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► **To cite this version:**

Clement Allan Tisdell, Serge Svizzero. The Failure of Neoclassical Economics Modelling and Human Behavioural Ecology to Satisfactorily Explain the Evolution of Neolithic Society. 2015. hal-02152047

HAL Id: hal-02152047

<https://hal.univ-reunion.fr/hal-02152047v1>

Preprint submitted on 11 Jun 2019

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ISSN 1444-8890

ECONOMIC THEORY, APPLICATIONS AND ISSUES

(Working Paper)

Working Paper No. 71

**The Failure of Neoclassical Economics Modelling and
Human Behavioural Ecology to Satisfactorily Explain the
Evolution of Neolithic Society**

by

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And

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February 2015

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The Failure of Neoclassical Economics Modelling and Human Behavioural Ecology to Satisfactorily Explain the Evolution of Neolithic Societies

ABSTRACT

Examines two parallel approaches, one in economics and the other in anthropology, intended to explain the behaviours of Neolithic societies, particularly their transit from foraging to agriculture. Both approaches assume that human behaviour is a response to rational human decisions to optimise. The application of microeconomic theory by a Danish professor to explain the transition of foragers to agriculture and the corresponding complementary views of some American anthropologists about this transition are outlined and discussed. While these approaches provide valuable insights into the evolution of Neolithic societies, it is also important to be aware of their limitations, several of which are identified in this article. Such approaches are unlikely to provide a general theory of the evolution of Neolithic societies. Because of the diversity of human behaviours, a range of theories are required.

Keywords: Economic evolution; economic optimisation; human behavioural ecology; hunter-gatherers; Neolithic Revolution; satisficing behaviour.

JEL Classification: D01, O10, P00, Q10

The Failure of Neoclassical Economics Modelling and Human Behavioural Ecology to Satisfactorily Explain the Evolution of Neolithic Societies

1. Introduction

Weisdorf (2005) uses comparative microeconomic analysis to explain and integrate different theories (mostly proposed by anthropologists and archaeologists) of why several Neolithic societies began switching from exclusively depending on hunting and gathering for their livelihood to engaging in some agriculture and becoming eventually, in many cases, highly reliant on it. Seemingly unaware of Weisdorf's comparative static analysis (because they do not refer to it), the anthropologists, Winterhalder and Kennett (2006, p. 11), extoll the virtue of using (modern) microeconomic concepts to explain the transition of foraging societies to agriculture. This type of approach is classified in the anthropological literature as part of human behavioural ecology¹. Winterhalder and Kennett claim that the virtue of this approach is that it enables many different theories of the transition of Neolithic societies to agriculture to be integrated. Weisdorf's (2005) analysis bears this claim out. Winterhalder and Kennett (2009, 2006) single out marginal values, optimisation, opportunity costs, risk-sensitive behaviour, discounting, transaction costs and economies of scale as highly promising concepts for analysing the evolution of Neolithic societies, but do not provide detailed applications of these concepts in these papers.

Nevertheless, specific applications of human behavioural ecology are available. Several early applications are, for example, in Winterhalder and Smith (1981) where the main emphasis is on general features of hunting-gathering strategies of foragers, taking into account selected measures of costs and benefits of alternative strategies. However, it is probably less difficult to apply behavioural ecology to this particular subject than to the determinants of transition of foraging societies to agriculture. Yet, even in this case, human behavioural ecology seems to give insufficient attention to cultural influences on the behaviour of foragers, as is apparent from the studies of Bird-David (1992). While the influence of the cultural dimension on human behaviour has been taken into account

by very few economists (conventional institutionalists, such as Veblen (1934) being exceptions) most mainstream economists ignore this factor in their analysis, and Weisdorf (2005) is no exception. This is because Weisdorf's contribution to explaining the evolution of Neolithic societies relies on neoclassical microeconomic modelling.

Weisdorf (2005, p. 568) points out that many archaeologists and anthropologists have used economic concepts (at least, implicitly) to explain the occurrence of the Neolithic Revolution (that is, the commencement of agriculture) but few economists have done likewise 'despite its [the Neolithic Revolution's] tremendous impact on economic growth and the wealth of nations.' This revolution eventually resulted in most societies depending heavily on agriculture for their economic welfare, enabled increased urbanisation to occur, and provided essential support for the Industrial Revolution, for example, by supplying food for industrial workers. It is, therefore, little wonder that Physiocrats, such as Quesnay (Kuczynski and Meek, 1972), regarded agriculture as the prime source of economic wealth.

