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Working Paper No. 75

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Different Behavioral Explanations of the Neolithic Transition from Foraging to Agriculture: A Review

ABSTRACT

This article examines how well two parallel behavioral approaches, one in economics and the other in anthropology, explain the economic evolution of Neolithic societies, particularly their transit from foraging to agriculture. Both assume rational optimizing behavior. It is argued that satisficing theories provide a superior explanation of transition (and non-transition) by some hunter-gatherers. Furthermore, many of the concepts associated with neoclassical economics are shown to be inadequate for analyzing the choice problems involved. Moreover, it is argued that all behavioral theories considering the relationship between human behavior and economic evolution need to pay attention to the way that decision-making is embedded in social structures. It is unlikely that a single theory will be able to explain the economic evolution of all societies when social structures and other relevant variables differ between communities.

Keywords: Economic evolution; economic optimization; human behavioral ecology; hunter-gatherers; Neolithic Revolution; satisficing behavior, social embedding.

JEL Classification: D01, O10, P00, Q10

Different Behavioral Explanations of the Neolithic Transition from Foraging to Agriculture: A Review

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 behavioral ecology.

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 optimization analysis. Smith and Winterhalder (1992, p. 52) state that 'optimization analysis is a convenient heuristic tool or simplication for analyzing evolutionary outcomes.' They specifically reject satisficing models mainly on the basis that those who fail to optimize will be eliminated by competition generated by those who optimize(Smith and Winterhalder, 1992, p. 54). Most of the types of arguments advanced by Smith and Winterhalder (1992) in favor of optimization models as a basis of human behavior have also been put forward by economists (see, for example, Tisdell, 2013, Chs. 6 and 7 for a critical discussion of these arguments).

Winterhalder and Kennett claim that the virtue of their approach is that it enables many different theories of the transition of Neolithic societies to agriculture to be integrated. Weisdorf's (2005) analysis supports this claim. Winterhalder and Kennett (2009; 2006) single out marginal values, optimization, opportunity costs, risk-sensitive behavior, discounting, transaction costs and economies of scale as highly promising concepts for analyzing the evolution of Neolithic societies, but do not provide detailed applications of these concepts in these papers.

Nevertheless, specific applications of human behavioral ecology are available. Several early applications are given, 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 behavioral ecology to this particular subject than to the determinants of transition of foraging societies to agriculture. Yet, even in this case, human behavioral ecology seems to give insufficient attention to cultural influences on the behavior of foragers, as is apparent from the studies of Bird-David (1992). While the influence of the cultural dimension on human behavior 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 urbanization to occur, and provided essential preconditions 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.

It should be noted that it is widely agreed in the literature about the Neolithic Revolution that there is heterogeneity in adoption of agriculture and pastoralism by different Neolithic societies. Such heterogeneity has been explained empirically (Pryor, 2004), theoretically (Svizzero and Tisdell, 2014b) and by a combination of both approaches (Thurnwald, 1932). For instance, according to the integrationist approach (Zvelebil, 2001), the adoption of agriculture by European hunter-gatherers has followed different patterns, depending on the period and region considered. Furthermore, some hunter-gatherers decided not to adopt agriculture, while others have switched to a low-

level food production, that is, to a mixed economy based on foraging and farming (Smith, 2001; Svizzero and Tisdell, 2015), or to other rural combinations for obtaining a livelihood (Thurnwald, 1932).

The purpose of this article is to examine the analysis of Weisdorf (which entails the use of marginal values, optimization 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. Alternative behavioral approaches are also given consideration, such as satisficing types of behavior. Moreover, particular attention is given to social embedding as a constraint on economic change and to non-marginal limitations to economic evolution.

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

The type of standardized 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 labor used in hunting and gathering and that marked BC in the marginal physical productivity of labor 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 labor 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.

