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Neolithic Economics: A Case Study in Age, Sex and Labour

Abstract: This paper looks at the hypothesis that the inhabitants of a Linear Pottery house can be described as a patrilocal extended family, comprising the parents and their sons with their wives and children. This hypothesis was tested using a simulation whereby the calculated values were found to correlate positively with the numbers of houses belonging to different size classes. With reference to this household model, the average number of inhabitants was calculated using Early Neolithic life tables. This results in an estimated six to seven persons per household. The age of the household members is taken into account when estimating the total work force per household. Taking into account the abstract character of this value, it is seen mainly as an approach to create a common standard of calculation, which allows the comparison of the workforce per household across time and space. Finally the calculated values, the average number of residents as well as the work force per household, have been upscaled to larger social units of regional importance.

Introduction

In traditional peasant societies labour is one of the most important resources. This paper attempts to estimate the work force of an average household in the Early Neolithic (Linear Pottery Culture or LBK) period. This approach was developed within the scope of the project “Econometrics of the Central European Neolithic” (KERIG 2008).

The lignite area of the Rhineland is the key area for the present research. Here, due to the extensive open cast mining, large scale settlement archaeology has been undertaken (ZIMMERMANN 2002). Within the framework of my Master thesis, more than 400 ground plans of Early Neolithic houses from this region have been recorded.

Modderman observed that LBK houses can comprise up to three sections, and subject to the number of sections, different types of house types were defined (MODDERMAN 1970). The function of the respective sections is unknown (*Fig. 1*).

Although the aforementioned LBK house typology is still valid, it is not useful for the quantitative analyses of house sizes presented here. The transitions between the different sections of any given house are often blurred, thus resulting in an error of measurement running up to 10–20%, i.e. approximately the area of one or two trusses. Meanwhile, the whole area of one house is quite easy to measure. Furthermore those houses comprising three sections have significantly larger sections than

those houses composed of just two parts (*Tab. 4*). In turn, the latter display a significantly larger central section than those houses comprising just this central part of the building (MATTHEUSSER 1994, 88–89).

The Model

The size of LBK houses varies from 40 m² up to 250 m². One explanation for this could lie in social inequality (e.g. VAN DER VELDE 1979, 139), and another in the specific function of particular house types (e.g. MILISAUSKAS 1976, 70). The model postulated here favours a demographic perspective.

Often the family unit residing in one house is described as a nuclear family (e.g. LÜNING 2002, 125). According to the different sizes of the houses, a patrilocal extended family is postulated in the presented paper, suggesting that a household is composed of the parents and their sons with their wives and children. Thus, the size of a household depends primarily on the number of sons.

The assumption that during the LBK patrilocal residence rules were favoured refers to reconstructions of kinship (EISENHAEUER 2003) and migration (PRICE et al. 2003, 50) through the analysis of skeletal data as well as the comparison of regional and local traditions in pottery style and silex technologies (STRIEN 2000, 33).

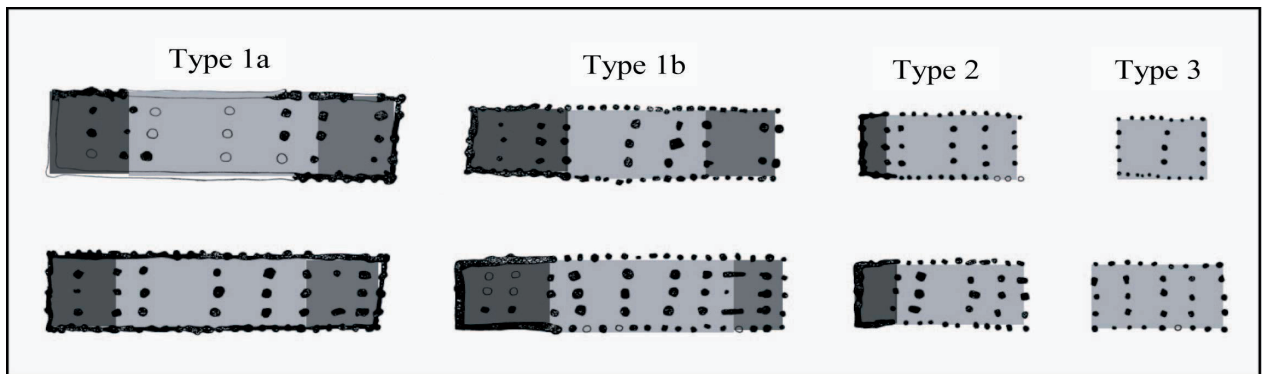


Fig. 1. Typology of LBK houses; the different sections of the structures are highlighted (MODDERMAN 1970, 111; modified).