The purpose of this article is to examine the analysis of Weisdorf (which entails the use of marginal values, optimisation and the neoclassical approach to economic choices) and then consider the scope for applying the concepts which Winterhalder and Kennett single out for special mention; several of which are apparent in Weisdorf's analysis. A general discussion and concluding comments then follow.

2. Weisdorf's (2005) Analysis of the Transition from Foraging to Agriculture Examined

The type of standardised model used by Weisdorf (2005) to explain different reasons for the transition of hunting-gathering societies to agriculture is shown in Figure 1. He uses it to illustrate three types of theories which have been proposed for the shifting of Neolithic societies to agriculture. These types include explanations based on increased populations, on the falling relative productivity of hunting-gathering, or on the rising relative productivity of agriculture. In these cases, the comparative economic benefit of engaging in some agriculture increases. In Figure 1, the line marked AB represents the marginal physical productivity of labour used in hunting and gathering and that marked

BC in the marginal physical productivity of labour engaged in agriculture which, for simplicity, Weisdorf assumes to be constant. Nevertheless, it is not only for simplicity that Weisdorf assumes that the regional productivity of labour employed in early agriculture is constant. He is also of the view that fertile land was plentiful relative to the level of the Neolithic populations initially contemplating the adoption of agriculture as an option and so, the marginal productivity of agriculture for these populations was actually constant.

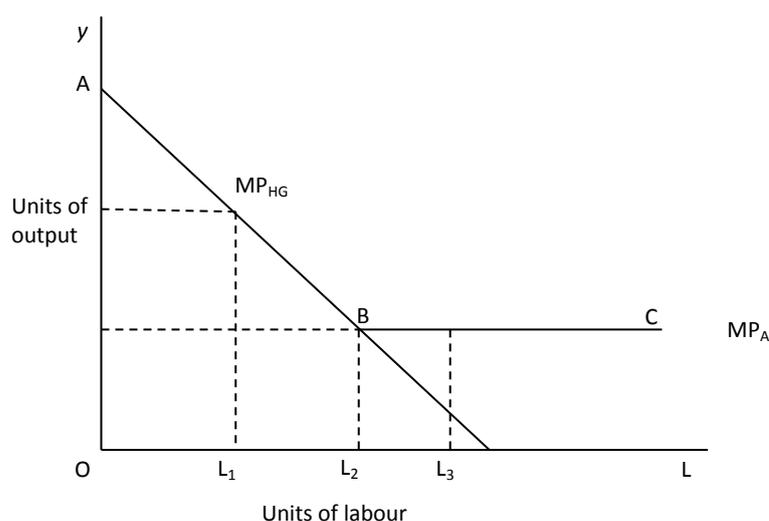


Figure 1: Weisdorf's standard model with minor presentational adjustment.

Given the relationship shown in Figure 1, a hunter-gatherer society has no economic incentive to commence agricultural production unless its labour force (proxy for population size, which is assumed to be a constant multiple of the size of the labour force) exceeds L_2 . If, for example, its available units of labour increase from L_1 to L_3 , this society finds it economic to switch from total reliance on foraging for its livelihood to using $L_3 - L_2$ of its available units of labour in agricultural production and L_2 in hunting and gathering. Furthermore, this theory predicts that, all other things being held constant, an increase in the productivity of labour in agricultural production or a reduction in marginal physical yields from foraging will result in a higher proportion of

its units of labour being engaged in agriculture. In the former case, MP_A shifts upwards and in the latter case MP_{HG} moves downwards. At first sight, this seems to be a straightforward and convincing approach to explaining the transition of hunter-gatherers to agriculture. However, closer consideration of the theory reveals some unresolved issues.

First, it is widely accepted (see Lee and Daly, 2004, p. 4) that sharing of the product was the norm in most foraging societies. If so, economic decisions in such societies seem more likely to have been based on the average product available to tribal members rather than the marginal product. Consequently, the total product may not have been maximised for the amount of labour used and switching to agriculture would have been delayed compared to Weisdorf's prediction. Furthermore, it is possible that when it initially began, agriculture was a communal activity involving sharing by tribal members, that is, it was a primitive form of communism, even though this did not continue once agriculture was able to yield a significant surplus. Therefore, adapting Weisdorf's standard diagram, the representation shown in Figure 2 appears to be more relevant. There the relationship AFC represents the average product of labour. No labour is engaged in agriculture in this case unless the labour force exceeds L_3 . For example, if the available number of units of labour become L_4 and the tribal band is guided by average product, $L_4 - L_3$ of labour would be allocated to agriculture. However, it is possible after some agricultural production begins that $L_3 - L_2$ of labour is withdrawn from foraging to work in agriculture because it may become evident that the productivity of these units would be higher in agriculture. This would increase the total product and the average level of income available to tribal members. It would result in $L_4 - L_2$ units of labour being allocated to agriculture, thereby maximising the output of the society relative in its effort.

