared to the forest yield that would have occurred without artificial reforestation. Incremental analysis is a business and financial decision-making tool used to compare relevant costs and revenues of one alternative to those of another alternative. Relevant costs are future costs that differ between alternatives; thus, those that are identical between alternatives are considered irrelevant and not included in the analysis. Opportunity costs (costs of foregone opportunity or spending the same money on something else) are relevant costs and sunk costs (costs that occurred in the past and are irrelevant today) are not [51]. In this incremental analysis the two alternatives were the forest yield resulting from the area reforested under the cost-sharing program and the forest yield that would have resulted under natural regeneration without funded reforestation [52].

Alternative forest yields were necessary for the two alternatives. Conventional growth and yield models were used to estimate the expected yields on average sites (a site index of approximately 20 m of height at base age 25 years) in the state [53]. The yields for the planted stands were generated using FASTLOB, a growth and yield model developed at Virginia Tech for thinned and fertilized loblolly pine plantations [54]. The yields for the natural stands were grown to age 25 in NATLOB, a growth and yield model developed at Virginia Tech for unthinned natural loblolly pine stands [55], and then passed to FASTLOB to be thinned and grown to harvest (as NATLOB does not include a thinning option). Tables 1 and 2 summarize the yields for planted and natural loblolly pine stands on average sites in South Carolina. Planted stands are based on 1344 trees per ha, the most commonly used spacing in South Carolina and the forest management regimes are typical for natural and planted loblolly pine stands in South Carolina. Best management practices in South Carolina allow for either natural or artificial reforestation [56]. Typical forest management regimes (thinning and harvesting ages) were used to generate Tables 1 and 2 based on SCFC forest management guidelines. Reforestation standards are defined by SCFC guidelines [57].

Table 1. Estimated timber yields for loblolly pine planation on average site in South Carolina.

Year	Practice	Timber Yield (Tons per ha)		
		Pulpwood	Chip-n-Saw	Sawtimber
15	First Thinning	94.6	6.7	0
20	Second Thinning	18.5	34.3	0
30	Final Harvest	11.1	12.1	244.1

Table 2. Estimated timber yields for naturally-regenerated loblolly pine on average site in South Carolina.

Year	Practice	Timber Yield (Tons per ha)		
		Pulpwood	Chip-n-Saw	Sawtimber
25	Thinning	94.6	0	0
35	Final Harvest	62.8	93.4	92.4

Data for this study were acquired from the FRP records of replanted area obtained from the SCFC for the time period 1983–2015 [58]. Using the yields and management regimes from Tables 1 and 2, timber production by product (pulpwood, chip-n-saw, and sawtimber) attributed to FRP reforestation was calculated by year. This resulted in timber production by year for FRP reforestation area under the pine plantation management regime and the natural regeneration management regime. Timber production by the natural regeneration regime was subtracted from that of the plantation regime, resulting in incremental timber production by year for the FRP forest area. Figure 1 shows the hectares planted beginning in 1983 and Figure 2 represents incremental timber production on FRP reforestation area by year. Figure 2 begins with 1998, the first year that timber harvest occurs on these plantations. These timber harvest volumes were then multiplied by the estimated south-wide average annual stumpage prices for 2015 [59]. For years after 2015, timber prices were assumed to remain constant. The resulting incremental timber revenue by year represented in Figure 2 is presented later in the Results section.