Simulation

Provided that the population was stationary (cf. NEUSTUPNÝ 1983), monogamy was preferred and the sex ratio was approximately proportional (1 : 1) the hypothesis can then be tested with a simulation. A sufficient discussion of these premises can not be included in this paper, but will be presented in a following work (SCHIESBERG in press).

A stationary population implies that one couple has an average of two children reaching the reproductive age. Therefore, the probabilities for other numbers of children can be calculated using a Poisson distribution.

The sex ratio is given by a binomial distribution. If, for example, two children are assumed, the probability for two girls (or two boys) is about 25%. These values have to be multiplied with the corresponding values, calculated by the Poisson distribution.

According to the Poisson distribution the probability that a couple will produce two children is about 27.1%, with a probability of 50% that one of these children is a boy. Therefore, the probability that a pair of children includes a boy is 13.5%.

The values achieved by this multiplication are listed in the geometric arrangement of Pascal's triangle (Tab. 2). The first row shows the probability for zero children; the second row represents the probabilities for one daughter and one son; and the third one shows the probabilities for two daughters, one son and one daughter and for two sons. Therefore, every diagonal contains the probability for different numbers of children, but always assuming the same number of boys.

For example, by adding the values of the first diagonal all probabilities of zero sons are summed up. It is also possible to interpret these values as the probabilities for the birth of a specific number of daughters, since it was calculated with a balanced sex ratio.

These summed values are the simulated values for a specific number of families per household. The probability for one son corresponds to the probability of two families living in one house, because the model implies that the generation of the parents also remains in the household.

	Poisson distribution		Binominal distribution			
P(0)=	0.135	x	1			
P(1)=	0.270	x	0.5		0.5	
P(2)=	0.270	x	0.25	0.5	0.5	0.25
P(3)=	0.180	x	0.125	0.375	0.375	0.125

Tab. 1. Probabilities for a specific number of children, given by a Poisson distribution, and probabilities for the birth of a specific constellation of boys and/or girls within a specific number of children, given by a binomial distribution.

				0.135			
			0.135	0.135	0.135		
		0.067	0.067	0.067	0.067		
	0.022	0.022	0.022	0.022	0.022		
	0.005	0.005	0.011	0.033	0.022	0.005	
	0.001	0.001	0.002	0.003	0.002	0.001	0.001
Sum:	P(0)= 0.367	P(1)= 0.362	P(2)= 0.183	P(3)= 0.061	P(4)= 0.015	P(5)= 0.002	P(6)= 0.000

Tab. 2. Simulation for specific numbers of sons. Based on the multiplication of the values shown in Tab. 1.

Size Classes

Altogether 103 LBK house floor plans from the Rhineland were sufficiently preserved to permit the complete measurement of their surface area. The diagram (Fig. 2) displays the cumulated number of houses and the associated surface areas. The areas do not show a normal distribution; instead, they are grouped in several size classes which are defined by differences of more than six square metres.

The number of houses for each size class is compared to the predicted number, which is gained by multiplication of the calculated probabilities with the total number of houses observed. Recognizable at a first glance, the predicted and given values are very similar (Fig. 3). The predicted numbers are found

to correlate strongly with the observed number of houses per size class ($r = 0.99$). This strong relation between the values suggests to apply the model for calculating the average household.

Average Household

For modelling an average household Early Neolithic life tables were used as an external source. One originates from the LBK cemetery at Aiterhofen-Ödmühle in Bavaria (A. Zimmermann unpublished on the basis of NIESZERY 1995) and the other is based on a collection of several burials from the central Elbe-Saale region (BACH 1978). There is no evidence for incompleteness of the life tables, except for children.