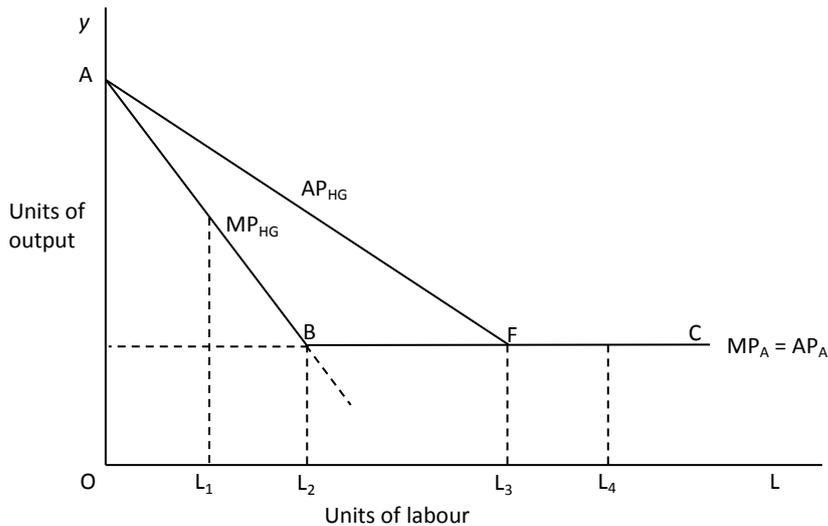


Figure 2: Early Neolithic societies may have based their production choices on average rather than marginal productivity because of the prevalence of sharing by community members. Given Weisdorf’s analysis, this could have delayed (as is illustrated) their transition to agriculture.

Second, Weisdorf (2005) relies primarily on neoclassical microeconomic analysis. This assumes that decision-makers have a considerable amount of knowledge about economic relationships. In reality, however, most early hunter-gatherers might have been very uncertain about their comparative returns from adopting agriculture. Presumably, they needed to learn about the value of adopting agriculture by experimentation and by learning-by-doing, both of which are not costless activities. Because there were no markets (or well developed ones) in early Neolithic times, the option of engaging in decentralised information-efficient decision-making of the type eloquently described by Hayek (1948) did not exist. Lack of knowledge about production possibilities and surrounding uncertainty (especially about the prospects of agriculture) presumably had a major impact on the decision-making of Neolithic tribes about the adoption of agriculture.

Depending on their geographical situation and the stock of potential domesticates

available, the risks faced by Neolithic communities in experimenting with agriculture would have varied. For example, in areas having fertile soils and regular availability of water for watering gardens, the risk of experimenting with agriculture might have been low, especially if agricultural products (and other products) could be stored. In addition, the comparative risks and variability of returns from foraging and agriculture would have presumably been taken into account.

The question also needs to be considered of the extent to which an incremental or marginal transition to agriculture was economically feasible. The successful cultivation of most plants requires their constant management in a particular location. Where tribal groups needed to range over a large territory to obtain sufficient produce for their subsistence, settling in one location by a tribe (or settlement by a significant portion of it) in order to engage in agriculture would have been problematic because those involved in farming would have had limited available produce from foraging to supplement their income from agriculture. Consequently, in this case, the scope for gradually relinquishing hunting and gathering in order to depend increasingly on agriculture is quite limited. In addition, in these circumstances, farmers have limited social security (their safety net is weak) because they lack access to sufficient amount of hunting-gathering resources for their use in the event of a crop failure. They faced a similar problem in the latter case, to that identified by Chambers (1987) as occurring among some of the rural poor in developing countries. In cases where relatively abundant produce could be had from hunting and gathering in close proximity to an agricultural settlement, this would, however, not have been a serious problem.

