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Research Articles

Research Article

Farm Trajectories and Recent Changes in the Rubber Farms in Southern Thailand

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Abstract

Rubber has been grown in Southern Thailand for many decades. Now a day the rubber sector faces several challenges such as land use changes, labor constraints, and price fluctuation inducing changes in the structure of the agricultural system. The aim of this paper is to analyze how Thai rubber farms evolved in this changing environment. A purposive sampling household survey of 393 rubber owners and interviews of key informants from four representative villages in Songkla and Patthalung provinces provided data for analysis. We established and characterized a typology of rubber farm trajectories since 1990. For that, we adopted an innovative method using two sequence steps: multivariate analysis and the repeated clustering technique. We found that six farm trajectories can be identified using the evolution of farm structure. Stability of family farms (38.2% of farms) showing no evolution of the farm size and labor use, is the trajectory gathering the largest proportion of farms for the past 20 years. High structural change of the farms (10.5% of farms) and declining very small farms (25.0% of farms) are constituted by farms that experienced a decrease in the size of the landholding and limits to expansion. In opposite, three trajectories, namely the growth of large family farm enterprises (4.1 %), the growth of medium family farm enterprises (14.5%), and toward patron farms (7.7%) are composed of farms with a continued expansion in landholding and hired labor use. These six farm trajectories show that a polarization process is at work which may further induce changes in the rural Thai rubber economy.

Keywords: Farm Trajectories, Typology of Farm, Farm Change, Rubber Economy

Introduction

Rubber is the engine of economic growth and rural development, especially in traditional southern rural areas of Thailand. About 80.0% of Thai natural rubber come from the Southern region and are produced by smallholder about 1.0 million households depend on rubber production for their livelihood [1].

From the beginning of the 20's century until the 1980's, there was a massive expansion of new planting due to a wide availability of land [2]. Afterwards, land expansion was limited and rubber farm size

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gradually declined from 3.3 ha in 1993 to 1.87 ha in 2007 [3, 4]. The share of small holdings with 0.3-6.24 ha decreased from 64% in 1998 to 60% in 2003; in contrast, the share of the holding with 6.24-22.25 ha increased from 26% in 1998 to 31% in 2003 [3]. This indicates that distribution of landholding was apparently changing. Labor force was also abundant until the early 1990s, when increasing number of farm labors migrated to manufacturing and service sector [5]. Since the beginning of the 1990's, the share of farm labor forces had continually decreased to less than 41 percent in 2012 [1]. The available family labor dropped from 3.4 persons per household in 1993 to 2.1 persons in 2010, especially decline of young labor for the 15-24 age group [4, 6]. Aging farmers and workers were no longer fully replaced [1, 7]. Labor use in the rubber farms is probably changing too. Furthermore, the farms are facing socio-economic problems and new challenges such as price fluctuation and inefficient market system, etc., leading to decline in farm engagements. These provided strong evidences that the rubber sector has changed structurally possibly affecting the future of rubber based economy. Understanding the past is necessary to prepare the future. Therefore, the aim of this paper is to analyze the evolution of the rubber farms on a long period through the identification and assessment of farm trajectories. A second aim is to analyze the process of farm change and the consequences of these trajectories. Farm trajectory is process of farm structural/organizational changes in defined time in order to understand and assess series of structural changes, drivers, successive conditions and deterministic patterns in history of the farm. An understanding of farms trajectories would be documented for decision makers and the farms to have appropriate policies for the future of rubber economy.

Materials and Methods

Study area

The study was conducted in two provinces representative of rubber development in Southern Thailand, Songkhla and Patthalung. Two villages in each province were selected based on the following criteria: rubber is dominant in terms of land and labor use, the social and economic development of the village depends on rubber, and there are both rubber farmers who created their plantation under the re-plantation scheme and rubber farmers who used private investment. Ban Mai and Ban Koa Phra villages in Songkhla, and Ban Lohhan and Ban Kok Muang villages in Patthalung were selected.

