EVOLUTIONARY ASPECTS OF PEASANT PRODUCTION UNITS OF TERRITORY MANAUS AND SURROUNDINGS

Jesse Rodrigues dos Santos[1]

ABSTRACT

This paper presents the results of the application of factorial analysis in an evolutionary approach to the processes of economic change in Family Peasant Farms (FPF) located around Manaus (AM). We obtained the survey data through georeferenced forms filled during technical visits to FPF. Then we applied the factorial analysis technique R on the database in order to identify factors that indicate causal aspects of differentiation in adaptive trajectories of FPF. The results revealed four factors by which we analyzed two clusters of production systems located in territories with ecosystemic similarities. Thus, it shows the similarities and differences, between the analysed FPF, related both to their production systems as those territorial aspects.

KEYWORDS: Evolutionary Economics, Peasant Family Production Units, Factoriaç Analysis, Adaptive trajectories.

1. INTRODUCTION

The Peasant Family Production Units (PFPU)[2] are peculiar institutional structures formed by a group of individuals living and exercising economic activities in the family. These peasant families live in a territory and interact with the ecosystem and the institutional environment, aiming to ensure the physical and social reproduction of its members. In order to achieve this goal, the family, embeded by a reproductive pattern, consisting of consumer habits and a production system consisting of a combination of productive activities, employ family labor in the production of use values and goods (COSTA, 2012).

It is assumed that the PFPU evolve over the time through economic changes in their production systems that may result from both outside interventions and endogenous initiatives. In the latter case, it is assumed that the PFPU use their responsiveness to reproductive stress imposed by the surrounding socio-economic system. This reactive property, in turn, is associated with the availability and quality of family labor. Thus, this

[1] PhD on Social and Environmental Development at Amazon Senior Center Studies (NAEA) at the Federal University of Pará (UFPA). Economist at the Superintendency of the Manaus Free Trade Zone (SUFRAMA). jesse.edsa@gmail.com

[2] The expression PFPU defines what those Costa (2000) classified as having its area comprised of between one and 200 (two hundred) hectares and employing a maximum of 50% of the workforce as waged labor.

attribute, family labor, a source of innovations becomes, whose purpose is to raise levels of reproductive efficiency, reconfiguring and diversifying their standard of productive activities through changes in their labor routines. This diversification results in a variety of adaptive paths that correspond to the evolutionary chain of technical solutions built, implemented and rebuilt throughout history of PFPU differentiating them in the territories where they are located.

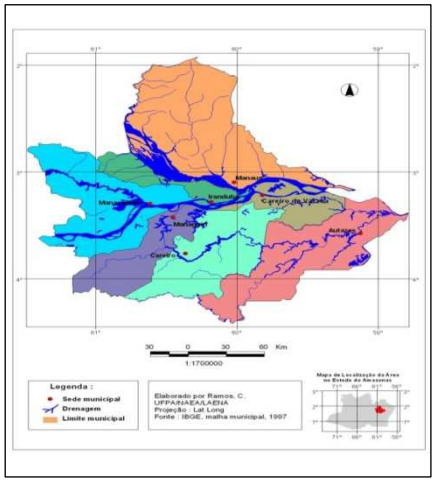
From these assumptions, the research problem can be stated through a primordial question: **What factors influence the economic changes and differentiate the evolutionary trajectories of the PFPU?** The construction of the answer was based on an evolutionary approach so that the initial question had to be split into two: i) In what levels the concepts of evolutionary economics may be applied in comprehensive studies on the mechanisms of change in economic trajectories of the PFPU? ii) What perception of evolutionary proceSESs in progress at the productive systems of PFPU may be produced by applying an evolutionary analytical framework? These issues are fundamental in analytic structure built from the possibilities and limits of treatment of economic changes in PFPU in evolutionary perspective.

The central hypothesis is that the evolution of PFPU describes different paths conditioned by exogenous and endogenous aspects. Exogenous aspects correspond to the injunctions of the institutional environment and the ecosystem in which the peasant families live and work. Endogenous aspects are associated with the process decision which results - or not - in innovative investments that alter the reproductive efficiency level of PFPU. Starting from these assumptions, it has established itself as objective to understand the differences in the trajectories of productive peasants of PFPU systems through an evolutionary analytical framework.

This paper is the result of the work done to achieve this goal. It is presented here a technique for obtaining and processing economic data for a set of PFPU, located in four counties located around Manaus, using factorial analysis. This exercise revealed four factors that explain the differences observed among the PFPU involved in the research, considering its economic characteristics and the territories where they are situated. The following are the theoretical and methodological aspects of the work and a summary of the results obtained for two types of production systems of groups based in similar natural environments.

2 CONTEXT AND CRITERIA OF FIELD RESEARCH

The research context is the micro-region of Manaus, presented in Map 1. Its geographic support is contained in the quadrilateral limited by the parallel 2º00'S and 4º30'S and the meridians of 58º30'W and 61º30'W.



Map 1 – Micro-region of Manaus.
Source: IBGE – Conty Mesh, 1997.