In some cases, 'lumpiness of choices' or high overhead costs, or social obstacles to reaching transit agreement to agriculture may have restricted the scope for incremental (marginal) switching to agriculture by foragers. For example, the whole tribe or a major portion of it may have had initially to agree to such a transition if it involved settlement and some major capital works may have been needed, such as the clearing of vegetation. Because of the existence of overhead costs, transition to agriculture of a sufficiently large magnitude might have been needed to recoup these costs, that is, to achieve economies of size. When incremental adjustment was not practical, this would have been a deterrent to the adoption of agriculture.

Other factors that can also contribute to the lumpiness of choices in switching from hunting-gathering to agriculture is that if a small group from a tribe switches to agriculture and to a settled way of life, it may fail to reproduce itself, as is evident from the Allee effect (Courchamp, Berec, and Gascoigne, 2008). Furthermore, a small group is likely to be more vulnerable to being wiped out by invaders than a large group. This all suggests that the likely success of an initial agricultural settlement probably depends on its size.

Another limitation of Weisdorf's (2005) model is that it does not consider the trade-off between work and leisure. Weisdorf appears to assume the effort and time spent by each 'labourer' is unchanged whether or not they are engaged in foraging or in agriculture. The available evidence, however, indicates that this was probably not so in practice.

The question of whether and to what extent, Neolithic societies aimed for economic optimisation is also contentious. Weisdorf's (2005) modelling implies that they maximised output relative to their effort. However, it is unclear in his analysis for what length of time output was maximised relative to effort. In some cases, productivity would have been different in the short run and in the long run. How much foresight was displayed by hunter-gatherers?

Some scholars (for example, Sahlins, 1974; Gowdy, 1998) contend that not all Neolithic social groups were maximisers: some were satisficers. In these circumstances, the latter groups may have displayed a high degree of social inertia. Provided they were satisfied with their actual level of income (and did not aspire to a higher one), they would have had little or no incentive to adopt techniques or production methods which could increase their productivity. For example, they might have had no incentive to switch to agriculture in this case even if it could raise their productivity. They would only consider such a switch if given their current practices, they were unable to realise the level of income to which they aspired. Nevertheless, two different types of behaviours can be displayed by satisficers. Some groups of satisficers may wait until their aspiration level is not being met before they react. They may then search for possibilities that will once again enable them to reach their aspiration level or adjust their aspiration level downwards or do both. Their behavioural approach is reactive. Others may anticipate or predict the possibility that their aspiration level will not be met

and take remedial action in advance. Their behaviour is proactive.

Figure 3 illustrates a situation in which satisficers do not adopt agriculture even though its adoption would increase their income. In Figure 3, the 'kinked' relationship AFC represents the (envelope of) average product available to a Neolithic tribe. The segment AG is the average product available if the tribe relies only on foraging (to employ its units of labour) and the portion FC indicates the tribe's average product and marginal product from embarking on agriculture. Assume that the aspirational and minimum acceptable satisfactory level of income per head for the tribe is y_1 . In other words, an income level per head of y_1 or greater (a threshold value) is regarded as satisfactory by the tribe. Also suppose that L_1 units of labour are available. Then, by engaging only in hunting and gathering, the tribe can obtain an income per head of y_2 . This exceeds their minimum satisfactory level of income, y_1 , but does not maximise the tribe's income per head. To maximise the tribe's income per head, some labour needs to be employed in agriculture. For example, by employing $L_1 - L_0$ units of labour in agriculture, the tribe's income per head would increase to y_3 . However, a tribe will not choose this income-raising option (nor the output-maximising one, which would require the marginal productivity of labour to be equal for both foraging and agriculture) if it is satisfied with an income per head of y_2 . Should, however, the tribe's population increase beyond \bar{L} , it will be unable to obtain a satisfactory level of income. As a result, the tribe is likely to begin to search for opportunities which will increase its productivity or it may reduce its aspiration level of income. Both reactions may, of course, occur. The tribe may be inclined to commence agriculture in response to being stressed because it does not obtain a satisfactory level of income.