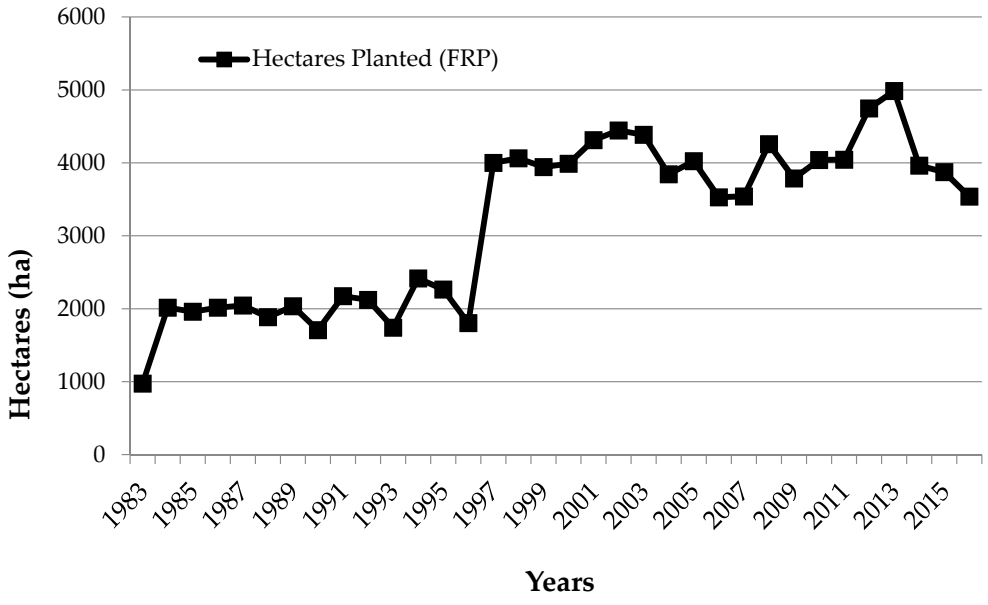

Figure 1. Total hectares planted per year in South Carolina using the Forest Renewal Program.

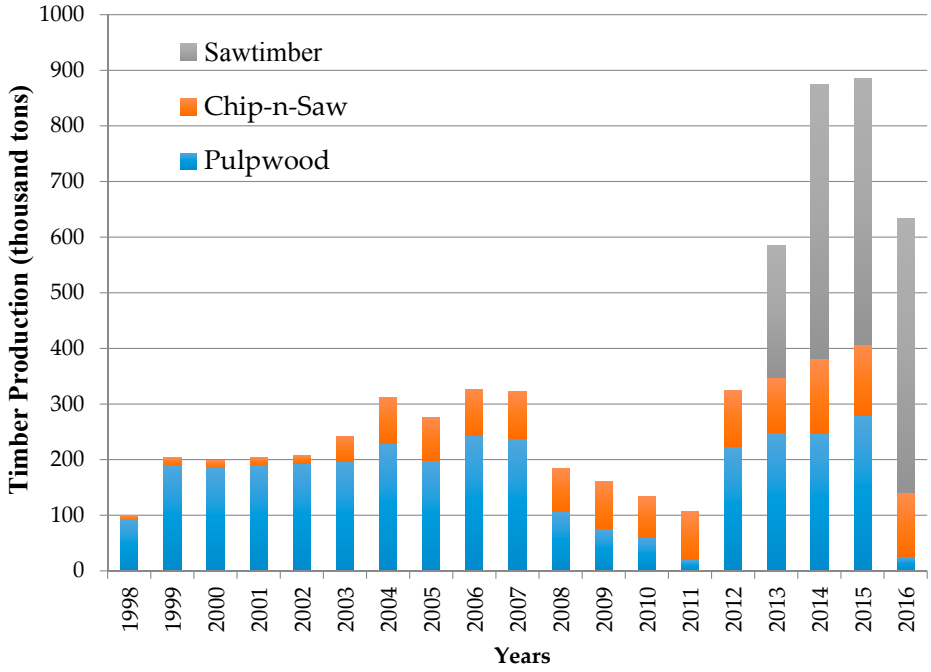

Figure 2. Total incremental production by timber product using the Forest Renewal Program.

The incremental investment in reforestation by forest industry and the FRP produces forest area with higher forest productivity (since both generally use genetically improved growing stock and active forest management). Each year additional loblolly pine plantations occupy forest area that would have been natural stands. This is equivalent to adding additional area to the state's timber production base, and thus the state's forest economy and this can be used to approximate economic impact to South Carolina's overall economy [60]. Recent economic impact studies produced state-level annual economic impact estimates for the entire forestry industrial sector: $18.6 billion of economic activity, resulting in 90,320 jobs, labor income of $4.1 billion, and a harvested timber crop worth $759 million [61,62]. These estimates are based on the IMPLAN input-output model, the research standard model for developing these types of estimates for each industry sector in the state [63,64]. The increased forest productivity can be used to estimate a simple expansion of the economy based on these established economic impacts [60,65].

FRP accomplishments were used to estimate incremental forest productivity across the state and to develop estimates of equivalent forest area created. These incremental equivalent hectares were then used to project incremental economic impact based on prorated expansion of the current economy. Incremental reforestation results in increased timber output that contributes to the state's total timber output [66]. These efforts eventually equate to more timber supply to support the state's forest industry. Economists call this a "shift in the supply curve to the right." At any market price, more timber will be supplied. What about timber demand? South Carolina's economy has expanded to an increasing timber supply and increased timber demand has resulted from an expanding forest industry base. This analysis includes a key assumption that primary wood-using mills will continue to accommodate expanding timber supply. This same approach was recently used to estimate the contribution of SCFC project foresters to South Carolina's economy [67] and is supported by recent timber demand analyses [68].

