Research Article

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Structural Changes of Farm Size and Labor's Occupation in Bangladesh- A Markov Chain Analysis

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Abstract: Over the last few decades, Bangladesh has experienced significant structural changes within the agricultural sector. This research estimates the current and forecasts the future changes of farm size and labor occupational mobility over time and across the region. A panel dataset, which is used in this study, was collected in the three different years (1988, 2000 and 2008) from 62 villages across 57 districts. Stationary Markov chain approach was used in this analysis to estimate structural change. The results of this study imply that the agricultural sector is dominated by small farms in past, present and also in the future. The forecasting predicts that the numbers of marginal, medium and large farms are going to decrease in future. Moreover, it indicates that the average farm size of small landholders will slightly increase as the numbers of marginal and large landowners reduces. The analyses of the transition probabilities of labor occupational change show that rural households are gradually shifting to non-farm activities and mostly part-time farming from other income generating activities over time. In general, the forecast also suggests narrowing of agricultural activities and expansion of part-time farming and non-farm activities in future.

Keywords: Structural change, Farm Size, Occupation mobility, Markov chain, Bangladesh

1 Introduction

The agricultural sector in developing countries like Bangladesh is undergoing a far-reaching structural change, which is driven by over-population, technological

change, farming-system change, industrial development, changes in policy and so on. Goddard et al. (1993) described structural change in agriculture as a situation where a drastic change in average farm size along with a rapid change in number of farms occurred. It was also characterized by high mechanization and greater integration between farm and non-farm sector. Generally, number and size of farms, labor activity and ownership of the resources, along with managerial, technological and capital requirements for farming activities represent the structure of agriculture (Tweeten 1984). Though the process of structural change is necessary in the pathway of economic development, it has both positive and negative consequences for the economy (Massey 1995). Due to population pressure and inheritance law, land has become fragmented and the land– person ratio has been getting surprisingly smaller. Therefore, numbers of small and marginal households, in fact landless households has been increasing drastically.

Besides, agriculture alone cannot provide employment for all of the household labor. Mechanization and availability of modern farm machinery lead to more surplus labor in farm households. At the same time, the expansion in the industrial and service sector owing to the structural change is pulling some of this excess labor out of agriculture. As a consequence, households are partially or fully diversified into the non-farm sector, either in the rural areas or shifting to the urban areas. In 2010–2012, 50 percent of rural households earned their livelihood from a combination of farming and non-farm activities or non-farm activities (Pramanik et al. 2014). This trend of rural inhabitant's participations in non-farm sector is also increasing in other developing countries (World Bank 2007; URT 2005; Katega and Lifuliro 2014). This structural shift from farming to non-farm activities is influenced by the availability of land. Scarcity of land pushes agricultural labor into the non-agricultural sector. Switching occupational pattern stimulate the rural rental market, which ultimately creates a number of small farmers in replacement of a large farmer. Therefore, it is

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important to know the present and future extent of farm size change and occupational mobility of agricultural labor in rural areas which will help the policy makers to plan effective agricultural policies for rural development.

Numerous existing researches provide evidence that average farm size has decreased in most low and lower-middle-income countries, whereas it has increased in some upper-middle and high-income countries (Lowder et al. 2016; Zimmermann and Heckeley 2012a). Empirical research on structural change issues is very rare in case of Bangladesh. Moreover, Markov chain analysis is mostly used in farm structural change analysis of developed countries which is characterized by large farm size, smaller number of land-owners (Tonini and Jongeneel 2002; Piet 2008; Zimmermann and Heckeley 2012b). However, the application of Markov chain in case of farm size and labor occupational mobility, has not been observed in the literature of Bangladesh. Therefore, this research focused on the structural changes in farm size and rural household's participation in economic activities (occupation of rural labor force) following Markov chain model. Results of this research might provide clear scenarios in rural household agricultural involvement as well as agricultural structure over time. These changes might have impacts on the livelihood situation and poverty level of the rural households.

