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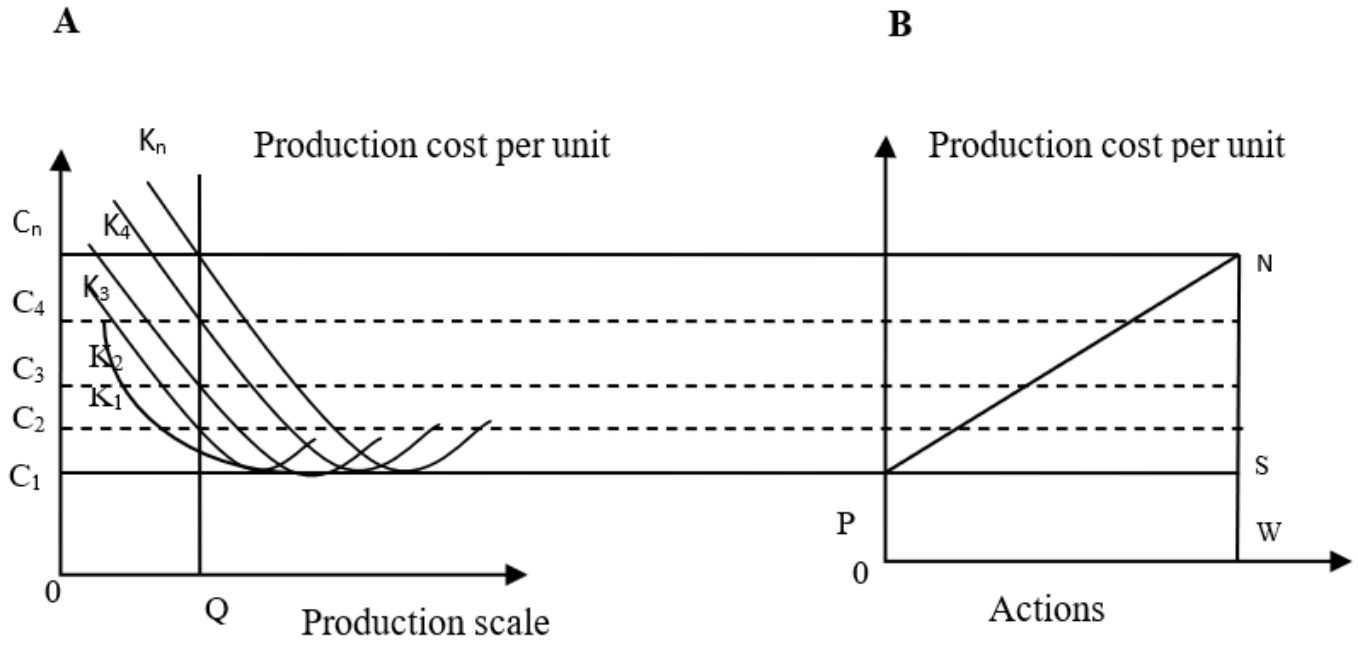
S1. Theoretical framework

Agricultural social service results from technological progress and the social division of labor. As specialization increases productivity, agricultural producers gradually shift from their self-operated production to more specialized service organizations (or individuals). Under the premise of pursuing individual utility maximization, farmers are faced with the choice of production and trading. Production means that the farmer operates all the links, where the cost of production can be pretty high. Trading means that farmers choose specialized production methods and hand over some production operations that are not suitable for them to specialized service providers (organizations or individuals). Farmers tend to choose social services if the transaction cost is lower than their production cost, stimulating their adoption of these services.

This paper draws on Gong's (2000) theory to analyze the theoretical economic basis of farmers' adoption of forestry social services. We assume that a forest product, from production to consumption in the whole process, can be decomposed into n operations. Each operation can be independent with its own optimal scale and change with technical conditions. The operations can have up to n different optimum scales of production. The producer's actual choice of forest production scale is only one of them. We assume that the actual production scale is one of the most optimal scales of production, where the optimal operation means that the cost of production per unit of product is the lowest. The n-1 scale of production does not reach an optimal scale because the lower products share a higher fixed cost, thus increasing the cost of individual products. Now we assume that the unit production cost of n different operations is the same when they reach the optimum production scale, then the unit production cost curve of these N operations is a cluster of curves with different slopes K_i (I =1,2,...,N), as shown in Figure S1.

Figure S1 A, N types of the production cost curve from the unit operation. **B**, Production cost of the overall process of social production from a product. C_1-C_n, unit production cost curves; K_1-K_n, operation curves; *Q*, actual production scale of the farmer; *N*, operations; *OPNW*, area of trapezoidal showing



unit production cost of the product, if the farmer completes all the operations by himself.

In Figure S1(A), the actual production scale of the farmer is Q. Only the operation K_1 reaches the optimal production scale with the production cost of C_1 while the other operations fail to reach the optimal production scale. Other unit production costs $C_2,...,C_n$ have this relation: $C_n > C_4 > ... > C_1$.