For convenience in data collection and analysis, production systems visited were classified as social-ecological system (SES) where they are located. The SES is derived from the concept and consists of Institutional Economics "[...] bound intrinsically ecological system and influenced by one or more social systems." (ANDERIES; JANSESN; OSTROM 2004, p. 3). Based on this concept, the SES are considered in this paper as complex adaptive systems involving smaller subsystems - the PFPU - and at the same time, are embedded in wider systems - the institutional environment and the natural environment. So, we have a web of interrelationships based both on existing social relations in an institutional environment, the interactions between human populations and the natural environment.

The concept of SES was employed by interconnecting the PFPU interactions versus institutional environment and PFPU versus natural environment, which allows us to concatenate the ongoing phenomena in the field of production and cultural and economic circulation. In this way, the economic results and environmental impacts are perceived as socio-ecological products, that is, dependent on both social relations as of anthropogenic interventions on nature for economic production. Thus integrating the social and ecological dimensions, one might consider the area where the survey data are obtained as a socio-

historical construction cumulative and enable the perception of singularities that influence the conformation of adaptive trajectories of PFPU.

The Chart 1 shows the visited SES and relates to the counties in whose territory they are located. Altogether, were analyzed data about several PFPU located in ten (10) SES located in four (4) counties.

SES	COUNTY
Janauacá Lake	Manaquiri
AM 070 highway and roads	Iranduba
Purupuru Lake	Careiro
BR 319 highway	Careiro
Settlement Panelão (Big Pot)	Careiro
Large Acará River	Autazes
Rural surroundings of Autazes	Autazes

Chart 1 – SES visited in the field research.
Source: Author elaboration.

The Chart 2 presents the results of an effort for the aggregation of productive systems (Sp) and socio-ecological systems (SES) in analytical categories defined by their economic characteristics.

Specific Production Aggregate Systems (S_Pas), S=(1,2)	
Name	**Features**
1_Pas	The income from Manioc cultivation is larger than others in the gross income
2_Pas	The fishing or fish farming have the largest share in the gross income
Socio-ecological systems (SES) Aggregates (SES_A),	
Name	**Features**
SES_1	Highlands with highways and roads
SES_2	Highlands with streams and lakes

Chart 2 - Strategy aggregation of production and socio-ecological systems.
Source: Author's elaboration.

The concrete production systems were grouped in the category Production Systems Aggregates Specific [S_Pas where E=(1,2)] including the PFPU in which an activity is necessary for its predominance in the composition of gross income. SES visited - shown in the Chart 1, were aggregated into two major groups [SES_A where A = (1,2)]; the SES_1 located on highlands permeated by highways and roads; and the SES_2 located on highlands interspersed with streams and lake formations. This stratification made possible the synthesis

of observations on different production systems and the application of factor analysis technique.

It was estimated a random sample stratified by two procedures. First, it was estimated to calculate the total sample, n. The calculation was performed using the following format:

n = (Nz2p (1-p)) / (d2 (n-1) + z2p (1-p)) where: (1)

n = total sample;

N = total population of PFPU in the four counties;

z = level of confidence;

d = absolute precision or error;

p = expected proportion of the variable reproductive efficiency in the population.

Then, with values of n, the sizes of the strata have been estimated by the model:

nh = (Nh / N) Σn, where: (2)

Nh = population stratum of PFPU in the specific municipality;

nh = sample size of strata;

Σn = nh sum.

Table 1 - Sample Sizing

Strata	N_h	Planned observations (nh) with 7% error
Autazes	1.168	12
Careiro	2.686	28
Iranduba	1.678	18
Manaquiri	1.425	15
N, n	6.957	73

Source: Author's elaboration (2009).

The results of applying this algorithm to calculate the sample, shown in Table 1 were obtained by assigning to the variable ***d*** the value of 7%, to the variable ***p*** the value of 76.5% to the varible ***N*** value 6.957 and adopting a level of 90% reliability. From these conditions the model indicated a viable sample amounting to 73 (seventy-three) PFPU to visit. However, during the field work, this number was increased to one hundred (100) PFPU among which were filled eighty (80) georeferenced forms of data collection.

The database analysis was performed using statistical techniques to: i) provide descriptively data through matrix where the Pas are correlated with SES_A; and ii) conduct a factorial analysis using the R software (CORE TEAM, 2009) to identify factors that group the PFPU around two ideal types: i) the Peasant Integrated Production Market, by incorporating technologies and diversification of production; and ii) the Peasant Occasional Production for the Market, dominated by production for self consumption associated with occasional insertion in the market and the income of the PFPU has strong participation of social benefits. This procedure generated **the factors that indicated the differences among the PFPU and allowed the grouping of the observations in relation to these factors**. From these results, it was identified characteristics that indicate the PFPU evolutionary trends in the market depending on their integration propensities, i.e., a model with which to characterize the PFPU and place them in evolutionary trajectories.

3 ANALYTICAL FRAMEWORK

The core of the analytical framework are the assumptions of economic theory of evolutionary change proposed by Nelson and Winter (2005) who elect the dynamics of labor routines as the object of study to understand the economic evolution. Labor routines are defined as decision rules or regular and predictable behavioral patterns of organizations. They are embeded rule systems of technical knowledge and information that characterize and drive the organizational behavior. In this sense, the dynamics of labor routines represent continuous search for solutions to trivial and unusual problems through experiments in unique environments within specific technological paradigms (DOSI, 1982).