2 Material and Methods

2.1 Data source

A panel data set over the span of 20 years was used in this study, which was collected from secondary sources. In 1987–1988 the benchmark survey was conducted by the Bangladesh Institute of Development Studies (BIDS) on 1,246 rural households from 62 villages across 57 districts (Hossain and Baayes 2009). The International Rice Research Institute (IRRI) revised the villages selected in 1988 to collect relevant information in 2000–2001. Information was collected from same household correspondent person of 1987–1988 survey or from their descendants. In 2008, the same households were also studied under the supervision of Research and Evaluation Division (RED) of Bangladesh Rural Advancement Committee (BRAC). This whole data set was collected from Research and Evaluation Division (RED) of BRAC in 2014. The total numbers of used observations in this research are 510, which were collected and balanced from three years panel data set (1988, 2000 and 2008). Though this dataset is quite out dated, this is the latest data set of that panel.

Moreover, other required secondary information for this study was obtained through reviewing literatures such as publications, research articles, working paper etc. Besides, some important information gathered from different authentic websites (FAO, ILO, IFPRI, VDSA, etc.) and experts of the relevant field through email communication.

2.2 Household classification according to land holding and income sources

The sampling units (households) were classified into different groups based on their land holding status and major income earning sources (more than two-thirds of gross income). As a land-scarce country, most of the farmers in Bangladesh are marginal and small-scale farmers (84.27 percent) (BBS 2016). Following the classification of Department of Agricultural Extension, sample households were categorized into four groups based on land holding status: marginal (0.02 ha - 0.2 ha), small (0.21 ha - 1.01 ha), medium (1.02 ha - 3.03 ha) and large (>3.03 ha). The average farm size of Bangladesh is 0.59 hectare (ha), whereas average farm sizes of marginal, small, medium and large farms are 0.11 ha, 0.47 ha, 1.55 ha and 4.71 ha, respectively (BBS 2010).

Households in Bangladesh are involved in different types of economic activities for earning their livelihood and they are also moving from one activity group to another over the period (1988 – 2000 – 2008). Broadly, households placed in three major groups, namely agricultural household, non-farm household and part-time farming household. In order to make a clearer view, these three groups are categorized into ten sub-groups where each specific group is focused on separately. Households belong to agricultural wage or off-farm group when they use their labor on other farms (within agriculture) and earn wage in kind or cash. As this earning also comes from agricultural activities, this sub-category is placed under agricultural group. The exact definitions and participation status of households in these sub-groups are provided in the Appendix Table 1.

2.3 Markov Chain Approach

The Markov chain model was used in this research to assess the change and predict future number of farms based on farm size and labor occupation in Bangladesh. As significant regional differences might exist in the changing pattern of farm size and household economic

specializations, the whole country dataset was divided into seven regions according to administrative division of the country in 2014.

In a Markov chain, it is assumed that the probability of farm movement from one category at the period t to another category at time $(t+1)$ is not dependent on the earlier periods. Transition probability implies the likelihood for the movement of farm among categories in certain time period. A stationary first order Markov chain is presented as (Zimmermann and Heckeleei 2012a):

$$n_j = \sum_{i=1}^J n_{i-1} P_j \quad (1)$$

This equation explains that, the number of farms 'n' in farm category j ($j=1, \dots, J$) at time period 't' is equal to the sum over the total number of farms in all farm categories i in the previous period ($t-1$) multiplied by their respective transition probabilities P_{ij} . In this analysis, the numbers of farm categories are four and ten in case of farm size and economic activity changes respectively.

Transition probability matrix, P ($J \times J$) is a combination of all transition probabilities P_{ij} :

$$P = \begin{bmatrix} P_{11} & P_{12} & \cdots & P_{1J} \\ P_{21} & P_{22} & \cdots & P_{2J} \\ \vdots & \vdots & \cdots & \vdots \\ P_{J1} & P_{J2} & \cdots & P_{JJ} \end{bmatrix} \quad (2)$$

The probabilities hold both non-negativity condition and adding-up condition:

$$1 \geq P_{ij} \geq 0 \quad (3)$$

$$\sum_{j=1}^J P_{ij} = 1 \quad (4)$$

Transition probability that provides the likelihood of a farm to move from farm type 'i' to farm type 'j' can be estimated by:

$$\widehat{P}_{ij} = \frac{m_{ij}}{\sum_{j=1}^J m_{ij}} \quad (5)$$

Where m_{ij} indicates the number of farm movements from farm category 'i' to farm category 'j' in a period of time. This estimated transition probabilities can be used to predict any category's future farm numbers. If the initial state vector is indicated by X_0 and estimated transition probability in t state is P_t , row vector R_t in the t^{th} configuration vector can be predicted as:

$$R_t = X_0 P_t \quad (6)$$

This expression of Markov chain model implies the stationary nature of the model, which indicates that the transition probabilities do not change over time. This assumption may represent the actual situation until other factors remain constant. But in real economic situations, other variables are changing continuously. Therefore, time-varying or non-stationary transition probabilities are necessary to determine, where changes in exogenous variables are considered. Due to lack of available data for the selected time period, this study assumes that transition probabilities remain constant over time. Therefore, only the stationary Markov chain model was applied in this study.