Sample and data collection

Data was obtained by two household surveys carried out by a purposive sampling method. In the first survey (January-June 2011), data were gathered using a questionnaire with both quantitative and qualitative data on the farm and household. Data concerned family structure, production, farm management, cost of production, and income as well as the evolution of landholding, labor changes and household activities. A total of 393 farm holders were interviewed of whom 220 of farm holders provided the complete data for the period 1990 to 2010. 220 respondents were therefore used for the analysis.

Table 1. Number of farmers surveyed, sample analyzed, size of subsample and number of experts.

Village	Number of farmers surveyed	Number of samples analyzed	Number of subsample	Number of experts interviewed
Ban Mai	120	68	28	2
Koa Phra	90	50	17	3
Ban Lohan	88	50	18	2
Ban Kok Muang	95	52	18	2
Total	393	220	81	9

In the second survey (June-September 2012), a subsample of 81farmers representative of each farm trajectory and selected by a purposive sampling method was interviewed using a semi-structure questionnaire. 9 experts who were local philosophers, leader and governors, were also included in this second survey (Table1). The aim of the second survey was to validate the results of the statistical analysis from the first survey and to obtain an understanding of the farm change, process of trajectories, and their impacts.

Statistical analysis

In the first step, a multivariate analysis was carried out to build a typology of farm trajectories using two sequential stages; principal component analysis (PCA) and cluster analysis (CA). We selected a set of variables of farm structure; each variable had a value for the three stages (1990, 2000 and 2010). A Kaiser-Maiser-Olkin value greater than 0.5 and the significance of Bartlett's sphericity test at a probability value $p<0.05$ were used as thresholds to indicate fitness of the variables selected for the analysis [8]. Principal component analysis with varimax rotation was applied on the selected variables that reduced the number of variables on the extracted factors [8, 9]. Factors with eigenvalues > 1.0 or more and variables with a variance greater than 0.5 were selected as factors for cluster analysis [8-10]. Both hierarchical and non-hierarchical methods were used to identify typology of farm trajectories. We applied the hierarchical cluster analysis technique using squared Euclidean distances and Ward's aggregation method [9] to identify a preliminary number of clusters and clustering profiles. Once preliminary cluster solution is identified, a non-hierarchical clustering technique was applied using the hierarchical results to determine the initial value of K-mean; and then nonhierarchical clustering was developed until optimal cluster solution is achieved [11]. Multivariate analysis of variance (MANOVA) was carried out to test the validity of the cluster solution and the resulting cluster profiles [11].

In second step, the repeated clustering technique proposed by Kongmanee [12] was applied. We used the same method as the first step and the same variables; but the analysis was performed three times using the set of variables for each year. This allowed identifying three typologies of farms: one at the initial date (1990), one at the intermediate date (2000) and one at the final date (2010). As a result of these three clustering

analysis, individual farm could get a combination of three cluster numeric codes based on the values of variables in 1990, 2000 and 2010, what we called "pattern of clustered farm pathway". Once patterns of clustered farm pathways were identified, they were all categorized according to the typology of farm trajectories established with the first method. Patterns of clustered farm pathway allowed us to identify individual farm trajectories and to analyze process and structural dynamic views of farm change between the initial, intermediate and the final periods. Interviewing representative farmers and local experts allowed us to confirm and validate the results of the statistical analyses and the real farms.

Results and Discussion

19 variables were suitable for PCA (Table 2). Each variable presented a value at three time periods: the value of the variable at the initial year, subscript by_1990, the value of the variable at the intermediate year, subscript by _2000, and the value of the variable at the final year, subscript by _2010. The total number of variables used for the analysis is 57 values.

The KMO test of sampling adequacy showed a value of 0.800 and the Bartlett's sphericity test showed significantly probability value $\rho < 0.0005$, indicating that the suitability of the set of variables for principal component analysis. A five-principal component solution is adopted, explaining 75.3% of total variance. Table 3 shows eigenvalue and the variance explained by the five extracted components.