General relationships can be derived from the economic impacts established by the input-output model studies [69]. A key assumption is that the estimated incremental timber supply will result in proportionate increases to the state's forest economy. The delivered value of South Carolina's timber harvest was $759 million and this was from a timber output of 23,400,000 tons. Economic impact of

$795 would be generated per ton produced ($18.6 billion ÷ 23,400,000 tons). These ratio of $795/ton provide general indication of the impact resulting from additional timber output produced.

Gradational mean annual increment (average annual growth) for reforested area rather than naturally-regenerated area can easily be calculated from Tables 1 and 2 as 4.25 tons/ha/year [70]. This can be calculated by adding all of the tons/ha values for each wood product together in Table 1 and subtracting the values acquired from Table 2, using the same method. Thus, a basic assumption is that the forest area involved would grow crops of planted trees, rather than naturally-regenerated stands, and would, conservatively, produce an extra 4.25 tons per ha per year of pine timber yield. The increased timber volumes gradually occur as the new plantations mature and produce steady increased yields.

Timber supply is characterized by three temporal frameworks. Stock timber supply is essentially timber inventory at any point in time. Forestry decision makers have no time to respond to market changes. In the short-run, forest managers can make changes to silvicultural inputs (such as increased thinnings, fertilization, or chemical control of undesirable species). However, in the long-run, all inputs can be changed, including the land base devoted to forestry [71]. Incremental reforestation is a long-run timber supply response and the impacts will be felt through incremental yield increases [72].

4. Results

These incremental timber yields occur in the future as the plantations become merchantable. Yields start with the first thinnings after 15 years of reforestation cost-sharing and produce steady streams of wood at full impact after 30 years (Figure 2). Notice in Figure 1 that from 1983 to 1996 South Carolina allocated $500,000 to FRP and from 1997 to today the allocation has been $1,000,000. Figure 3 shows the total revenue by timber product generated by the FRP investment. To more fairly estimate the future impact of FRP the current funding level was projected into the future. Then, after 30 years the FRP would create the equivalent combined total forest area of 121,950 ha (4065 ha per year over 30 years). This forest area would produce an incremental 4.25 tons per ha per year, and the eventual steady incremental sustainable timber harvest would be 518,288 tons per year. That is, the pine plantations would have produced an additional 518,288 tons/year over the original natural forests. Dividing the sustainable timber harvest by the natural stand yields (518,288 tons/year ÷ 343.2 tons/ha/year) provides an estimate of the equivalent ha of forest productivity produced. The result of a 30-year timber rotation would be equivalent to an additional 1510 ha of timberland. South Carolina has 5.2 million ha of forest land [2]. That equates to a 0.0293 percent increase in productive timberland in the state (1,510 ha ÷ 5,200,000 ha).

Note that this percentage increase occurs gradually as the new plantations grow and mature. An increase in timber supply would not necessarily result in a corresponding increase in timber demand; those are two separate relationships. However, gradually increasing forest productivity and increased timber inventory could be expected to attract new forest industry. This in turn would expand the economic impacts established by the recent input-output analyses. Assuming that the foundation of forest products industry and related impacts is the timberland base, then those estimates would increase by 0.0293 percent.

Considering only the $18.6 billion of economic impact in South Carolina from the forestry manufacturing sectors [62,73], the 0.0293 percent incremental increase in "effective" timberland resulting from incremental reforestation equates to $4.95 million dollars of annual incremental economic impact in terms of long-run timber supply. In addition, using that same proportionate increase, $222,000 of delivered value would be added to the state's wood supply, and nearly $22,000 of additional state and local tax revenue would be generated.