3 Results and Discussion

3.1 Mobility indices of farm size and own landholding

In this study, farm size implies the total amount of cultivated land by a household, which includes both own and all forms of rent-in land, and excludes all forms of rent-out land. On the other hand, land on which household possess only the ownership right, they may cultivate by themselves or rent-out to others, is termed as owned land. Farm size and own lands are categorized into four groups namely, marginal, small, medium and large (definition is provided in sub-section 2.2). Frequency percentages of farms by their cultivated and own land per household are presented in Appendix Table 2. In a theoretical sense, the Markov chain model should include reliable data on entry and exit groups along with different states of cultivated land (Edwards et al. 1985). About 78 and 74 new observations were added in 2000 and 2008 respectively to adjust it with the increasing rate of farm at national level. These numbers of farms are treated as new entrants in farming activities. Due to this entry and exit behavior of farms, numbers of observations (households) in the three periods are not same. The previous year's data shows a declining trend of large and medium farms number, whereas marginal and small farms number grew constantly.

Movement along these size categories can be assessed by the distribution of transition probabilities. Transition probability matrices for 1988–2000 and 2000–2008 are estimated separately and then these two matrices are averaged, which is presented in Table 1. Standard deviations of the transition probabilities across regions and times are also shown by the small italic numbers below the mean probabilities. In the case of farm size, the

matrix shows that almost 43 percent marginal, 57 percent small, 50 percent medium and 33 percent large farms retained their previous farm categories.

The tendency to leave agricultural activities is comparatively higher in the case of marginal farms, as 22 percent of marginal farm left farming within 1988–

2008. It is also found that about 32 percent of marginal farm and 31 percent of medium farms shifted to the small farm category. Moreover, large farms were broken up and mostly converted to medium farm (30 percent). Another finding is that, new entering farms mainly belong to the marginal and small farm category.

Table 1: Average transition probabilities and standard deviations across time & region of farm categories

Change of farm category based on farm size in 2008 (%)							
	Marginal	Small	Medium	Large	Exit	Total	
1988	Marginal	42.89	31.90	2.36	0.41	22.45	100.00
	<i>SD region</i>	0.09	0.08	0.03	0.00	0.06	
	<i>SD time</i>	0.06	0.02	0.02	0.00	0.10	
	Small	24.29	57.22	7.49	0.00	11.00	100.00
	<i>SD region</i>	0.06	0.08	0.04	0.00	0.04	
	<i>SD time</i>	0.02	0.02	0.00	0.00	0.04	
	Medium	7.56	30.87	49.54	4.92	7.12	100.00
	<i>SD region</i>	0.06	0.09	0.16	0.04	0.12	
	<i>SD time</i>	0.02	0.05	0.13	0.01	0.05	
	Large	12.18	14.96	30.34	33.12	9.40	100.00
	<i>SD region</i>	0.16	0.05	0.69	0.36	0.19	
	<i>SD time</i>	0.05	0.04	0.00	0.06	0.03	
	Entry	53.26	41.16	5.00	0.57	0.00	100.00
	<i>SD region</i>	0.13	0.13	0.04	0.02	0.00	
	<i>SD time</i>	0.09	0.05	0.02	0.01	0.00	
Change of farm category based on own landholding in 2008 (%)							
1988	Marginal	57.73	22.21	2.53	0.29	17.24	100.00
	<i>SD region</i>	0.10	0.09	0.03	0.00	0.05	
	<i>SD time</i>	0.08	0.02	0.02	0.00	0.08	
	Small	14.30	68.25	10.91	0.44	6.10	100.00
	<i>SD region</i>	0.04	0.05	0.05	0.01	0.04	
	<i>SD time</i>	0.04	0.04	0.05	0.00	0.02	
	Medium	9.55	27.12	53.68	4.87	4.78	100.00
	<i>SD region</i>	0.04	0.09	0.09	0.09	0.01	
	<i>SD time</i>	0.00	0.05	0.06	0.01	0.03	
	Large	0.00	3.85	14.83	81.32	0.00	100.00
	<i>SD region</i>	0.06	0.19	0.35	0.61	0.00	
	<i>SD time</i>	0.03	0.05	0.14	0.22	0.00	
	Entry	74.91	21.14	3.95	0.00	0.00	100.00
	<i>SD region</i>	0.18	0.19	0.03	0.00	0.00	
	<i>SD time</i>	0.06	0.08	0.01	0.00	0.00	