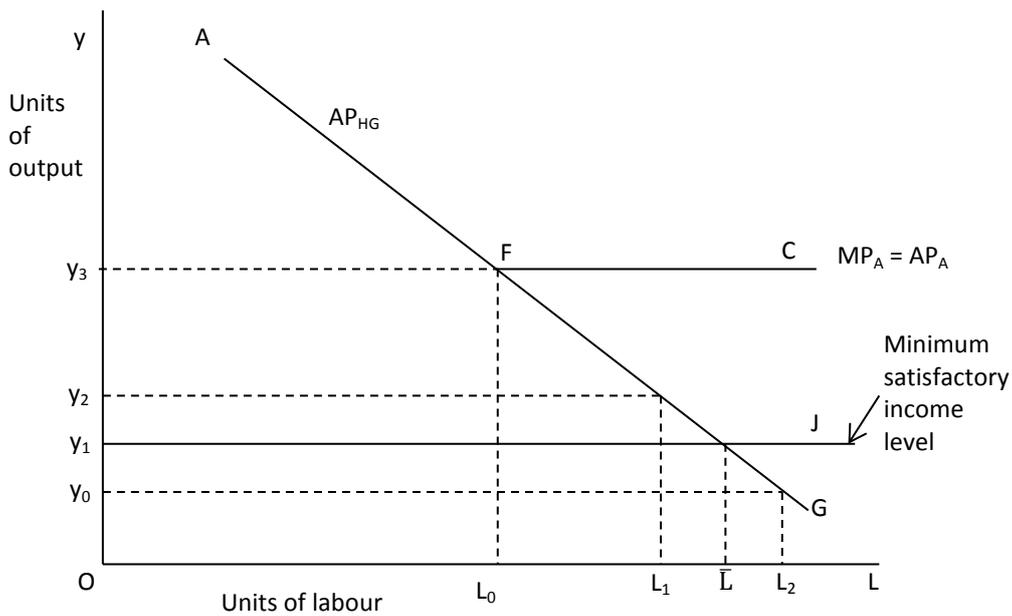


Figure 3: An illustration of satisficing behaviour and its influence on the choice between foraging and agriculture.

In Weisdorf's (2005) modelling, the level of population is assumed to be a constant multiple of the available units of labour. Both the number of available units of labour and the level of population are treated as an exogenous variable. Therefore, there is scope to extend Weisdorf's analysis by considering influences on the size of the population and the labour force. For example, Childe (1936 [1965]) suggests that in agriculture the demand for labour is likely to be greater than in foraging and this favours population increase. Settled agriculture (that is a settled lifestyle) makes it less burdensome for a tribe to rear children. Caring for children is more burdensome given the nomadic lifestyle of hunting and gathering than it is given the sedentary lifestyle of agriculturalists. More importantly, children of agriculturalists contribute substantially more to food production than do the children of hunter-gatherers. Therefore, having children was less costly for early agriculturalists than for hunter-gatherers. Furthermore, food production per unit of land increased after agriculture, commenced and this triggered the first demographic explosion in history (Guzman and Weisdorf, 2011;

Childe, 1936 [1965]). Guzman and Weisdorf (2011) rely on optimisation as the basis for human behaviour. They suppose that the interdependent development of agriculture in Neolithic times with population growth can be explained by the optimising decisions of a representative agent. This is an ‘as if’ model which makes no allowance for behavioural diversity. The extent to which it mirrors reality is not obvious.

Following the commencement of agriculture, it may also have been the case that women and children were increasingly required by males to engage in extra work to cultivate crops and tend to livestock. In many societies, a dominant class became established after agriculture became sufficiently established and this altered the social dynamics of economic growth (see, for example, Svizzero and Tisdell, 2014).

Although Weisdorf’s (2005) model does help to integrate various theories of why many Neolithic societies adopted agriculture or failed to do so, it does not provide a sufficiently general framework to encompass the wider range of behavioural patterns that presumably existed in Neolithic societies, and which influenced the nature of social and economic evolution. Apart from the likelihood that different Neolithic societies adopted different decision-making procedures, neoclassical microeconomic modelling fails to take sufficient account of the bounded rationality and the social constraints involved in such societies in deciding whether to transit from foraging to agriculture.

3. Economic Concepts and Human Behavioural Ecology

As mentioned earlier in this article, Winterhalder and Kennett (2009, 2006) are strong advocates of the use of microeconomic concepts to explain the transition of foraging societies to agriculture, and they have identified a set of such concepts which they believe are very promising in this respect. Concepts identified by them as important include economic optimisation and opportunity costs (relative economic benefits). These are central concepts in Weisdorf’s (2005) analysis. However, as the above discussion reveals, these concepts seem to be incapable of explaining the adoption or non-adoption of agriculture by all Neolithic societies which were in a position to increase their levels of income by engaging to some extent in agricultural production. Furthermore, these authors mention that decision-making based on marginalism or

incrementalism is important. However, it seems that (at least, in some cases) the marginal adoption of agriculture was not a realistic option for all groups of foragers, because a discrete change in their social and economic organisation was required. This was illustrated above as involving a ‘lumpiness’ problem or as entailing significant overhead or initial costs.