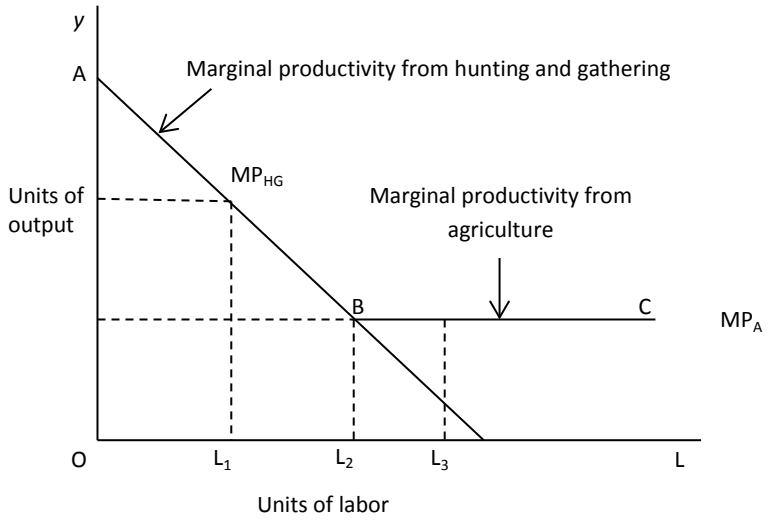

Figure 1: Weisdorf's standard model with minor presentational adjustment.

Given the relationship shown in Figure 1, a hunter-gatherer society has no economic incentive to commence agricultural production unless its labor force (proxy for population size, which is assumed to be a constant multiple of the size of the labor force) exceeds L_2. If, for example, its available units of labor 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 labor in agricultural production and L_2 in hunting and gathering. It begins to rely on agriculture to a limited extent for its livelihood. Furthermore, this theory predicts that, all other things being held constant, an increase in the productivity of labor in agricultural production or a reduction in marginal physical yields from foraging will result in a higher proportion of its units of labor being engaged in agriculture. In the former case, the line MP_A shifts upwards and in the latter case the line 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; Thurnwald, 1932) 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 than on their marginal product. Consequently, the total product may not have been maximized for the amount of labor used and switching to agriculture would have been delayed compared to Weisdorf's prediction.

Secondly, 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.

In Figure 2, the relationship AFC represents the average product of labor. No labor is engaged in agriculture in this case unless the labor force exceeds L_3. For example, if the available number of units of labor become L_4 and the tribal band is guided by average product, $L_4 - L_3$ of labor would be allocated to agriculture. Nevertheless, it is clear that there would be more to share in circumstances depicted by Figure 2 with a switch of some human activity hours to agriculture before L_3 is reached. This switch may not occur since decision-makers may confuse marginal and average productivity or be only aware of the latter. However, it is possible after some agricultural production begins that $L_3 - L_2$ of labor would be 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 labor being allocated to agriculture, thereby maximizing the output of the society relative to its effort.

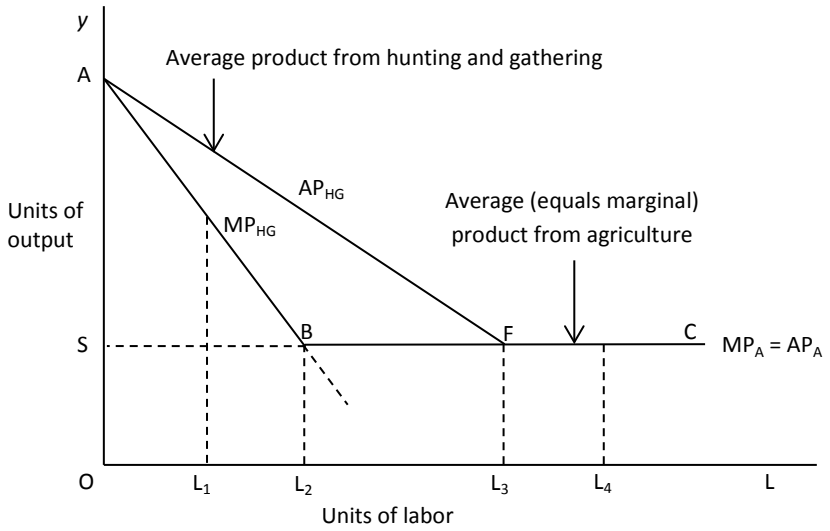

Figure 2: Early Neolithic societies may have based their production choices on average rather than marginal productivity because of the prevalence of sharing by community members. Given Weisdorf's analysis, this could have delayed (as is illustrated) their transition to agriculture.