Over time, the labor routines diversify and disseminate thenselves among PFPU in the SES, and are selected through the interactions among organizations and the institutional environment and relations with the ecosystem. The development of production systems consisting of self-organizing movement through the construction or acquisition of knowledge during continuous interaction with the natural and institutional environment. This process is revealed in the dynamics of labor routines, whether by modification, addition or deletion in the productive systems of PFPU.

Nelson (1995) presents a possibility of evolutionary approach to PFPU without necessarily using empirical references on historical data series, but through aspects of analysis of their present condition[3]. Accordingly, the interest of this research is to present aspects of the change mechanisms that operate on the productive units in its current state: the factors that contribute to the differentiation of trajectories. In other words, it is to identify and systematize, through the study of the institutional environment associated with the analysis of production systems, the crucial aspects of evolutionary trajectories that follow the PFPU.

Costa (2012) uses the concept of **reproductive efficiency** to understand the logical of innovative investment in PFPU. According to this author, investments consist of reactions to the pressures of the institutional environment[4] that are reflected in the dynamics between efficiency and **reproductive tension**. Therefore, it is plausible to assume that reproductive efficiency is directly linked to the labor routines of PFPU. It is likely that the peasant families intuitively evaluate the efficiency of labor routines and to select then according the returns they provide in economic terms.

The analysis of the trajectory of economic change resulting from innovative investment resulting from this process can be performed by observing the changes in the amount of the **balance budget *He*** of the PFPU. This change is caused by the pressure of reproductive needs on the **labor budget *Hr***, determining the quantity and quality of labor that PFPU have to invest to overcome the pressure from the institutional environment. The struggle for change is limited by the availability of existing labor time ***Ht*** in PFPU, but is enhanced by the advance of mechanization and the use of chemical products on the agricultural sector, as well as the instructions for use of labor time available in PFPU. The reproductive effort of the PFPU tends to minimize the difference between the actual amount of labor time ***Hr*** and required ***He***.

Costa (2012) derived an index ***h*** of transformation of labor expended on reproduction means is the measure of reproductive efficiency of PFPU. This author defines ***h*** with a total labor rate of transformation applied to the means of reproduction of PFPU. By deduction, **h=(He/Hr)**. Formally, ***He*** is defined as a **balanced budget** that enables the

[3] Nelson (1995) presents two possible approaches in evolutionary theory: a) understanding the dynamic process that causes changes in a variable or set of variables over time; or b) special understanding of the current state of a variable or a system event in order to come to the current state occurs. (Emphasis mine).

[4] It is included within the institutional market environment where the commercial capital imposes an exploitation rate α in commercial transactions with the PFPU.

perpetuation of PFPU. In turn, ***Hr*** is the amount of labor achieved by multiplying the quantity of equivalent workers in the PFPU by the time unit of the working day.

One way to obtain reference values for reproductive efficiency, ***h*** is to use proxies for the categories ***He*** and ***Hr***. Costa (2012) offers the option of recourse to the familiar labor time applied in specific productive activities related to the products that make up the portfolio of PFPU, defined by $\boldsymbol{W_{LCi}}$. Like this,

$$H_r = \Sigma W_{LCi} \quad (1)$$

The transformation of labor allocation in a ***He*** budget of reproduction means occurs through a rate determined by the quality of the PFPU interaction with the market and may be obtained by the relationship:

$$H_e = \frac{1}{(1+\alpha_1)(1-\mu_1)} W_{LCi} + \cdots + \frac{1}{(1+\alpha_n)(1-\mu_n)} W_{LCn} \quad (2)$$

In the way, the ***h*** index, ranging between 0 and 1, is obtained and it and represents how much the PFPU take advantage of each unit of labor expended for self-reproduction. Thus, insofar as ***h*** approaches 1 (one) it indicates the growth of economic efficiency of the PFPU; when it tends to 0 (zero) it indicates the crisis of the reproductive pattern of the production unit due to low efficiency of its production system. Therefore, ***h*** expresess the synthesis of the conditions for family self-reproduction and the conditions set by the institutional environment.

The reproductive tension is the antithesis ***δ=1/h*** of reproductive efficiency ***h***, representing the stresess exerted by the institutional environment and making noticeable changes in the reproductive efficiency of PFPU (COSTA, 2012). Thus, ***δ*** expresses the tension resulting of increased workload ***Hr*** required to ensure a satisfactory budget somewhere between ***He*** and ***Ht***. Hence, the PFPU does not have full control over ***Hr*** because its value depends on the tension from engaging socio-economic system, that is, market structures in which they operate and the exploitation rate ***α*** they impose on commercial transactions.

In such conditions the PFPU turn its reproductive pattern into a governance structure to deal with risks, uncertainties and consequent transaction costs of market share in order to ensure the efficiency ***h*** of reproductive pattern. The dynamics of ***h*** induces the PFPU to change their reproductive patterns, especially through adjustments in labor routines that

regulate their production systems. This phenomenon does not occur seamlessly and differs in the Amazon region, creating different trajectories in different territories.