Winterhalder and Kennett (2006) identify optimisation, marginal values, opportunity costs, discounting and risk-sensitive behaviour as important concepts in considering the livelihood decisions of Neolithic societies. In Winterhalder and Kennett (2009), they add economies of scale and transaction costs to this list. We have already brought attention to possible limitations of the first three concepts in considering Weisdorf’s analysis of the transition of Neolithic societies to agriculture. It should also be observed that in adding economies of scale as a significant concept to their list, Winterhalder and Kennett restrict the scope for marginal or incremental change. This is because economies of scale can act as a barrier to entry to agriculture or to new forms of livelihood. This is because transition must be on a large enough scale to be economic and this also tends to increase the degree of risk involved in trying it.

Compared to foraging, agriculture involves a longer delay before an economic return is obtained after effort is expended than does foraging. This is likely to retard the adoption of agriculture. Furthermore, in most cases, agriculture requires a larger regular investment than foraging³. In other words, the adoption of agriculture involved delayed economic returns and a larger investment compared to foraging. Presumably, some discounting of delayed economic returns in relation to the required investment was taken into account by Neolithic decision-makers. However, it is difficult to know in retrospect the level of the discount rate and what determined it in such societies. It is also probable that the (social) discount rate differed between tribes or bands⁴. One would expect that those groups having a high discount rate (high rate of time-preference) would be less inclined to adopt agriculture than those with a lower discount rate, other things being held constant.

One associated issue is the length of time taken into account by Neolithic societies in choosing development strategies. How long were their planning horizons? How myopic were they in choosing their development strategies and how realistic were they in

assessing possibilities?

Furthermore, Winterhalder and Kennett (2009) stress the need to take account of risk-sensitive behaviours in considering the transition of hunter-gatherers to agriculture but point out that little research has been done on this aspect. Presumably, geographical areas which had suitable natural endowments for agriculture (such as fertile soils, a stable climate and ready and reliable availability of water for watering crops) would have reduced the risks associated with transition. In addition, the ability to store food would have provided a safeguard against lower than expected crop yields. River valleys in the Middle East may have had natural resource endowments which reduced the risks of transition to agriculture compared with less suitable environments in early Neolithic times. In some areas of the Middle East, once a food surplus was obtained, it may have become economic to establish olive trees, grape vines, leguminous shrubs (chick peas) and other food perennials that took longer than annuals to bear edible food but which were also less reliant on natural conditions needed for the successful cultivation of annuals such as wheat and barley.

An additional concept identified by Winterhalder and Kennett (2009, p. 647) as being important in understanding the economic evolution of Neolithic societies is transaction costs. Transaction costs are important in influencing the extent to which exchange takes place. Exchange is, as a rule, facilitated by lower transaction costs. Lower transaction costs can arise for several reasons. These include lower transport costs, greater trust and certainty between the parties involved in exchange, and increased knowledge of the possibilities for exchange. Childe (1950) points out that cities which grew up along rivers and navigable waterways in the Middle East were well placed to facilitate regional exchange of goods, because of their comparatively low level of transaction costs required for exchange of commodities. Trade can be an important factor in increasing national wealth and in reducing local economic risks. Presumably, the development of writing also facilitated trade because it allowed contracts to be specified in written form, thereby reducing uncertainty. Several of the clay tablets (based on cuneiform) in ancient Sumeria recorded contracts for exchange in commodities.

4. Discussion

There is little doubt that the use of economic concepts can help us to better understand the economic evolution of Neolithic societies and the failure of some to shift to agriculture from hunting-gathering. However, the range of microeconomic models is wide and not all assume optimising behaviour by individuals or groups. It is clear that Neolithic societies varied considerably in their social organisation of production possibilities (see, for example, Kelly, 1995). Consequently, neoclassical microeconomic models, such as those applied by Weisdorf (2005), most likely fail to predict the behaviours of all Neolithic societies in deciding whether or not to commence agriculture, even when agriculture could increase their productivity.

Furthermore, it is uncertain what ancient societies were intent on optimising and what their time-horizon and preferences for doing this were. How myopic were they in their decision-making and how realistic were they about their production possibilities? Testing for such past behavioural features seems to be a daunting task, especially in situations involving prehistory. Even written records may not provide reliable evidence of intent. This restricts the scientific basis for applying human behavioural ecology.