Note that both Weisdorf's model and the satisficing model represented in Figure 2 do not imply that there was an abrupt transition to agriculture in the Neolithic period. Both imply the existence initially of mixed economy with hunting and gathering being the dominant source of livelihoods in the initial transition. Over time, labor productivity in foraging probably declined while that in agriculture (and pastoralism) increased. Boserup (1965) gives reasons why agricultural productivity is likely to have trended upward once it started. Given these trends, one might expect that in many ancient communities, agriculture would have increasingly displaced hunting and gathering as a means of subsistence.

The above theory needs further development (which is done when Figure 3 is introduced) because it does not adequately explain why the 'tipping' point for commencing some agriculture should be when per capita income falls to the level OS. Other tipping points are possible and can be expected to depend on the nature of income-sharing in tribal communities and their social structures. The importance of both these aspects have been stressed by Thurnwald (1932) and Polanyi (1944) but are

overlooked in the neoclassical economic theory applied by Weisdorf (2005). The main purpose of the simple exposition given in Figure 3 is to demonstrate that income-sharing arrangements can significantly influence communal tribal decisions about whether or not to engage in agriculture and the timing of such decisions.

Note that the adoption of satisficing types of behavior does not necessarily result in irrational behavior. Adoption of this type of behavior can be a deliberate choice and can result in well-reasoned and purposive actions when aspiration levels are unmet or if it is anticipated that they are going to be unmet. This behavior can, therefore, be consistent with Elster's description of what constitutes rational behavior (Elster, 1984). Nevertheless, as was demonstrated the behavioral implications of satisficing models differ from those of the optimizing model realized by Weisdorf (2005). However, both the satisficing model outlined above and Weisdorf's model should be regarded as special cases. This is because, given the theories of Thurnwald (1932), and his empirical observations, and the theory of Polanyi (1944), the occurrence of economic change and innovation depend on the way in which individuals and economic functions are embedded in social structures. Particularly in tribal communities, there can be considerable differences in the nature of this embedment between different tribes, and as stressed by Polanyi, its nature can alter with the passage of time, usually slowly. Modern market economies are, in fact, embedded in a different set of social structures than ancient economies. While neoclassical models are capable of capturing the nature of economic change in modern market economies, they may be of limited or no value for doing this when applied to tribal situations.

Given the social embedding perspective, it is also necessary to relate satisficing models to the social structure of ancient societies. For example, how and who decided what levels of income for a tribe were socially unacceptable or in danger of becoming so? How was the intention for economic change socially determined and how were the pathways for economic change selected? Clearly, the processes involved were not straightforward. According to Thurnwald (1932, p. 275), innovation in tribal communities depends on the attitudes of their leaders to economic change. Therefore, they would be crucial players in determining the income threshold which becomes a trigger for economic innovation.

At the same time, they may have been aware that economic innovation often alters the social structure of society, changes power and distributional relationships, and jeopardizes the social cohesion of a tribe. To what extent did they act in their role as tribal leaders to foster their own self-interest rather than the communal interest? To what extent were they limited in their behavior by established customs and codes? These questions are all relevant to considering the genesis of economic innovation required for transition from hunting and gathering to agriculture in ancient societies but are not considered in the theory proposed by Weisdorf.

Second, because Weisdorf (2005) relies primarily on neoclassical microeconomic analysis, he assumes that lack of knowledge does not prevent decisions being made which maximize income per capita. This assumes that decision-makers have a considerable amount of knowledge about economic relationships. In reality, however, most early hunter-gatherers would 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. Therefore, since it is usually assumed that there were no markets (or well developed ones) in early Neolithic times, the option of engaging in decentralized 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. Thurnwald (1932) emphasized the importance of both the availability of natural resources and social structures as influences on economic innovations in tribal communities.

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. Even the location of shifting agriculture is fixed for a period of time. 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 would have been quite limited. In addition, in these circumstances, farmers have had limited social security (their safety net was weak) because they lacked 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. Boserup (1965) makes it clear that overhead costs and the need for learning-by-doing (and in many cases communal cooperation) can be significant barriers to agricultural development in ‘primitive’ economies.