The concept of reproductive efficiency ***h*** has been adapted for use in this research, using as reference the relationship between investment of family labor time in each group of activities. Starting from the model presented by Costa (2009), here there is a version compatible with the data collected in the field research.

$$h = \frac{He}{Hr} = \sum h_i \eta_i \quad (3)$$

In this version:

$$h_i = \frac{1}{(1+\propto)(1-\mu)} \quad (4)$$

$$\eta_i = \frac{W_{LCI}}{H_R} \quad (5)$$

Where $\boldsymbol{\alpha}$ is an exploration taxe imposed by the mercantile capital in transactions with the PFPU, arising from market structures and logistical aspects of the movement of goods. And $\boldsymbol{\mu}$ is the coefficient of self-consumption of own production of PFPU. For the purposes of calculations performed in this paper, it was considered an average value of 0.10 for **α**, while the **μ** values were obtained from the data collected in the PFPU. With this data, there were individual estimates of **h** levels for PFPU visited in the field research.

4 PATHS DIFFERENTIATION MODEL - MFdt

The model proposed in this approach is **appreciative** according to Nelson and Winter (2005) and **evolutionary** towards Nelson (1995), because it is intended to **understand the object of study through the mechanisms that determine their evolutionary trajectory**. We try to reveal the current configuration of production systems and elaborate conjectures about how they reached the point where they are nowadays and what determine their trajectory. The essential principle of the approach of Nelson and Winter (2005) preserved in the model maintains that the changes occur at the level of labor routines of production units. Finally, this model is considered as **exploratory** because it tries to establish itself as an initial and experimental method of identify evolutionary trajectories in the peasant production systems.

4.1 DESIGN THE *MFdt MODEL* BY THE ANALYSIS FACTORIAL *R*

Factorial analysis is a technique defined by Pestana and Gageiro (2005, p. 487) as "[...] a set of statistical techniques that seeks to explain the correlation between observable variables, simplifying the data by reducing the number of variables necessary to describe them." Thus, by aggregating the variables factors, we tried to identify the elements that reveal the causes of trajectories differentiations and allow us to understand the mechanisms of change in progress in the PFPU.

The premise of factorial analysis is that the covariance and correlations between observable variables result of its relations with underlying variables or concepts designated by common factors. According to Spider, (2008) the variability in the data can be explained by a few factors that group variables. These factors are the dimensions underlying the object of study and that are not directly observable by the variables, but express something in common existing in the original variables.

In this paper, we used the exploratory analysis, applying the Factorial Analysis R [5] in search of likely clusters between the database variables. This exercise sought to identify causal relationships between variables, discussing the reasons why the variables are associated linearly. In this regard, possible explanation is causation correlations among variables, that is, how they are interrelated.

The Kaiser-Meyer-Olkin (KMO) and Bartlett's sphericity receives the correlation between the variables which makes possible the continuation of factor analysis. This value ranges between 0 and 1 and is considered reasonable from 0.6 to 0.7, average between 0.7 and 0.8, between 0.8 and 0.9 good good world and between 0.9 and 1 (Pestana; GAGEIRO, 2005, p 491.). The values obtained with the sample data, were 0.716 for the KMO and 1,403.88, above the critical value of Bartlett, indicating the feasibility and significance of the application of factor analysis.

[5] It is used Factorial Analysis R for identifying and verifying relationships between variables to identify groups of variables that form latent dimensions, i.e., the factors.

Table 2 – Variables and the matrix of rotated factors

Original variables		Factors resulting						
Denominação	Código	1	2	3	4	5	6	7
Flooded area for fish farming	X_1	**0.836**	0.069	-0.024	0.075	0.103	0.038	0.120
Income from fish farming	X_2	**0.782**	0.256	0.022	0.006	0.095	0.108	0.309
Goods for consuming and to work	X_3	**0.770**	0.107	-0.008	0.091	-0.266	-0.245	-0.017
Extra PFPU labour force payment	X_4	**0.747**	0.238	-0.091	0.061	-0.174	-0.196	-0.200
Reproductive efficiency of PFPU	X_5	**0.676**	**0.635**	-0.029	0.060	-0.141	0.011	0.122
Gross income from cattle and agricultural	X_6	**0.669**	**0.648**	-0.023	0.049	-0.125	0.024	0.106
Agricultural income	X_7	0.017	**0.925**	-0.058	0.188	-0.081	-0.099	-0.100
Bilt area of greenhouses	X_8	0.346	**0.830**	-0.018	0.112	0.045	-0.007	0.176
Signed credit agreement by PFPU	X_9	**0.477**	**0.677**	-0.029	0.059	-0.021	-0.020	0.217
Expenditure on inputs	X_{10}	0.139	**0.620**	-0.033	0.228	-0.103	-0.219	-0.096
Income from the creation of small animals	X_{11}	-0.044	0.017	**0.883**	-0.280	-0.072	-0.133	-0.004
Income resulting from fishing	X_{12}	0.013	-0.084	**0.848**	0.158	0.025	0.084	-0.091
Labor income earned out of PFPU	X_{13}	-0.056	0.023	**0.774**	-0.340	0.047	-0.208	-0.010
Fisheries closure insurance	X_{14}	0.009	-0.105	**0.709**	0.332	0.196	0.228	-0.082
Cultivated area of domestic agroforestry	X_{15}	-0.088	0.023	0.525	**-0.501**	-0.282	0.112	-0.025
Electricity availability in the SES	X_{16}	0.001	0.170	-0.123	**0.724**	-0.081	-0.050	0.210
Occurrence of irrigation in PFPU	X_{17}	0.129	0.361	0.062	**0.723**	-0.067	0.028	0.008
Family membre under 14 years old	X_{18}	-0.080	-0.029	0.021	0.004	**0.833**	-0.137	-0.148
Self- consumption	X_{19}	-0.178	-0.137	0.089	-0.488	**0.543**	0.133	0.035
Social benefits and social security	X_{20}	-0.080	-0.062	-0.010	-0.029	-0.131	**0.829**	-0.030
Family Grant received by the family	X_{21}	-0.026	-0.182	-0.050	-0.042	0.476	**0.517**	-0.138
Training of producers	X_{22}	0.087	-0.045	-0.066	0.099	-0.133	0.025	**0.855**
Technical Assistance available for PFPU	X_{23}	0.171	0.218	-0.119	0.108	-0.071	-0.335	**0.526**