Note: SD = Standard deviation, Source: Own calculation based on panel data of 1988–2008

In case of owned land, the shifting rate from the original category to another category is less than the farm movement in total farm size. About 58 percent marginal, 68 percent small, 54 percent medium and 81 percent large farms retain their previous farm categories. Although the shifting pattern within categories are the same as in total farm size, their magnitudes of movements are less than total farm size. The rates of household movements towards the landless category are also slower. In fact this rate is zero for large farm. These indicate that rural households are less likely to shift their land ownership rights to others; even if they are not directly involved in farming activities.

Additionally, the probability matrices also exhibit much more variability over regions than time. On an average, more than twice the standard deviation across regions over time implies that the changes of farm size and owned land in different regions are much higher than their changes over time.

3.2 Projected changes of farm categories based on farm size and land ownership patterns in rural areas

Like many other developing countries, projected results show that number of small farms is increasing over the years, whereas large farms number is decreasing gradually. The two sets of forecasts provide a clearer view of the future agricultural land structure in Bangladesh. In terms of farm size, the distribution of marginal, medium

and large farms are projected to decrease from the base period of 2008 (Figure 1). Conversely, based on owned farms, the future distribution of marginal and large farms will increase, while numbers of small and medium farms are going to decrease compare to the base period.

These forecasts indicate that more people will leave agricultural activities but they will not relinquish ownership of the land. All of these patterns imply that marginal and large landowners will reduce their farming activities or even leave farming activities by renting out their land to small and medium farm groups. Based on these predictions it can be assumed that average farm size of small farm will increase a little compared with the current situation.

3.3 Labor occupational mobility of rural households

The distribution of transition probabilities generally explains the results of the mobility (Table 2). The average transition probability matrix reveals lesser variability over time than region. Standard deviations over time is on an average half or less than half compared to the standard deviations across regions, which indicates changing occupation in different regions are much higher than they change it over time.

Among the diagonal elements, the highest value is found in farm and migration-based households. In this sub-group, 62 percent of households did not change their

Figure 1: Actual and projected size distribution of farms for the period of 2008-2018-2028. Source: Author's own computation

Table 2: Average transition probabilities and standard deviations across regions & time of rural households