Factor 1 shows highly positive correlation coefficients with variables of landholding, land use, and the use of hired labor in 1990, 2000, and 2010. Farms with high variance for this factor show increment in landholding and orientation towards farm enterprise. Factor 2 is positively correlated with variables of the use of hired labor in 1990, 2000, and 2010 and is negatively correlated with family tapper for the same periods. The high variance of PC2 expresses a farm orientation towards the dependence on hired labor. Factor 3 is positively correlated with the use of family labor for off-farm tapping in 1990, 2000, and 2010 and the size of off-farm tapping areas for the same periods, explaining about 10% of total variance. Farms with a high variance for this factor correspond to the ones with the highest participation to off-farm activity for both numbers of labors and off-farm areas. Factor 4 has a high positive correlation coefficient with the use of family labor mixed on-farm and off-farm in the 1990, 2000, and 2010. Farms that have the highest variance for this factor show high percentage of family labor tapping both on-farm and off-farm. Factor 5 is positively correlated with the variables of the use of family labor and hired labor in 1990, 2000, and 2010. Farms that have the high variance for this factor use both family labor to tap on-farm and hired labor for their owned share-tapping areas, which expressed farm enterprise profiles.

Table 2. Variables used in PCA.

Variables	Descriptions and units
LHH	= landholding (rai)
RLH	= land planted with rubber (rai)
MRLH	= mature area of rubber land (rai)
OFFL	= off-farm areas (rai)
SLH	= land tapped by hired labor (rai)
LHFL	= landholding per family labor (rai/labor)
RLFL	= rubber land per family labor (rai/labor)
MRFL	= mature rubber land per family labor (rai/labor)
FML	= number of family labor $\geq$ 15 years (person)
FTP	= number of family tapper (person)
HTP	= number of hired tapper (person)
UFL	=1 if use only family labor, 0 if otherwise
UHL	=1 if use only hired labor, 0 if otherwise
UFHL	=1 if use family and hired labor, 0 if otherwise
UOFL	=1 if use family on farm and off farm, 0 if otherwise
UFFL	=1 if use family only off farm, 0 if otherwise
FAG	= household head (HH)'s age (year)
FGD	= 1 if HH is male, 0 if otherwise
FED	= 1 if HH finished primary school, 0 if otherwise

Table 3. Principal components (PC) selected, eigenvalue, explained and accumulated variance with the different PC.

Principal component	Eigenvalues	Cumulative variance	Chief associated variables
Factor 1	16.54	42.42	LHH_2010, LHH_2000, LHH_1990, RLH_2010, RLH_2000, RLH_1990, SLH_2010, SLH_2000, SLH_1990, LHFL_2010, LHFL_2000, LHFL_1990, RLFL_2010, RLFL_2000, RLFL_1990, HTP_2020, HTP_2000, HTP_1990
Factor 2	4.78	54.68	FTP_2010, FTP_2000, FTP_1990, UHL_2010, UHL_2000, UHL_1990
Factor 3	3.97	64.86	OFFL_2010, OFFL_2000, OFFL_1990, UFFL_2010, UFFL_2000, UFFL_1990
Factor 4	2.15	70.38	UOFL_2010, UOFL_2000, UOFL_1990
Factor 5	1.92	75.30	UFHL_2010, UFHL_2000, UFHL_1990

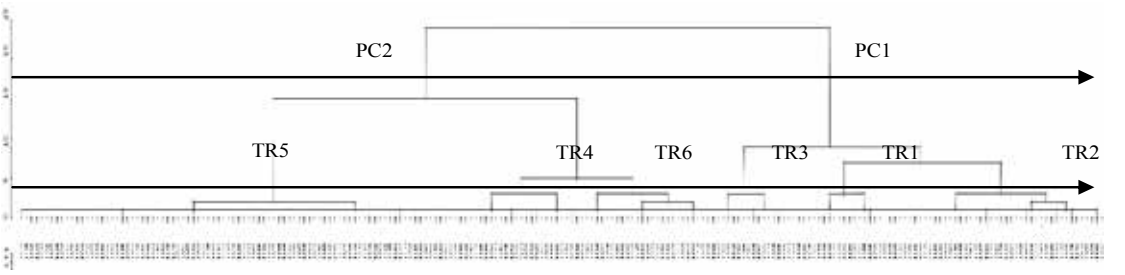

Figure 1. Dendogram resulted from cluster analysis.