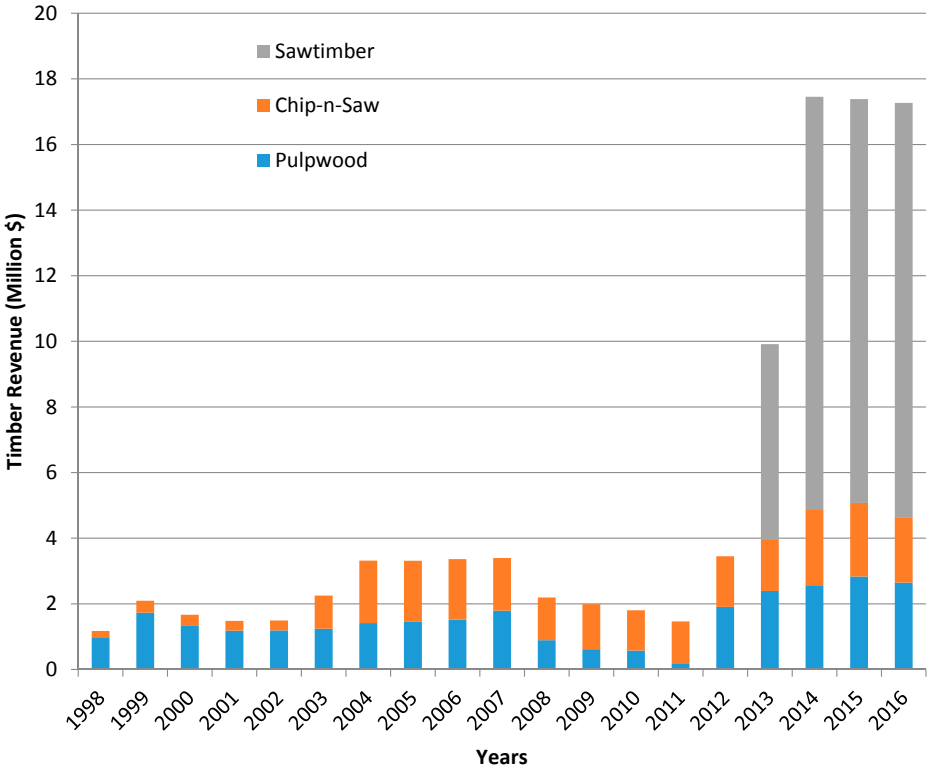

Figure 3. Total revenues for each timber product by year from timberlands using the FRP program.

5. Discussion

This analysis is based on published estimates of economic activity, employment, and value-added by the forestry sector and other sectors of the South Carolina economy. These estimates were the best available in the literature. Like all estimates, they have a range of possible values and vary over time with the general economy. The calculations in the analysis are simple and easy to understand. This is a strength many analyses lack.

We note that economic impact analyses are demand-based; that means they assume the incremental output produced will be utilized. One could argue this analysis is primarily supply-driven (additional investment in reforestation creates additional wood inventory that ends up being harvested and manufactured into products of some sort, creating jobs and economic activity). Our analysis is based on an assumption that the increased long-run timber supply will occur in an environment where that increased timber demand will continue to develop as timber supply expands. The South is expected to continue to be the "wood basket" of the nation and long-term studies of timber demand support this assumption [74].

In summary, over the long-run, annual investment in reforestation cost-share in South Carolina was found to have a substantial impact on the state's economy. The public investment in reforestation has an annual long-term economic impact of nearly $5 of additional economic impact for each dollar of reforestation cost-share, creating over a half million extra tons of wood, and generating nearly $22,000 of state and local taxes.

These results are of value to forest policy analysts and state legislators tasked with evaluating the cost effectiveness of state forestry cost-share programs. The intent of such programs is usually focused on expanding the state's forest economy. That is why the programs are most common in states with strong forest economies and the timber production potential to expand that economy. We have shown that an expectation of an expanding timber supply is reasonable for the anticipated incremental yields resulting from increased reforestation in a state. Our model is based on pro-rated expansion of the forest economy based on that land area, resulting in an estimate of expected economic

impact. A fully-developed timber supply model that included simultaneous timber demand estimates would produce stronger results; however, for forest planning purposes these results provide useful information on expected economic impacts. State-level forestry cost-share programs have been shown to have a substantial influence on long-term timber supply and potential to produce a positive impact on the forest economy.

Author Contributions: This study served as the Master of Forest Resources project paper for Brandon G. Stoots and he designed the study, performed the analysis, and wrote the paper. Thomas J. Straka provided guidance and supervision for the research as graduate committee chair. Scott L. Phillips provided the data used in the research and contributed to the analysis.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

The following abbreviations are used in this manuscript:

FFOs	Family Forest Owners
FRP	Forest Renewal Program
SCFC	South Carolina Forestry Commission

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