Household labors occupation in 2008 (%)											
	Crop	Agricultural					Part-time farming				Total
		Non-crop	Crop& Non-crop	Ag. wage	Farm & ag. wage	Non-farm	Farm& labor	Farm & service.	Farm & self	Farm& mig.	
							vii	viii	ix	x	
	i	ii	iii	iv	v	vi	vii	viii	ix	x	xi
Crop	32.07	1.74	19.50	2.43	5.41	0.74	2.10	7.44	8.22	20.35	100
SD region	0.11	0.02	0.10	0.03	0.03	0.01	0.03	0.05	0.05	0.16	
SD time	0.13	0.02	0.05	0.01	0.04	0.01	0.02	0.05	0.08	0.02	
Non-crop	5.09	40.74	8.34	0.93	0.00	1.39	2.08	16.20	9.03	16.20	100
SD region	0.19	0.33	0.38	0.02	0.00	0.03	0.05	0.19	0.18	0.19	
SD time	0.07	0.13	0.12	0.01	0.00	0.02	0.03	0.12	0.13	0.12	
Crop& non-crop	21.71	6.59	26.69	2.96	8.04	0.65	3.65	8.02	11.54	10.15	100
SD region	0.09	0.06	0.11	0.03	0.07	0.02	0.04	0.11	0.08	0.11	
SD time	0.07	0.02	0.02	0.00	0.07	0.01	0.02	0.05	0.05	0.02	
Ag. wage	2.83	6.90	3.38	26.88	11.46	6.28	15.22	6.73	10.16	10.16	100
SD region	0.04	0.10	0.06	0.21	0.08	0.12	0.14	0.08	0.12	0.08	
SD time	0.02	0.06	0.03	0.12	0.04	0.03	0.01	0.03	0.06	0.01	
Farm& ag. wage	9.45	6.87	12.42	9.23	28.08	1.01	9.44	9.19	10.53	3.78	100
SD region	0.10	0.06	0.09	0.18	0.16	0.02	0.12	0.12	0.09	0.05	
SD time	0.06	0.03	0.06	0.09	0.13	0.00	0.04	0.00	0.11	0.00	
Non-farm	4.58	1.59	4.29	0.00	0.71	33.32	4.29	24.48	13.40	13.34	100
SD region	0.06	0.03	0.09	0.00	0.02	0.25	0.09	0.16	0.14	0.18	
SD time	0.00	0.00	0.04	0.00	0.01	0.13	0.04	0.18	0.02	0.01	
Farm& labor	2.00	0.55	8.66	4.44	4.32	6.71	39.31	9.69	7.09	17.23	100
SD region	0.02	0.01	0.09	0.06	0.04	0.07	0.10	0.06	0.10	0.15	
SD time	0.00	0.01	0.06	0.02	0.03	0.00	0.14	0.04	0.07	0.01	
Farm& service	12.10	1.28	6.90	1.91	3.08	7.63	5.34	39.92	8.65	13.19	100
SD region	0.06	0.03	0.08	0.03	0.05	0.07	0.04	0.13	0.06	0.11	
SD time	0.01	0.02	0.03	0.03	0.04	0.03	0.08	0.01	0.02	0.03	
Farm& self	16.07	5.28	6.74	1.43	3.19	8.15	7.56	4.81	38.15	8.62	100
SD region	0.10	0.04	0.05	0.04	0.03	0.05	0.04	0.06	0.08	0.08	
SD time	0.08	0.03	0.05	0.02	0.04	0.04	0.05	0.00	0.01	0.02	
Faem & mig	4.22	0.60	6.46	1.79	1.90	13.26	5.46	3.37	1.15	61.79	100
SD region	0.09	0.03	0.14	0.09	0.07	0.14	0.13	0.09	0.03	0.22	
SD time	0.06	0.01	0.09	0.03	0.03	0.05	0.08	0.05	0.02	0.30	

Note: SD = Standard deviation; Non-crop= Fisheries, livestock and poultry; Self = Self-employment; Mig. = Migration; Definitions of these specialized groups (under economic activities) are provided in Appendix Table 3.

Source: Own calculation based on panel data of 1988–2008

income-earning source and 13 percent of households left farming activities within last two decades (1988 to 2008). Frequent movements were also found among the groups and sub-groups. Firstly, concentrating on the agricultural households show that 32 percent and 41 percent of households remained in crop farming and non-crop agriculture, respectively in 2008 as compared to 1988.

Rather than this movement, about 38.11 percent of crop farming and 43.51 percent of non-crop based households shifted to part-time farming (vii + viii + ix + x) during that period. Perhaps, availability of microcredit programs induces people to involve in some sort of non-farm activities. Moreover, about 20 percent of households are involved in poultry, livestock and fish production along with farming. The higher standard deviation values of agricultural labor, and the combination of farming and agricultural labor imply that household involvement in these two activities changed more rapidly than others. This is quite normal for agricultural labor, as they are so poor that they always try every possible option for maintaining their livelihood (Hossain and Bayes 2009).

Although, 33 percent of households remain in the non-farm group in 2008 compared to 1988, the rate of movement from other groups to this group is not so high. This may be due to the subsistence farming nature in Bangladesh, where farm households cannot fully leave farming activities even when they are interested in non-farm work. Moreover, around 55.51 percent of full non-farm based households are diversified to part-time farming activities.

That means in the earlier period (1988) those households engaged in only non-farm works are now

shifted to farming activities along with different non-farm works. Hossain (2004) identified the expansion of tenancy market as one of the main reasons for this type of movement. Beside these findings, the most frequent direction of movement is found towards migration from all types of part-time farming. There are approximately 17 percent, 13 percent and 9 percent labor-based, service-based and self-employment based households shifting to the migration oriented households, respectively. These movements from agriculture and other non-farm activities to migration indicate a strong preference of household members to move out of the locality or country. Financially capable household have more possibilities to migrate abroad, whereas poor households move within country.