Cluster analysis was performed on the five retained factors of the PCA. The dendogram obtained (Figure 1) shows two large homogeneous groups of farms that we call "patterns of change". Each pattern of change (PC) could be sub-divided into "farm trajectories (TR)". Six-farm trajectories were obtained. The MANOVA applied on the six farm trajectories was statistically significant (F (225,846) =41.119, p values = 0.000). The individual univariate F-statistics was statistically significant (p values equal to 0.0005) as shown in Table 4.

Pattern of changes 1 (PC1) concerned 26.3% of farms which experienced an increment of landholding and/or hired labor in farms. This evolution presented a structural trend toward a growing farm enterprise and/or high dependence of hired-labor. This pattern of change consisted of three trajectories.

Growth of large family farm enterprise, TR1 (4.1% of farms) was observed by the large farms that experienced the largest increment of land and use of hired labor. Landholding grew mainly during 1990-2000 and remained to increase after. The number of family tappers decreased even if the number of family labor slightly increased. Family labor was mainly dedicated to farm business management with limited family tapping activity. These led to depend on hired labors. Initial large farm size combined with specialization and intensification in production, allowing simultaneously capital-led expansion. New technologies and modern farm management were widely adopted. The farms were attempting a strong growing farm structure toward expansion of farm enterprise.

Growth of medium family farm enterprise, TR2 (14.5% of farms) was observed in medium farms that experienced moderate increase of landholding and an increase of the use of hired labor. The increment of land holding was high during 1990-2000 and remained to expand thereafter. Family labor slightly increased and farm labor forces remained stable in the past 20 years. Family labors worked for both tapping activities and farm business management. Hired labors were employed to complete insufficient family labor for all mature rubber plantations. These farms were the same as the farms in TR1 in term of specialization, intensification, technological use, and their concentration of effort on maintaining productive farm enterprise. The farms were also pursuing an enlargement of farm structure and to expanding farm enterprise.

Toward patron farm, TR3 (7.7% of farms) grouped the farm holders that experienced moderate increase in the size during 1990-2000 and then slightly increased in 2010. At the same time, family labor

remained stable but family farm labors gradually decreased until there were no more family labors to engage fulltime farm in 2010, and hired labors are fully employed to substitute. Number of hired labors had increased considerably. All the rubber owners have now only non-farm activities. They then were dedicated part-time to farming. The farms were found to have low specialization and intensification in rubber production comparing with TR1 and TR2. All farms in this trajectory also pursued expansion of the size and may have developed small farm enterprise.

Pattern of change 2 (PC2) was observed for a large number of farms, 73.7% of farms that could be characterized as small farms in the current period. This pattern was observed in farms which landholding comparatively declined or remained stable for the whole period of study. This pattern of change includes three trajectories.

High structural changes of farms, TR4 (10.5% of farms) was observed in downsizing of farms that experienced the largest decrease of landholding throughout the study period, and at the same time hired labors considerably decreased. The farms have substantially reduced landholding between 1990 and 2000 and continued to decline in 2010. In order to overcome compounding socio-economic pressures and constraints that they are facing, landholding has been sold continuously. In consistent with the reduction of the size, the number of hired-labors also sharply decreased. At the same time, family labor also decreased leading to a reduction of family labor dedicated to farm. These farms gradually adapted the size and the available farm labor. Specialization and intensification were limited. New technologies were rare. All farms were currently in the process of downsizing at the study period.