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 et al., 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.

The problems identified previously lead us to identify another limitation of Weisdorf's approach, namely the fact that cultural influences on decision making are ignored. Indeed, it seems – at least implicitly - from the reading of Weisdorf's paper that the primitive society is viewed from the perspective of a corporate entrepreneur or socialist central planner deciding where best to allocate 'human resources' whose identity is unchanged under different uses. However, it is possible that in some primitive economies a switch by part of the tribe to agriculture would be unthinkable in normal circumstances because of the importance of one's productive role to one's social identity in such societies (Thurnwald, 1932).

Both Thurnwald (1932) and Polanyi (1944), see also Polanyi in Dalton (1971), argue that economic activities of individuals are primarily determined by the constraints of social structures unlike in modern market economies. Finley (1999) adopts a similar point of view. Therefore, economic change and innovation must be related to social structures, customs and codes of behavior. This differs radically from the approach taken by Weisdorf. Also satisficing behavior by tribal groups should be similarly analyzed, as is considered later in this article.

More recently it has been argued that modern market economies are embedded in social institutions but that the socially accepted behaviors differ from those in earlier societies. For example, Gowdy and Krall (2013; 2014) claim that market economies exhibit ultrasociality. Furthermore, they are of the view that ultrasociality became (increasingly) more marked following the commencement of agriculture. Their view is at odds with the hypothesis of Polanyi and Thurnwald that social embedding was more marked in ancient societies than in modern market economies.

Despite their appropriate emphasis on the importance of social structures as an influence on economic behaviors and the operation of economics, theories of economic embedding as proposed by Polanyi and by some other economic anthropologists, appear

to suffer from a significant limitation because they do not adequately answer the following question: If ancient economies and the behavior of individuals were as deeply embedded in existing social structures and cultural constraints, as is claimed, why and how did they manage to evolve? While some such societies displayed little or no social and economic evolution, it is clear that many did evolve, albeit in different ways and with different rates of change. It seems that on a global scale, social and economic evolution was at first slow but subsequently accelerated. Presumably, forces of circular causation played an important role in this evolutionary process; economic change resulted in altered social structures and changed social structures influenced economic change and innovation. These processes are not adequately considered in the theories of the economic anthropologists just considered, and are not taken into account at all by Weisdorf.

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 'laborer' 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 optimization is also contentious. Weisdorf's (2005) modelling implies that they maximized output relative to their effort. However, it is unclear in his analysis for what length of time output was maximized 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; Sahlins, 1968) contend that not all Neolithic social groups were maximizers, 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 realize the level of income to which they aspired. Nevertheless, two different

types of behaviors 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 behavioral 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 behavior 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 labor) 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_1units of labor 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 maximize the tribe's income per head. To maximize the tribe's income per head, some labor needs to be employed in agriculture. For example, by employing $L_1 - L_0$ units of labor 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-maximizing one, which would require the marginal productivity of labor 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.