3.4 Projected changes of household labor's occupation in rural area

To examine the future occupational structure, the estimated transition probability matrix is used to forecast for the years of 2018 and 2028 (Table 3). Both forecasts provide same direction of future occupational changes of the sampled households.

Overall, the forecast suggests decreasing nature of agricultural activities and expansion of part-time farming compared to base period (2008). Households have lost their interest in pure farming activities over the years, as farming alone is not a profitable business in Bangladesh nowadays. Moreover, household's participation in full-time non-farm activities is also increasing. There are drastic drops in the household participation in agricultural wages and a combination of the wage and farming groups. This forecasted

Table 3: Projected distribution of rural economic activity in 2018 and 2028

Economic activity	Percentage in base level (2008)	Projection for 2018 (%)		Projection for 2028 (%)	
		2018	Change	2028	Change
Crop	15.95	13.13	-17.68	12.22	-23.39
Non-crop	4.23	4.75	12.29	4.61	8.98
Crop & non-crop	11.67	11.25	-3.60	10.86	-6.94
Agri. wage	5.63	3.53	-37.30	2.84	-49.56
Crop & agri. wage	6.35	5.38	-15.28	4.86	-23.46
Non-farm	7.06	7.79	10.34	8.43	19.41
Farm & labor	9.36	8.59	-8.23	8.14	-13.03
Farm & service	11.36	11.96	5.28	12.21	7.48
Farm & self-employment	11.92	11.97	0.42	12.18	2.18
Farm & migration	16.49	21.64	31.23	23.63	43.30
Total	100.00	100.00	-	100.00	-

Source: Own calculation based on panel data of 1988–2008

result for agricultural labor is not surprising. They can rent-in more land and cultivate own land more intensively than working other's farms or they can completely shift to the non-farm sector.

4 Conclusion

Analysis of agricultural structural transformation in rural areas during 1988 to 2008 unveils some important insights. Rural households are gradually shifting to non-crop agriculture (poultry or dairy or fisheries), non-farm activities and mostly part-time farming from other income generating activities over time. Among the part-time farming group, the most frequent direction of movement is found towards migration. Moreover, rate of occupation mobility in different regions are much higher than they change it over time. In general, the forecast suggests narrowing of sole agricultural farming and expansion of part-time farming and non-farm activities in future. This type of diversification from pure agricultural activity may be influenced by the reduction of farm size and expansion of the non-farm sector in all-over the country. The results of this study also imply that the agricultural sector is dominated by small farms in past, present and will also in the future. The forecast based on the Markov chain model shows that the numbers of marginal, medium and large farms are going to decrease in future. In contrast, the proportion of marginal and large farms will increase according to their land ownership. Therefore, in general it indicates that average farm size of small landholders will slightly increase. Mostly these marginal and large landowners rent-out their land to small landholders.

The consequences of structural change within agriculture are crucial from the policy point of view. The importance of non-farm activities cannot be denied in the rural economic growth of Bangladesh. Along with the non-farm sector, some adjustments within and outside agricultural sector will help to improve the economic situation of Bangladesh. For instance, opportunities to participate in non-farm activities should be created through establishment of small and medium industries, especially agro-based industries in the rural area. Besides these non-farm job creations, government should take initiatives to start commercial farming or expansion of large farming.