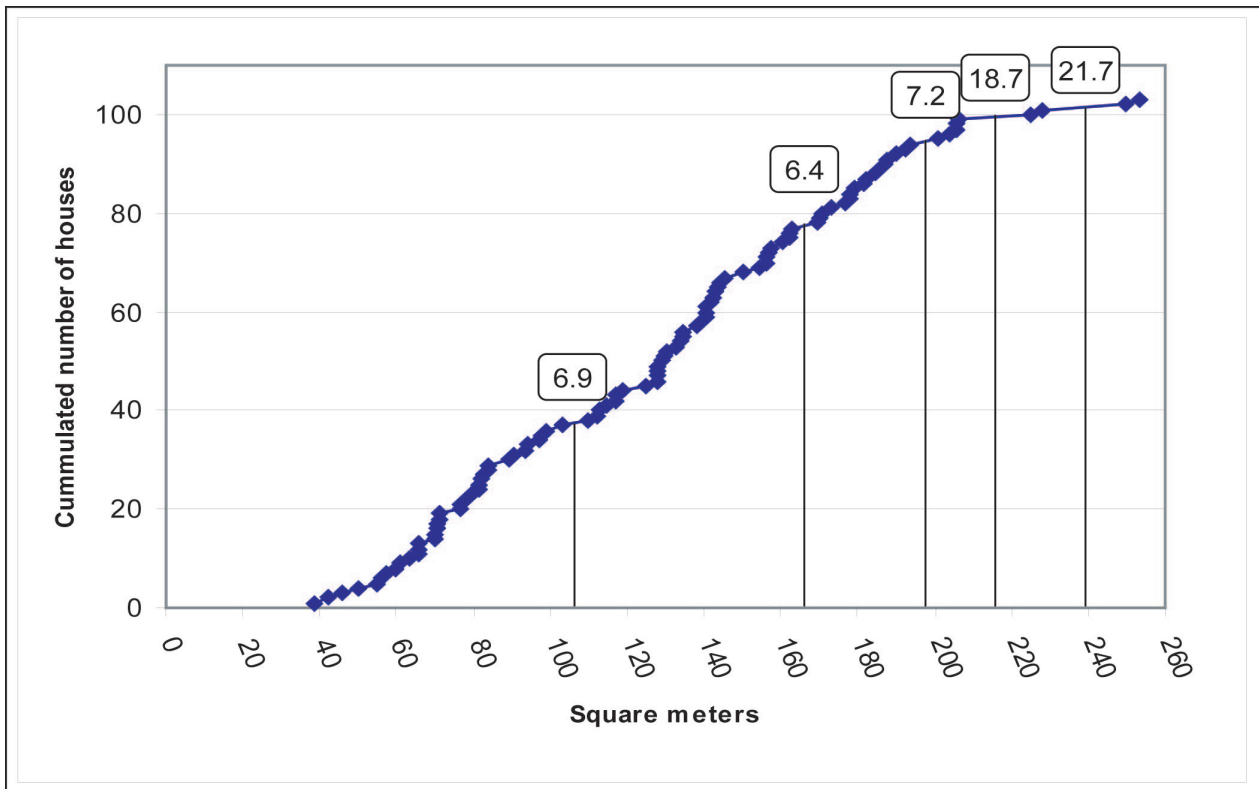


Fig. 2. Cumulated number of houses and their areas. Groups are defined by differences of more than 6 m².