Stability of family farms, TR5 (38.2% of farms) grouped the small farms that experienced stability of landholding and use of family labor since 1990. Landholding was comparatively small over the study period. Family labor slightly increased. Family labors dedicated to farm were available and had no change throughout the period. They engaged full-time on their own plantations and did not need to employ hired labor. It is the only trajectory where the size of mature rubber land was sufficient for the tapping capacity of family labor. These farms have been specialized in rubber production. A limiting capital investment for maintaining productive production was observed in these farms as well as high adaptation of technology. The farms are currently facing a wide array of challenges and serious risks and pursue various farm strategies. Many farms therefore present the risk to fall into trajectory of farm decline.

Declining very small farms, TR6 (25.0% of farms) was observed in very small farms that experienced decline in small landholding and used only family labor. Landholding was comparatively small since 1990, and showed a slight decrease in landholding throughout the period of study. At the same time, family labor increased and farm labors then slightly increased. These farms had to specialize in production and skilled labors allowed the adoption of off-farm under share-tapping employment. It was the only trajectory where the farms were involved in off-farm under share tapping. Size of off-farm sharply increased during 1990- 2000 and still

increased thereafter. In 2010, size of off-farm was larger than their own plantations. The farms gradually adapted workforce availability and production orientation by increasing size of off-farm under the share tapping. Technologies and capital invested for the productive activities were rare similar as the farms in TR5. All these farms are currently in process of declining.

Table 4. Characteristic of clusters of farms and P-Value of the one way analysis of variance

Name of variables	TR 1	TR 2	TR3	TR 4	TR5	TR6	Univariate F	P-value
	n= 9	n=32	n=23	n=17	n=84	n=55	df = 5,213	
% of total farm	4.1	14.5	10.5	7.7	38.2	25.0		
Land in 2010 (rai)	151.8	45.0	28.4	24.9	14.6	7.5	116.0	0.000
% change of land 2010/1990	+27.1	+26.8	+11.4	-66.5	+3.5	-25.7		
Family farm labor in 2010 (person)	1.0	2.2	0	1.1	2.1	2.3	31.4	0.000
% change of family labor 2010/1990	-44.4	+4.7	-100	-47.6	0	+4.7		
Hired labors in 2010 (person)	8.7	2.8	3.1	1.8	n.a	n.a	122.6	0.000
% change of hired labors 2010/1990	+10.1	+27.3	+34.8	-66.7	n.a	n.a		
Size of off-farm in 2010 (rai)	n.a	n.a	n.a	n.a	n.a	13.4	83.2	0.000
% change of off-farm 2010/1990	n.a	n.a	n.a	n.a	n.a	+148.2		
Household income in 2010 (baht)	3,880,504	1,267,000	952,200	727,000	532,560	466,848		

Using the repeated clustering technique, five clusters of rubber holders were identified for the years 1990, 2000 and 2010 (Table 5). Once individual farm received a coded cluster number for each year, 22 patterns of clustered farm pathway were identified. These farm pathways are grouped into six farm trajectories. The pattern of clustered farm pathway helps understanding farm pathway's composition in each farm trajectory highlighting structural dynamics between 1990, 2000 and 2010 (Figure 2).

TR1 grouped two pathways: 1-1-1 and 2-1-1. 1-1-1 pathway (3.2% of farms) was characterized by the growth of farm structure within the cluster of large family farm enterprise. The farms were already large in 1990 and continued to expand. Pathway of 2-1-1 (0.9% of farms) indicated that the farms were medium family farm enterprise in 1990, grew moving toward large family farm enterprises in 2000 and continued to expand in 2010.

TR2 comprised of four pathways: 2-2-2, 2-1-2, 4-4-2, and 4-2-2. 2-2-2 (9.1% of farms) showed the growth of medium farms within the cluster of medium family farm enterprise. 2-1-2 (0.9% of farms) showed that the farms substantially increased the size of landholding and number of hired-labor moving into cluster of large family farm enterprise in 2000 but it was not stable. 4-2-2 (3.6% of farms) and 4-4-2 (0.9% of farms) showed that some farms were small family farms in 1990 or until 2000 and grew in the size and hired labors moving toward cluster of medium family farm enterprise during 2000 or 2010.