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References

- BBS, Statistical yearbook of Bangladesh, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, 2016
- BBS, Census of agriculture 2008. structure of agricultural holdings and livestock population, Vol. 1, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, 2010
- Edwards C., Smith M.G., Peterson R.N., The changing distribution of farms by size: a Markov analysis, *Agric. Econ. Res.*, 1985, 37, 1–16
- Goddard E., Weersink A., Chen K., Turvey C.G., Economics of structural change in agriculture, *Canadian J. Agric. Econ.*, 1993, 41, 475–486
- Hossain M., Rural non-farm economy-evidence from household surveys, *Econ. Political Wkly.*, 2004, 39, 4053–4058
- Hossain M., Bayes A., Rural economy and livelihoods insights from Bangladesh, A H Development Publishing House, Dhaka, 2009
- Katega I.B., Lifuliro C.S., Rural non-farm activities and poverty alleviation in Tanzania a case study of two villages in Chamwino and Bahi districts of Dodoma region, Research report 14(7), REPOA, Dar es Salaam, 2014
- Lowder S. K., Skoet J., Raney T., The number, size, and distribution of farms, smallholder farms, and family farms worldwide, *World Dev.*, 2016, 87, 16–29
- Tweeten L.G., Causes and consequences of structural change in the farming industry, Report No. 207, National Planning Association, Washington D.C., 1984
- Massey D., Spatial divisions of labour: Social structures and the geography of production, 2nd ed., Routledge: London, 1995
- Piet L., The evolution of farm size distribution: revisiting the Markov chain model, In: Proceeding of the 12th Congress of the European Association of Agricultural Economists (26–29 August 2008, Ghent, Belgium), 2008
- Pramanik S., Deb U., Bantilan C., Rural non-farm economy in Bangladesh: Nature, extent, trends and determinants, In: Proceedings of the 8th Conference of the Asian Society of Agricultural Economists (ASAE) (5–17 October 2014, Dhaka, Bangladesh) Dhaka, Bangladesh, 2014
- Tonini A., Jongeneel R., Dairy farm size restructuring in Poland and Hungary, In: Hinnens-Tobraegel L., Heinrich J. (Eds.), *Agricultural Enterprises in Transition: Parallels and Divergences in Eastern Germany, Poland and Hungary*, Wissenschaftsverlag, Stud. Agric. Food Sect. Centr. East. Eur., 2002, 15, 317–339
- URT, National strategy for growth and reduction of poverty, United Republic of Tanzania, Dar es Salaam, 2005
- World Bank, Tanzania rural investment climate assessment: Stimulating nonfarm micro enterprise growth. sustainable development network, Eastern Africa country cluster 1, Africa Region, World Bank, Washington D.C., 2007
- Zimmermann A., Heckelei T., Differences of farm structural change across European regions, Discussion paper 4, Agricultural and Resource Economics, University of Bonn, 2012a
- Zimmermann A., Heckelei T., Structural change of European dairy farms – a cross-regional analysis, *J. Agric. Econ.*, 2012b, 63, 576–603

Appendix

Table 1: Definitions and proportion of household participations in economic activities

Specialized farm type	Definition*	% of total observation (N=510)		
		1988	2000	2008
Crop	Household earns $\geq 2/3$ of gross income from different farming activities including crop and/or horticulture	25.34	14.50	15.95
Non-crop	Household generates $\geq 2/3$ of gross income from livestock and/or fisheries and/ or poultry	0.90	3.52	4.23
Crop & non-crop	Household generates $\geq 2/3$ of gross income from both farming and other agri. activities	9.70	11.78	11.67
Agricultural wage	Household generates $\geq 2/3$ of gross income from off-farm activity	14.09	6.81	5.63
Farm & agri. wage	Household generates $\geq 2/3$ of gross income from farming and off-farm activity	7.95	6.51	6.35
Non-farm	Household generates $\geq 2/3$ of gross income from totally non-farm activity	6.79	6.95	7.06
Farm & labor	Household generates $\geq 2/3$ of gross income from farming and labor-based work in rural non-farm sector	8.56	6.74	9.36
Farm & service	Household generates $\geq 2/3$ of gross income from farming and rural service sector	11.84	13.86	11.36
Farm & self-employ	Household generates $\geq 2/3$ of gross income from farming and self-employment activities like business	13.39	15.89	11.92
Farm & migration	Household generates $\geq 2/3$ of gross income from farming and migration (both internal and overseas).	1.42	13.45	16.49
Total		100.00	100.00	100.00

Note: N= number of total observation

* Author's own specifications based on Zimmermann & Heckeley (2012a) and Pramanik *et al.* (2015)

Source: Own calculation based on panel data of 1988–2008

Table 2: Proportion of farm households in different farm categories based on owned and cultivated land per household

Farm category	% of total observation based on farm size			% of total observation based on owned land		
	1988 (510)	2000 (509)	2008 (553)	1988 (593)	2000 (509)	2008 (459)
Marginal	27.36	35.83	36.17	27.56	35.04	38.10
Small	46.53	44.70	47.92	50.00	45.29	43.81
Medium	22.55	16.92	14.29	20.94	17.01	15.24
Large	3.56	2.55	1.63	1.50	2.66	2.86
Total	100.00	100.00	100.00	100.00	100.00	100.00

Note: N= Figures in the parentheses indicate number of total observation.

Source: Own calculation based on panel data of 1988–2008