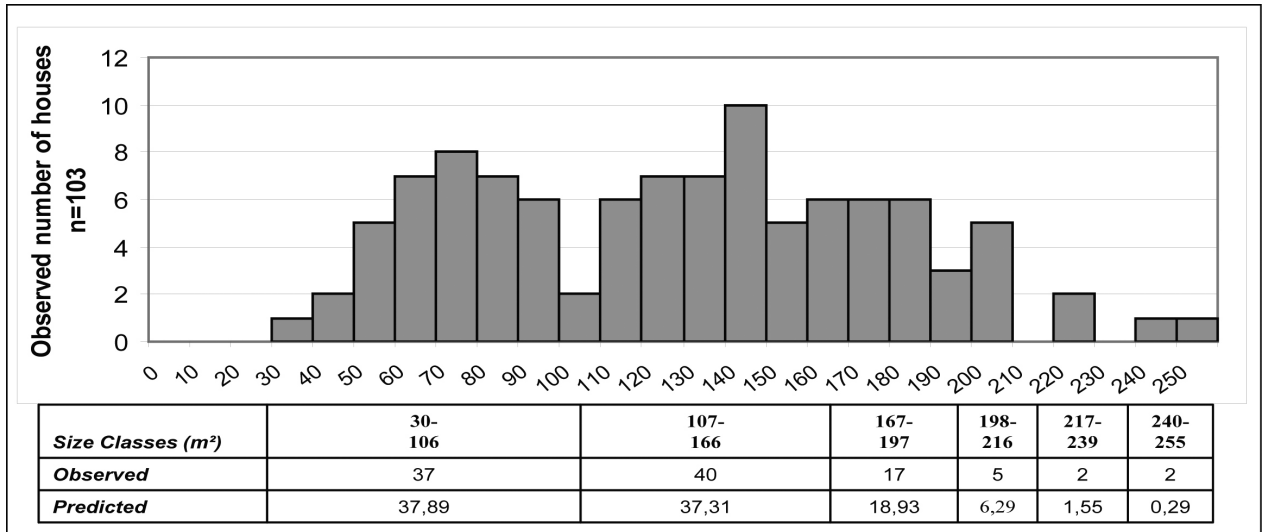


Fig. 3. Size classes of houses. The observed values are the number of houses per size class. $\chi^2 = 9.99$, $r = 0.99$.

Even if the life tables are from different regions, they show comparable demographic parameters. For both, a shortage of women in the reproductive phase is characteristic, for example. However, considering a critical assessment of the source, the inaccurate age determination of older individuals may be a problem.

The estimated average life span of a house varies between 20 to 25 years (exactly: 23.3 years) (STEHLI 1994). Furthermore, patrilocal residence is assumed. Thus, age cohorts of men, encompassing 20 to 25 years, were constructed.

In order to estimate the lower limit of the constructed age cohorts it is necessary to examine the model household in the concept of the household cycle. The cycle of a model household would start with one couple and their children. In the phase of household expansion the sons would marry and have their

own children, whereas the daughters would leave the household. LBK houses were built in one building episode and not added to in the course of time; there are only very few exceptions where later attachments are probable (e.g. VON BRANDT 1988, 121). This indicates that the observed correlation can only be explained if the size of the family can be estimated at the time of foundation. Therefore, it is suggested that the fission of a domestic group occurred late in the life cycle of an individual, maybe at the death of a senior member of the household. In this case the life expectancy at the average age of foundation should approximately correspond to the mean life span of a house. The life expectancy for men aged 20 was calculated between 40 and 43 years, whereas the life expectancy for men aged 25 was calculated between 43 and 45 years. The remaining life span of the first group corresponds to the estimated mean life span of a LBK house. How-

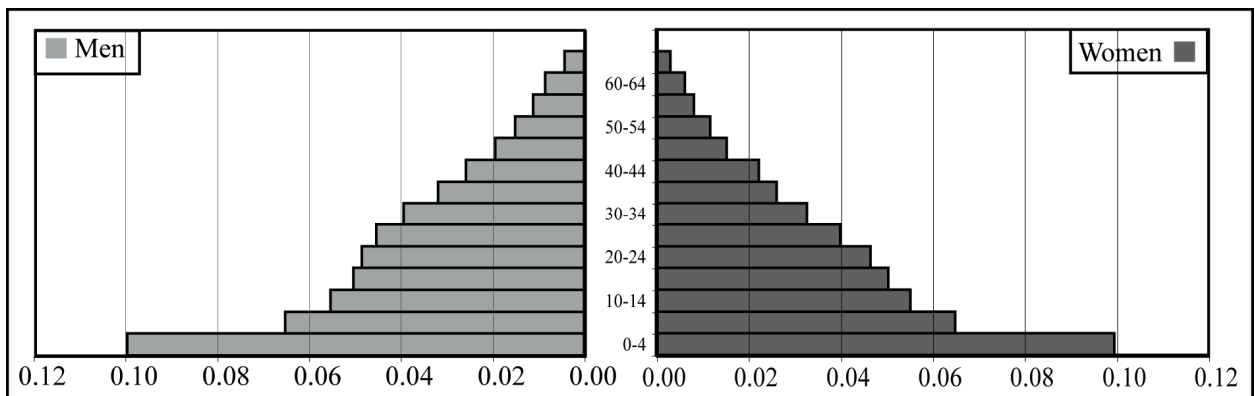


Fig. 4. Age pyramid of the population Alterhofen-Odmühle. Children up to 10 years are reconstructed.

	Cohort comprising men aged	20-45	25-50	20-40	25-45
MES	Percentage of men	0.190	0.161	0.164	0.141
	Persons per household	5.25	6.19	6.07	7.04
	Work force	2.77	3.41	2.98	3.72
Bavaria	Percentage of men	0.221	0.196	0.189	0.146
	Persons per household	4.50	5.09	5.29	6.83
	Work force	2.85	3.37	2.97	4.39

Tab. 3. Number of residents per household under the described terms.

ever, a man with an average age of 25 years fits better to the idea of a late fission of the domestic group.