TR3 grouped five farm pathways: 3-3-3, 2-2-3, 2-3-3, 4-3-3, and 4-2-3. 3-3-3 included 3.6% of farms that maintained structure of patron farm since 1990. 4-2-3 and 4-3-3 (2.3% of farms) showed the structure of family farms in 1990 that evolved into patron farms in 2000 (0.5% of farms) or 2010 (1.8% of farms). 2-3-3 and 2-2-3 consisted of 1.9% of farms which were medium family farm enterprises in 1990 or until 2000 and evolved into patron farms during 2000 or 2010.

TR4 grouped six farm pathways: 1-1-3, 1-3-3, 1-1-4, 1-4-4, 1-2-4, and 2-2-4. 1-1-3 and 1-3-3 (2.7% of farms) corresponded to large farms in 1990 or until 2000 and substantially declined in farm structure downward into patron farm in 2000 or 2010. 1-1-4, 1-4-4, and 1-2-4 (1.9% of farms) indicated that large farms in 1990 or until 2000 substantially downsized into family farms during the past 10 years or even before. 2-2-4 (3.0% of farms) had known the structural change from medium family farms downsizing into small patron farm in the last decade.

TR5 only consisted of pathway of 4-4-4 and constituted 38.2% of farms. They remained with structural characteristics of family farms over the study period. Stability of the landholding size and availability of family labor were observed in this trajectory.

TR6 grouped three farm pathways: 5-5-5, 4-5-5, and 4-4-5. 5-5-5 (11% of farms) corresponded to the farms that remained characterized by cluster of very small farms over the period of study. 4-5-5 and 4-4-5 (13.6% of farms) showed that the farms were small family farms in 1990 or until 2000, and gradually declined into cluster of very small farms in 2000 or 2010.

Table 5. The five farm clusters: coded number, proportion of farms, and characteristics for the years 1990, 2000, and 2010 (220 rubber farms surveyed in Southern Thailand).

Coded cluster number	Coded cluster name	Percentage of farms (% of a total of 220 farms)			Cluster characteristics
		1990	2000	2010	
1	Large family farm	6.8	6.4	4.1	Largest landholdings, hired labor, capital intensive, specialized in rubber plantation, high business orientation
2	Medium family farm	19.5	17.3	15.0	Second largest landholdings, hired and family labor, capital intensive, specialized in rubber plantation with moderate business orientation
3	Patronal farm	4.1	10.0	12.7	Farm owners involved full- time in non-farm employment, small to medium landholding, high dependence on hired labor.
4	Small family farm	58.6	45.0	42.7	Small landholding, family labor
5	Very small farm	10.9	21.4	25.5	Very small landholding, family labor, high off-farm tapping area