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 8 interations.
Source: Field research (2009).

Table 3 presents the original variables and the matrix components rotated by orthogonal Varimax method. This matrix gives the correlation between the original variables and factors obtained. This is the first exercise aggregation of variables to identify aspects of the sample, the perception is not observed when such variables separately. It considered the relevant factors from the groups of variables with correlation levels above 0.5 each other. Therefore, after applying the orthogonal spin on the original data, gathered variables with statistical clustering possibilities factors.

Table 3 – Total explained variance – (%)

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.728	29.254	29.254	6.728	29.254	29.254	3.845	16.719	16.719
2	3.010	13.086	42.339	3.010	13.086	42.339	3.634	15.801	32.520
3	1.811	7.874	50.213	1.811	7.874	50.213	2.942	12.791	45.311
4	1.570	6.828	57.041	1.570	6.828	57.041	2.017	8.770	54.081
5	1.427	6.205	63.246	1.427	6.205	63.246	1.568	6.819	60.900
6	1.151	5.005	68.252	1.151	5.005	68.252	1.411	6.137	67.037
7	1.105	4.806	73.058	1.105	4.806	73.058	1.385	6.021	73.058

Extraction Method: Principal Component Analysis.
Fonte: Elaboração do Autor

Table 3 presents the percentage of total variance explained in the model variables that are explained by all and each of the factors extracted from the factor analysis, presented in Chart 3, below. Together, the seven factors explain 73% of the total variance, indicating their model explanatory power for specific issues raised by the original variables. However, the first four factors apply 57%, while others, such as lower explanatory power, together explain 16% of the variance. Thus, the first four factors revealed a differentiated explanatory power and therefore were elected as the most interesting to understand the current pattern of differentiation of evolutionary trajectories in the analyzed PFPU.

Factor 1 - Integration to the market by diversifying production load variables	**Variable**	**Load**
This factor gets together six variables. Two are related with the income earned in market transactions due to the increase in consuming and labour goods values at the level of reproductive efficiency and the ability to employ extra-familial workforce. There is, then, a process of integration to the market represented by the increase in gross income of PFPU, together with the diversification of production. It is inferred that the increased income resulting from the economic and technical capacity to put these technologies in the production system.	X_1	0.836
	X_2	0.782
	X_3	0.770
	X_4	0.747
	X_5	0.676
	X_6	0.669
Factor 2 - Integration to the market by diversifying agricultural activity	**Variable**	**Load**
This factor is constituted by the aggregation of five variables, two of which related directly to agriculture, especially to crops in greenhouses - plasticulture. Then come the credit and the cost of inputs. The variables "reproductive efficiency of PFPU" and "Gross income from cattle and agricultural production" are also significant for this factor, despite the higher correlation requires their inclusion in the Factor 1 - see Table 2 above. This factor indicates the integration to the market through diversification of agricultural activity in the productive system of PFPU	X_5	0.635
	X_6	0.648
	X_7	0.925
	X_8	0.830
	X_9	0.677
	X_{10}	0.620
Factor 3 – Production for subsistence with occasional integration market	**Variable**	**Load**
Factor 3 results from the group of variables related to artisanal fishing activity, the income from poultry and the income from work outside the PFPU. Field observations indicate that these activities are typically for familiar subsistence, very common in PFPU where productive systems only occasionally produce goods. The priority of the production is the self-consumption and income is complemented by the work outside the PFPU and social benefits. Therefore, it appears that this factor evidencing the slope of PFPU for the production for subsistence which does not mean that thouse families dont get any income from the sale of its surplus production.	X_{11}	0,883
	X_{12}	0,848
	X_{13}	0,774
	X_{14}	0,709
Factor 4 - Change associated with the availability of energy and technology	**Variable**	**Load**
This is one of the most complex factors in the model. Their formation results from the aggregation of three variables, with one showing negative correlation with the other. The presence of electricity networks indicates the emergence of the conditions for experiments with more complex technologies and is associated with changes and additions of new labor routines. Thus, the factor analysis provided a relationship between these variables, where the presence of electric power has positive correlation with investments in irrigation and negative with the domestic agroforetry typical representatives of traditional technologies sites.	X_{15}	-0,501
	X_{16}	0,724
	X_{17}	0,723

Chart 3 - Factors extracted in the factor analysis.
Source: Data drawn up by the author.