The analysis of optimal behaviour is a key feature of both mainstream economic modelling and behavioural ecology. However, in both cases, there is difficulty in deciding accurately on what is being maximised or minimised, that is identifying the relevant objective function, and there is a temptation to assume that a single variable is being maximised or minimised. For example, profit maximisation by firms is a standard assumption in neoclassical economies, and maximising net energy return to hunter-gatherers in searching for food was an objective used by Winterhalder (1981) in his early analysis of optimal foraging strategies. In both cases, these theories can be unreliable guides to actual behaviour and may fail to identify 'successful' behaviours (Tisdell, 2013, pp. 138-141). As the ecologist Marion Dawkins (1986, p. 21) stresses, efficient feeders may not be optimisers in a broad sense, because they may fail to pay adequate attention to predators and mating opportunities and therefore, are likely to be eliminated by natural selection.

It could also be argued that Weisdorf's (2005) model is a crude energy efficiency model

because it implies that output is maximised relative to the amount of labour employed which is an indicator of human energy expended. At the same time, his model assumes that the quantities of all commodities supplied whether by foraging or by agriculture can be measured in a common unit, even though they are heterogeneous. Consequently, a valuation problem is side-stepped. Furthermore, valuation problems are not fully resolved in the optimal foraging models outlined by Winterhalder (1981). As agriculture developed and as foraging became a relatively less important source of food, presumably the bundle of commodities available to humans altered. Therefore, with development, all goods were probably less likely to be valued by humans on the basis of their relative energy content even if they were so valued by Neolithic societies relying entirely on foraging. However, taking into account the findings of Bird-David (1992), the valuation of commodities in foraging societies cannot be attributed entirely to their energy content, and maximising net energy returns does not adequately explain the foraging strategies of all these societies. Bird-David provides specific examples of tribal groups who do not maximise their net energy returns from foraging. Furthermore, even in Neolithic societies, it seems unlikely that the utility of food to humans would have depended solely on its energy content, and consequently, the diet-breadth model developed in ecology to explain hunting by animals is likely to have limited applicability to human behaviour, despite the view of Winterhalder (1981).

The extent to which rational choice (design) and chance determined the survival and economic well-being of ancient societies is not clear in retrospect. It might be thought that those who survived and prospered made optimal actual choices (see, for example, Smith and Winterhalder, 1992). However, it is also possible that many of the choices were chance events or not made based on rational optimising procedures. In retrospect, there is a temptation to attribute the survival and superior economic growth of societies compared to those that have failed or which have experienced economic stagnation to the superior rationality of the former, that is in their ability to maximise their chances of survival and foster economic growth. This assumes that survival of the fittest depended on the fittest being optimisers. However, in reality, chance rather than rational optimisation could have played a major role in the survival and economic growth of several societies which proved to be the fittest *ex ante*. Social Darwinism is a weak basis for contending in retrospect that the most successful surviving societies must have

been forward looking optimisers in the past. This is because this conclusion ignores the possibility that chance played an important role in the selection and survival of societies, as it also has done in the evolution of species (Gould, 1989, 1990).

5. Concluding Comments

Winterhalder and Kennett (2009, pp. 646-647), prominent advocates of human behavioural ecology, warn fellow anthropologists that economists are a danger because they ‘threaten to steal our subject matter with, intriguing ideas (Ofek, 2001), although without our empirical understanding of actual cases’. Furthermore, they contend that the ‘analysis of the economy of early mixed or agricultural societies necessarily will employ terms with which they [economists] already are comfortable’ (Winterhalder and Kennett, 2009, p. 647). While these claims may be correct, these authors may fail to fully appreciate the variety of behavioural theories which are being applied by economists and the need to develop many of these theories further in order to apply them to the evolution of early societies. For example, while the economic analysis of Weisdorf (2005) relies on economic optimisation and opportunity costs to integrate many different theories, mostly of archaeologists and anthropologists and to provide the rationale for the transition (and non-transition) of foraging societies to agriculture, another economist (with a background in anthropology) John Gowdy (1998), adopts a satisficing behavioural framework to explain why some foragers did not adopt agriculture. Gowdy (1998) argues that many hunter-gatherers had (have) limited wants in relation to their means, and therefore, had (have) no incentive to switch to agriculture.