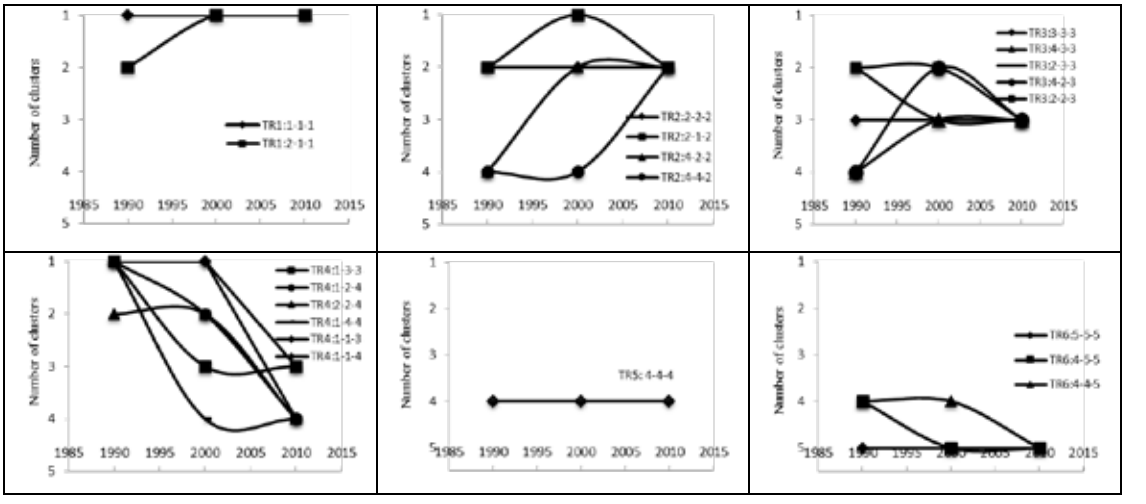

Figure 2. 22 patterns of clustered farm pathways for presenting compositions of the six-farm trajectories.

These six farm trajectories have significant implications for the evolution of rubber farms in southern Thailand. A large proportion of farms relying on stable trajectory which both the size and availability of farm labor remained stable. Many farms in this trajectory progressively adapted production and adjusted to available labor for improving livelihood and changes in socio-economic environments. However, they face constraints for incrementing size and a more vulnerable livelihood which might force them falling into a trajectory of farm decline.

The three of trajectories of farm growth constituted about 26% of the observed farms: Two of them, growth of large family farm enterprise, growth of medium family farm enterprise (TR1 and TR2) are characterized by increment of landholding and labor use through specialization, intensification in production and expansion of farm enterprise. Transformation toward patron farms (TR3) involves farm enlargement for economic opportunities and foresee small farm enterprise. The combined capital intensification in production and large size allowed these farms to continue capital-led expansion. Two trajectories were identified as trajectory of farm decline: high structural change of farms (TR4) and declining very small farms (TR6). The farms in TR4 correspond to the largest decline in the size and labor use. In TR6, even though they were originally very small farms, a decline in the size and availability of labors for farms and off-farm is observed. The opposing trajectories identified in our study further provide evidence to support the bimodalisation theory of "the strong getting stronger" [9].

Our results not only provide strong evidence an ongoing structural transformation of rubber economy in Southern Thailand during the 1990-2010 periods; they also provide a basis for further and deeper analysis of the determinants of these transformations. In another work to be published [12], we used these results to analyze the drivers of farm changes. We found that initial resource endowment (land and labor), land accessibility, credit accessibility, productivity and farm strategies appear to influence strongly the transformation of farm trajectories in the study area. We also found that the co-evolution of land and labor has a direct influence on the amplitude, direction and process of farm trajectories. Further analysis found that policy intervention and market forces also influenced the evolution. For example, government intervention promoted expansion of new planting and the replanting scheme regardless distribution of landholding and the difference in land accessibility. Government policies applied to all farms, but unintentionally tended to favor large farms (TR1 and TR2): productivity growth supported by the replanting scheme associated with the large size and a better financial resource helped farmers to specialize in rubber, intensify production and expand the landholdings of farm enterprise. In contrast, small size combined with low financial resource favored the trajectory of farm decline. High yield clone promoted by the replanting scheme has achieved to shift level of income and reduced several farm risks but these had less contributed to expansion and reinvestment in production. So, public policies failed to overcome market failure in distribution of landholding and then further simultaneously drove transformation of farm trajectories. Availability of farm labor became a major driver of

change as high adoption of off-farm activities by TR6. Availability of family labor is important resource for the small farm that allowed for their continued existence in the farm sector. They also are recognized value of land in terms of source of income, physical properties and local cultural value of land in a certain circumstances including a choice of living.

Conclusions

Combing multivariate analysis and the repeated clustering technique allows us to identify and assess pattern and amplitude of change in farm trajectories. Co-evolution of land and labor is a relevant discriminant factor to identify contrasted patterns of farm transformation. On that basis, six significant farm trajectories between 1990 and 2010 were identified. Although a large proportion of farms follow a trajectory of stability with no change in farm size and labor structure, we highlighted some polarization of rubber farms in southern Thailand. This polarization may increase in the future as small farms present a risk to follow the trajectories of farm decline: unless government initiate some intervention to reverse this process that it involuntarily contributed to.

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