4.2 THE RESULTS OF *MFdt MODEL* APPLICATION

Sample data for Specific Production Systems Aggregates (S_Pas) were divided into matrices in which are grouped into lines as the factors obtained in the factorial analysis and separated into columns according to the SES_A where the PFPU is located. It was considered for comparison purposes, the average values of these variables for each SES_A and Coefficient of Variation (CV), which allows obtaining the proximity level of the absolute data in relation to the average values, i.e. the degree of homogeneity of cases joined in the same S_Pas. Thus, the matrix has central values and the degree of homogeneity for each variable in different SES_A where the same S_Pas occurs. The intention is to show the characteristics of S_Pas itself, as well as variations in relation to different SES_A.

The data of Table 4 presents the average values for the 1_Pas, i. e., the aggregate productive system that comprises the PFPU where Manioc cultivation is the main activity in terms of its contribution to the composition of income.

Table 4 - Distribution of data inserted by the production system in SES_1 and SES_2 – 1_Pas

Pas_1	AVERAGE		CV	
	SES_1	SES_2	SES_1	SES_2
Factor 1 - Integration to the market by diversifying production				
Flooded area for fish farming (m^2)	1,080.00	0	2.24	-
Income from fish farming (R$ 1.00)	225.00	0	2.24	-
Goods for consuming and to work (R$ 1.00)	12,420.00	8,322.07	0.89	1.26
Extra PFPU labour force payment (R$ 1.00)	80.00	753.13	2.24	2.78
Reproductive efficiency of PFPU	0.54	0.61	0.83	1.19
Gross income from cattle and agricultural (R$ 1.00)	4,350.43	9,585.75	0.82	1.37
Fator 2 - Integração ao mercado por diversificação da atividade agrícola				
Agricultural income (R$ 1.00)	3,200.43	9,097.61	0.87	1.45
Bilt area of greenhouses (m^2)	0	0	-	-
Signed credit agreement by PFPU (R$ 1.00)	2,600.00	1,076.79	2.24	2.13
Expenditure on inputs (R$ 1.00)	299.00	36.96	1.9	1.03
Factor 3 - Production for subsistence with occasional market integration				
Income from the creation of small animals (R$ 1.00)	25.00	18.86	2.24	2.27
Income from fishing (R$ 1.00)	0	0	-	-
Labor income earned out of PFPU (R$ 1.00)	0	965.36	-	2.75
Fisheries closure insurance (R$ 1.00)	0	0	-	-
Factor 4 - Change associated with the availability of energy and technology				
Cultivated area of domestic agroforestry (ha)	0,05	0.42	2.24	1.58
Electricity availability in the SES_A	60%	11%	1	2.94
Occurrence of irrigation in PFPU	0%	0%	-	-

Source: Field Research, (2009).

* Coefficient of variation.

The values obtained for Factor 1 indicate that the PFPU located in SES_1 diversified their production systems with the inclusion of fish farming, investing in the expansion of the flooded area by building fish ponds and cages. These PFPU also have higher levels of spending on good for consuming and labor than that located in SES_2. However, the average income of the fish farming of the PFPU located on SES_1 is still incipient and does not seem to help overcome the gross income earned by the PFPU located on SES_2, which concentrate their investments in Manioc (*Manihot esculenta*) cultivation. Thus, these PFPU are more efficient, even being able to perform higher expenses with the hiring of extra-familial workforce than that PFPU of SES_1.

Regarding the Factor 2, there have been indications of the little diversification of agricultural activities, focused on Manioc cultivation. However, it is clear that the PFPU located in SES_1 have higher costs of inputs and higher amount of signed credit agreement, which certainly is correlated with their experiments with fish farming. Nevertheless, the income from agricultural activity is higher in PFPU located in SES_2 and indicating a likely cause for the higher level of reproductive efficiency of family labor.

These results indicate that innovative experiments in SES_1 has not provided economic and financial results to increase the efficiency of PFPU that performed those investiments. It is a reproductive pattern whose crisis has not yet been overcome, even with the institutional support. On the other hand, in SES_2, traditional Manioc cultivation get results that indicate an accommodating state of the reproductive pattern and the reduced need to search for change and low willingness to face risks whose returns are uncertain. In these cases, the trajectories tend to diversification related to their socio-cultural aspects such as the improvement of the production of domestic agroforestry.

The Factor 3 shows normal aspects of production systems based on Manioc cultivation. The low rents with small creations is presented as an indicator that these activities serve more to self-consumption, the value of which is significant for these systems - between 48% and 34% on average. Note the amount of income earned by working outside of the PFPU in SES_2 cases, indicating considerable labor market provided by the planting, harvesting, and processing of Manihoc crops.