Why such societies adopted a satisficing rather than an optimising approach to the economic change and the nature and dynamics of this satisficing behaviour requires further consideration. Furthermore, different types of apparent satisficing behaviour need to be considered. For example, there are at least three types of circumstances which can give rise to behaviour that appears to be of a satisficing nature.⁵ They are: (1) decision-makers have low levels of aspiration in relation to the goals they seek; (2) decision-makers are of the view that the cost of searching for choices which will improve outcomes is not worth the benefits; or (3) in relation to commodities, a stage is

reached where extra quantities of the available commodities are of no extra value or would cause disutility. In the latter case, a type of saturation is possible **relative to the limited variety of commodities available to foragers**, Case 1 would seem to fit Sahlins (1968) catch phrase as identified by Bird-David (1992, p. 34) of ‘Want not, lack not’, but it does not exactly fit Bird-David’s alternative of ‘Think rich, be rich’ because such a group of foragers would be rich (and could be made no richer) given their economic universe.

Lee (1998, p. ix) points out that ‘for most economists, the supremacy of the market, the sanctity of property, and the centrality of the doctrine of economic man are sacred tenets of their craft. Orthodoxies of this kind deserve careful scrutiny...’ Although the concept of economic man has predictive value in some cases, it also has its limitations. Human behavioural ecologists need to pay greater attention to the limitations of the concept of economic man and should allow for a greater diversity of human behaviours (some of which are being revealed by advances in experimental and psychological economics) than those behaviours singled out by Winterhalder and Kennett (2006, 2009) for functional applications in anthropology.

To conclude: Weisdorf’s (2005) analysis shows how the (neoclassical) microeconomic theory of optimal decision-making could be used to explain the evolution of Neolithic societies, that is their transit to agriculture or their non-transit to it. Furthermore, application of his analysis can be extended, for example to explain why some foragers after adopting agriculture returned to depend solely on foraging for their subsistence. However, this theory has not been tested and it leaves out of account several factors which appear to have been important influences on the behaviours of some Neolithic societies. Those identified in this article included cultural and knowledge factors, random influences on choice sets as well as the possible adoption by some societies of satisficing-like behaviour. In our view, human behaviours are diverse as well as the nature of the possibilities for economic and social transformation and a single microeconomic model of the type proposed by Weisdorf fails to adequately capture the extent of this diversity. Therefore, on its own, it cannot satisfactorily explain the economic and social evolution of all Neolithic societies. A wider range of theories (ideal types) is needed to do this. Similarly the optimisation models proposed by human

behavioural ecologists seem to be too narrow in their perspective and they need also to be supplemented by additional theories. Although human behavioural ecologists have proposed specific optimisation models to explain the possible foraging strategies of hunter-gatherers, they have not articulated the particular type of model developed by Weisdorf. Nonetheless, Weisdorf's model is compatible with the type of approach favoured by human behavioural ecologists. Behavioural ecologists may, however, feel that a worthwhile objective would be to extend his model taking into account those types of economic concepts which are identified by Winterhalder and Kennett (Winterhalder and Kennett, 2009, 2006) as promising. In doing this, some incompatibilities could arise. For example, in some cases, marginal changes in economic and social activities and structuring may be blocked by the occurrence of economies of scale and similar impediments.

6. Notes

1. Those who adopt this approach (for example, Winterhalder and Smith, 1992; Smith and Winterhalder, 1992) draw on evolutionary ecology to support it in conjunction with optimisation analysis. Smith and Winterhalder (1992, p. 52) state that 'optimization analysis is a convenient heuristic tool or simplification for analysing evolutionary outcomes.' They specifically reject satisficing models mainly on the basis that those who fail to optimise will be eliminated by competition generated by those who optimise (Smith and Winterhalder, 1992, p. 54). Most of the types of arguments advanced by Smith and Winterhalder (1992) in favour of optimisation models as a basis of human behaviour had also been put forward by economists (see, for example, Tisdell, 2013, Chs. 6 and 7).
2. Models of early agriculture include consideration of shifting cultivation as a basis for Neolithic food production. This is considered to be an "anti-surplus" mode of production not conducive to the creation of 'state' hierarchy (Sahlins, 1974)
3. This was true in immediate-return foraging societies in which food was consumed on the spot or soon after. However, in delayed return foraging societies, food and other resources might be stored for months or years with marked effects on social

organization and cultural notions of property (Woodburn, 1982).

4. This is evidenced by Tucker (2007, p. 204). He uses an experiment to estimate the discount rate (the rate of time preference) of Mikea hunter-gatherers-horticulturalists currently living in southwestern Madagascar.
5. In addition, as mentioned above, satisficing-like behaviour may be of a prospective or reactive nature.

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