The constructed age cohorts encompass 20 or 25 years and they start with men aged 20 or 25. The percentages of men in these age cohorts is the sum total of the percentages of the men from the appropriate age classes.

The percentages of these adult men cohorts were used for a standardisation. In other words, the sum of percentages of the other age and sex classes was divided by percentages of the male age cohorts described above. In this case, children, women and old people are proportional to the constructed age cohort of men. As an example, it can be assumed that 16.1% of the whole population are men between 25 to 50 years. Subsequently, the rest of the population represents 83.9%. Through dividing this number by 16.1% (= 5.2) the number of household members, excluding the man, is calculated.

In the case of an early fission of the domestic group and a long life span of a house the number of persons in the household decreases (Tab. 3).

The calculated numbers can be compared to the house sizes. Taking into account the method developed by NAROLL (1962), which suggests an estimation of one person per 10 m², the calculated number of persons per household seems to be low, even considering a high cultural variability of how much living floor per person is used. If one argues conventionally that only the middle part of the house was used as living space (e.g. MODDERMAN 1970, 109), a

	Number	Mean	Standard deviation
Total area	103	128.92	50.52
Northwestern section	133	36.21	17.13
Middle section	139	75.05	21.99
Southeastern section	109	27.52	12.86

Tab. 4. Mean size of LBK houses and their building sections.

number of six to seven persons seems to be the most probable estimation.

This estimation corresponds to earlier considerations about the inhabitants of a Linear Pottery Culture house. LÜNING (2002, 125) for example thought of a nuclear family composed of two adults with an average of four children. So his numbers are similar to those which are calculated above. However, the system suggested here is quite different, because several nuclear families instead of one would have lived in the great houses.

Work Force

The problem of estimating work force lies in the difficulty of ascertaining who would have actually belonged to the work force, which is, of course, highly culturally determined. However, the manpower of a man or women aged 20 is not comparable to the manpower of children aged 5 or of older individuals. Therefore, it seems sensible not to count children under 10 and seniors older than 50 years. Teenagers up to 15 count by half, as are seniors from 40 to 50 years of age. Since the children were not taken into account in these calculations, no reconstructed values influenced the standardisation.

The work force was calculated under the term of an average age of fission at 25, as this parameter seems to best suit aspects of the model. Using the aforementioned systems of counting and standardisation, workforce values from 2.8 to 4.4 people per household resulted.

These numbers are estimated figures of heuristic value and therefore can only be considered as approximations of prehistoric conditions. They are qualified guesses but since other ways of counting are possible, other solutions may be justified. However, the aim of this approach is mainly the construction of a common standard which makes it

possible to compare different societies across time and space.

Upscaling

Within the scope of the “LUCIFS” project (HILPERT / WENDT / ZIMMERMANN in this volume; ZIMMERMANN et al. in press) estimations of population density in the Rhineland, from the Palaeolithic up to the medieval period, were made. In the settlement areas a density of one household per square kilometre was calculated for the LBK. Since six to seven residents were calculated per household, six to seven persons per square kilometre are assumed for the settlement area of the Rhineland.

A total number of 2645 households dating to the 51st century BC was estimated for the area published in the Historical Atlas of the Rhineland, which covers a region of 37,989 km². ZIMMERMANN et al. (in press) calculated 6 persons per household, which results in a population density of 0.42 residents per square kilometre. Assuming 7 persons per household the number increases to 0.49 residents per square kilometre. By applying the method of calculating the workforce and upscaling the result to the area referred to, the workforce in one square kilometre is 0.23–0.3.

Further Perspective

A model of a LBK household was developed which can be described as a patrilocal extended family. The sizes of the houses might have been determined by demographic factors, and more precisely by the number of sons born per couple. This hypothesis was tested by a simulation. The observed values were found to correlate positively with those predicted.

In reference to this model there would have been a high variability of people in the workforce of different households. One could also argue that the intention to retain the labour of the sons and their wives in the household was a motive for favouring this kind of household structure.

The average number of inhabitants of a LBK house was calculated by the use of Early Neolithic life tables. The number of inhabitants was transformed into the work force. These preliminary results will have to be tested through further research that deals with large scale economic models. Another future prospect is to apply the methods presented to different societies across time and space.

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