Figure S1(B) is the projection of unit production cost in Figure S1(A). If the farmer completes all the operations by himself, the unit production cost of the product is the sum of the unit production cost of n operations, which is the area of trapezoidal *OPNW*. If the professional production method is adopted, that is, the N - 1 operation which does not reach the most optimal production scale is given to the social service organization to complete, the unit production cost of the product is equal to the area of rectangular *OPSW* and the area of triangular *PSN* is the unit production cost saved. If the transaction cost is 0, then the theoretical increment of social benefits provided by triangular *PSN* for FSS is the theoretical inducing mechanism for farmers' needs and behaviors. If a forestry producer's unit production cost to complete all operations is born by himself is C_i, and the unit production cost born to complete FSS is C_1, the transaction cost of both parties in terms of price negotiation, cooperation signing, supervision and execution, and loss of default risk is A. Then the requirements for farmers' FSS are as follows:

$$C_1 + A \leq C_i \quad (1)$$

S2. Independent variable selection and hypotheses

Labor factors

① The higher the number of laborers in the family, the more configurable labor resources, and the more likely the farmer is to adopt FSS.

② The degree of labor transfer directly affects the size of the labor force in rural forestry production, resulting in a shortage of rural labor force supply. The higher the degree of labor transfer, the smaller the adoption of technical services by farmer households (Kong et al. 2017). Therefore, labor factors are set as labor quantity and labor transfer degree.

Woodland elements

① Woodland management area is a critical factor of production that determines farmers' forest management and the choice of FSS. A larger woodland area requires higher production factor allocation capacity and a more vital willingness to demand FSS (Liu et al. 2017). Therefore, it is expected that the operation scale of forest land positively influences the social service needs of farmers.

② Land fragmentation is likely to push the cost of forestry services up, thus inhibiting farmers' choice of FSS (Liu et al. 2017).

③ The convenience of managing forest land is mainly reflected by the distance between forest land and the nearest highway (Qin et al. 2011). The distance affects the availability of FSS for farmers and the condition of forestry transportation infrastructure. The longer distance between the woodland and the highway means higher forest mining and transportation costs. For a similar income level, the high cost of FSS will likely inhibit farmers' adoption of FSS.

Technology

Technical elements in production and sales activities mainly refer to subjective technical elements such as experience and skills.

① Whether the farmer experiences relevant difficulties in woodland management like planting problems (Zhang & Mehmood 2001, O'Herrin & Shields 2016), pest and disease attacks (Ji et al. 2011, Bhatia & Yousuf 2013), and sales difficulties (Munn & Rucker 1994, Zhang & Mehmood 2001, O'Herrin & Shields 2016, Boakye-Danquah & Reed 2019) and other problems, will increase farmers' demand for the corresponding FSS. The difficulty experienced in woodland management positively correlates with the demand for FSS (He et al. 2011).

② The difficulty in applying for logging permits. This variable can reflect the complexity of the timber harvesting

permit in application procedures. The more complex and cumbersome it is for the forest farmer to apply for a timber harvesting permit, the more difficult it will be for them to turn the timber resources into cash. This will damage farmers' enthusiasm for forestry management to a certain extent. Therefore, the technical elements cover the following variables: whether they experienced corresponding difficulties in operations and the difficulty in applying for logging permits.

Capital factors

① Main sources of funds for the managed forest land. The primary source of forest land operating funds is the farmer households with loan funds, which have a high degree of specialization and thus have a more robust adoption for all kinds of social forestry services (Liu et al. 2017).

② The proportion of forestry income. The higher the forestry income received by farm households, the greater their dependence on forestry production for their livelihoods, the higher their willingness to invest in forestry, and the stronger the demand for social forestry services. However, it is difficult to eliminate the endogeneity problem of the variables of forestry income and forestry inputs. There is a close relationship between farmers' forestry income, forestry inputs, and demand for FSS, and the endogeneity problem is inevitable if they are directly put into the model. Therefore, the proportion of forestry income is used as a proxy variable, and the higher the proportion of forestry income to total income, the higher the forestry income and forestry input will be correspondingly higher.

③ Forestry subsidy policy is in place mainly to support the main body of artificial afforestation. The subsidies cover forestation, forest tending, and growing superior seed varieties. These subsidies can reduce afforestation's comparative cost or generate more income, stimulating farmers to engage in forestry production actively. The variable showing whether a farmer gets a forestry subsidy can judge whether farmers are engaged in forestry production and investment; the farmers should be more in need of FSS. Therefore, the capital factors are set as the primary source of operating funds for forest land, the proportion of forestry income in total income, and whether forestry subsidies are obtained.

Farmer's demographics

As forest managers, farmers' characteristics substantially impact the adoption of their social services (Tan et al. 2010).

① The age of the householder greatly influences the willingness to technology adoption and the choice behavior of farmers. Farmers' ability to accept new ideas and adopt new technologies will weaken with the increasing age, and they will become less enthusiastic about forestry production and management. Thus, for an older head of a household, the adoption and availability of FSS will also decrease (Emerick et al. 2016, Khan et al. 2017).

② Households with a higher degree of education not only have a more vital ability to master new technologies, but their risk tolerance in forestry production is also higher. Therefore, the factors of farm operators' characteristics are set as the age and education level of the household head.

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