The Factor 4 indications reveal that the PFPU located in the SES_2 domestic agroforestry have an average of 0.42 ha of planted area, emphasizing its important relationship with Manioc cultivation practiced in these places. In turn, the availability of eletricity networks is more present on the roads and secondary roads allowing investments that require electricity. In the case of these PFPU, the fish farming is induced by the low cost of electricity used to power electric pumps - instead of thouse diesel powered - to move the water from breeding tanks. Irrigation is non-existent because the Manioc cultivation as it is practiced in these PFPU does not require it. On the other hand, its absence indicates that experiments with irrigated agriculture are not common, at least in places where the survey data were collected.

In short, it is inferred that the 1_Pas is led by a traditional activity that in some SES is in the reproductive pattern lifetime, even when they occur incremental innovations in

production processes. One of the featured innovations is the inclusion of fish farming in the portfolios of investments, which implies diversification in the knowledge of producers and their integration in other market segments and institutional environment. It is conjectured that the Manioc cultivation, on the one hand, is restricted by the environmental policies, but on the other is induced by demand of flour and gum coming from metropolitan region of Manaus. These aspects suggest the development of adaptive changes in labor routines in the coming years. Moreover, due to the induction of fish farming, from the institutional environment, increases the probability of a growing number of producers including this activity in their production systems.

The 2_Pas aggregates production systems where incomes from fish farming and fishing are prevalent sobres those from other productive activities - see Table 5. These production systems have structural differences, because fish farming consists essentially in raising fish in captivity, rarely, captured in their habitat for this purpose. In turn, fishing is an activity basically extractive, where animals are captured for sale or self consumtion in the PFPU. As for the institutional structures, there are also differences in relation to the activities that constitute the labor routines and restrictions of environmental and legal order.

Table 5 - Distribution of data inserted by the production system in SES_1 and SES_2 - SpA_4

Pas_2	AVERAGE		CV*	
	SES_1	SES_2	SES_1	SES_2
Factor 1 - Integration to the market by diversifying production				
Flooded area for fish farming (m^2)	11,420.00	0	0.87	-
Income from fish farming (R$ 1.00)	45.290,00	0	1.36	-
Goods for consuming and to work (R$ 1.00)	78.540,00	28,029.00	1.42	0.02
Extra PFPU labour force payment (R$ 1.00)	9.367,00	157.50	1.33	1.41
Reproductive efficiency of PFPU	0,86	0.63	1.16	0.41
Gross income from cattle and agricultural (R$ 1.00)	48.760,00	21,361.25	1.21	0.40
Fator 2 - Integração ao mercado por diversificação da atividade agrícola				
Agricultural income (R$ 1.00)	1.900,00	1,940.00	1.73	1.05
Bilt area of greenhouses (m^2)	1.033,00	0	1.73	-
Signed credit agreement by PFPU (R$ 1.00)	0	0	-	-
Expenditure on inputs (R$ 1.00)	26.060,00	10	1.60	1.41
Factor 3 - Production for subsistence with occasional market integration				
Poultry income (R$ 1.00)	0	391.25	-	1.2
Income from fishing (R$ 1.00)	0	14,280.00	-	0.04
Labor income earned out of PFPU (R$ 1.00)	5.333,00	0	0.94	-
Fisheries closure insurance (R$ 1.00)	0	1,676.00	-	0.1
Factor 4 - Change associated with the availability of energy and technology				
Cultivated area of domestic agroforestry (ha)	0	1.5	-	1.41
Electricity availability in the SES_A	100%	0	0	-
Occurrence of irrigation in PFPU	33%	0	1.73	-

Source: Field Research, (2009).

* Coefficient of variation.

The similarity lies in the fact that both have structured their production base on the exploitation of the fish. However, while fishing is a traditional activity, fish farming is considered as an innovative activity that introduces new technologies in production systems peasants accustomed to fishing and other production systems. Thus, this addition carried out plans to produce a comparative analysis between the two labor routines: considering fishing as a traditional activity and fish farming as an innovation perspective inserted in the productive systems of the PFPU.

The Factor 1 presents average values for the variables that comprise it, which show that the fish farm incomes contribute to raise the gross income of the PFPU, and to increase the values of goods for consuming and labor. These average values are the highest among the two S_Pas analyzed, as it includes the machinery and equipment used in fish

farming based in fish ponds. The average values of the costs of extra-familial workforce are considerably higher than those presented by 1_Pas. This aspect highlights the ability of the fish farming has to sustain a labor market in the SES_A were it occurs.

Moreover, reproductive efficiency levels of fish are significantly higher than those observed for the cases of fishing. The values of coefficients of variation, in turn, indicate greater diversity among PFPU dedicated to fish farming in those inclined to fishing. This aspect is because fish farming being implemented in the PFPU, in many cases, is a process of experimentation with these labor routines. In these cases, it is inferred that fish farming is contributing to increasing the income of traditional activities such as livestock and Manioc cultivation.

The mean values assigned to variables related to Factor 2 are similar in terms of income from agriculture as fish farming is combined primarily with plasticulture investments in SES_1. The lack of credit for both activities indicates that, at least in the observed cases, the projects are carried out with own resources, despite the availability of credit. However, these PFPU face impediments in accessing credit to invest in fish farming, due to the difficulties for environmental licensing and in the case of fisheries, in getting the Declaration of Fitness for PRONAF. Thus, it is likely that the PFPU sampled constitute atypical cases, because there is institutional credit supply, since them provided the legal requirements.

Aspects inherent in the Factor 4 indicate a significant inverse correlation between the area of domestic agroforetry and the lack of electricity and investments in irrigation in PFPU located in SES_2. It is noteworthy that in both SES_1 as SES_2 agricultural activities are confirmed by the presence of agricultural income. However, in the PFPU located in SES_1 this activity often consists of combinations of fish farming and plasticulture, activities in which the presence of electricity networks is essential, as well as irrigation systems in greenhouses. On the other hand, the fisheries associated to agricultural activity is related to the activities on domestic agroforetry that do not use irrigation and electricity in their labor routines.

The evolution of 2_Pas trajectory can be split in adaptive trajectories, both associated with two main activities: fishing and fish farming. Fishing is a traditional activity and present in SES_2, i. e., highlands ecosystems permeated by lakes and streams. Is both focused activity for self-consumption and for the integration to the market. In this respect, fish farming is presented as an alternative not only to the complement of fish supply in line with

the fishing, but also for the diversification of production systems based on livestock, in Manioc cultivation and horticulture. Thus, in the case of 2_Pas, innovation follows due to the pisciculture, with the maintenance of artisanal fishing.

5 CONCLUSIVE CONSIDERATIONS

The results show a significant degree of effectiveness of *MFdt MODEL* to reveal the aspects of the differentiations of adaptive trajectories visited PFPU. Innovative trajectories were identified in traditional reproductive patterns, based on the inclusion of labor routines associated with fish farming and plasticulture and accommodative trajectories in reproductive patterns and prevalence of traditional activities, such as cassava and fishing. These standards are important to evaluate the positioning of the PFPU between the Peasant Integrated Production Market and the Peasant Occasional Production for the market.

The application of *MFdt MODEL* could perceive aspects relating to SES_A, which were prevalent in understanding the pattern that follows these innovative trajectories of the PFPU. These aspects are associated with institutional aspects and ecosystem inherent SES_A distinct in that: i) the characteristics of the natural environment increased the viability of investments in productive infrastructure; b) facilitate the logistics of the interventions from the institutional environment as well as the movement of goods produced in the PFPU. In view of these specificities of SES_A where they live, families intuitively perceive the difference between returns and risks and decide whether or not to modify their production systems by including labor routines of farming and the plasticulture.

The aspects related to the innovative dynamics of productive systems by revead by the *MFdt MODEL* have identified the reproductive patterns where there are more prone to innovation and where this propensity tends to zero. Thus, it became clear that the patterns where fishing and Manioc cultivation predominate, has an inclination towards the Peasant Occasional Production for the market. On the other hand, the patterns where these activities are not occurring or not predominant, families, due to institutional and ecosystem factors, tend to invest in new productive activities, modifying or incorporating labor routines. As a result, these families approach the Peasant Integrated Production Market.

These results are interesting both for researchers and scholars of the dynamics of the PFPU as for managers and policy makers and obviously for peasant families understand their condition in the local economy. To get to understand the paths that PFPU develop over time, researchers can adapt their methods and scientific research techniques. Managers and policy makers can understand more clearly and objectively the problems to be faced and the actions most likely come to be effective. In turn, families, with more accurate information, can reduce risk and improve the quality and quantity of the returns of their productive activity. Thus, the *MFdt MODEL* is presented as an incipient technique, but to allow evolutionary promising approaches to the farmer economy. However, it is necessary to further study and carry out the adjustments required by the specific characteristics of PFPU, the surrounding institutional environment and ecosystems.

REFERENCES

ANDERIES, J. M .; M.A. JanSESn; E. OSTROM. A framework to analyze the robustness of social-ecological systems from an institutional perspective. **Ecology and Society**, vol. 9, no. 1, 2004. Available at: http://www.ecologyandsociety.org/vol9/iss1/. Accessed: 10/10/2008.

ARANHA, Francisco; ZAMBALDI Francisco. **Factor analysis in administration**. Sao Paulo: Cengage Learning, 2008.

CORE TEAM, R Development. A: **A language and environment for statistical computing**. Vienna: R Foundation for Statistical Computing, 2009.

COSTA, Francisco de Assis. **Peasant economy on the borders of capitalism**: Theory and Practice in the US and in the Brazilian Amazon. Belém: NAEA, 2012.

DOSI, G. **Technological paradigms and technological trajectories**: the Suggested interpretation of the determinants and directions of technical change. Research Policy, vol. 11, no. 2, p. 147-162, jun. 1982.

NELSON, Richard R .; Winter, Sidney G. **An evolutionary theory of economic change**. Translation Claudia Heller. Campinas: UNICAMP, 2005.

NELSON, Richard R. Recent evolutionary theorizing about economic change. **Journal of Economic Literature**, Nashville, v. 33, no. 1, p. 48-90, sea. 1995.

PESTANA, Maria Helena; GAGEIRO, João Nunes. **Data analysis for social sciences:** the complementarity of SPSS. 4. ed. rev. and ampl. Lisbon: Syllabus Editions, 2005.