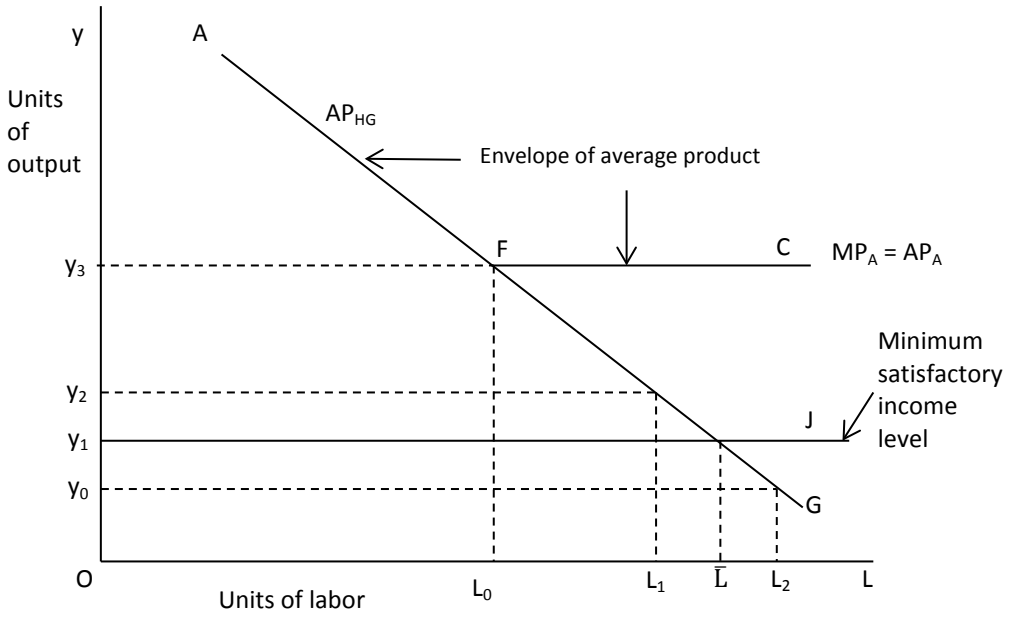

Figure 3: An illustration of income-satisficing behavior and its influence on the choice between foraging and agriculture.

In Weisdorf's (2005) modelling, the level of population is assumed to be a constant multiple of the available units of labor. Both the number of available units of labor 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 labor force. For example, Childe (1965) suggests that in agriculture the demand for labor is likely to be greater than in foraging and this favors 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 eventually increased after agriculture commenced and this triggered the first demographic explosion in history (Guzman and Weisdorf, 2011; Childe, 1965; Locay, 1989).

Guzman and Weisdorf (2011) present a model based on the economic optimizing decisions of a representative agent to explain why the development of agriculture in Neolithic times stimulated economic growth. This is an 'as if' model which makes no allowance for behavioral diversity of different tribes due to varied social structures. The extent to which it mirrors reality is not obvious. The idea of a representative agent seems rather fictitious. It assumes away principal-agent problems and fails to take account of the influence of social relationships on decision-making in societies and their consequences for economic development. This type of economic optimization approach fails to explain why some tribes did not adopt agriculture (or delayed it adoption) when they knew about it and could have increased their income levels by adopting it. Consequently, this placed them eventually in most cases at a competitive economic disadvantage with successful earlier adopters of agriculture.

After agriculture commenced, the social structures of many communities adopting it altered. Some types of agricultural development in the second stage of the Neolithic Revolution, as identified by Childe (1965),enabled palace-dominated societies to emerge and these were accompanied by ruling elites. As suggested by Childe (1965), and as further considered by Tisdell and Svizzero (2015) and Svizzero and Tisdell (2014a), these elites may well have attempted to extract the maximum level of economic surplus from their subjects. Therefore, the communities involved became embedded in a different set of social and economic relationships than those prevailing in their preceding tribal situations, and the dynamics of economic development changed in ways suggested by Tisdell and Svizzero (2015) and Svizzero and Tisdell (2014a).

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 behavioral patterns that presumably existed in different 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 Behavioral 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 optimization 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 organization was required. This was illustrated above as involving a 'lumpiness' problem or as entailing significant overhead or initial costs. Boserup (1965) provides examples of this problem.

Winterhalder and Kennett (2006) identify optimization, marginal values, opportunity costs, discounting and risk-sensitive behavior 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 often 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 foraging. 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). 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 within, as well as between, tribes or bands. 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.

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 where plans to create a Mikea Forest National Park began with the elimination of slash-and-burn maize agriculture and the encouragement to plant labor-intensive manioc instead. Time preference – which is typically described by a discount rate - refers to how one judges the value of a smaller reward available immediately versus a larger reward available after a delay. The result of the experiment was the following one : “Of 81 adults asked how they would cope with the elimination of maize in 2003 and 2004, only about half (N=41) said that they planned to become manioc farmers; the remainder said they planned to specialize on foraging and fishing (N=37) or market activities (N=3)”, (Tucker, 2007, p. 196).

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? Human behavioral ecology focuses on the costs and benefits associated with individual-level subsistence decisions in localized ecological settings. When it is considered in its simple formulation, this approach to human behavior corresponds to a basic pattern of "pursuit of pleasure - avoidance of pain". However this leaves open the question of how much time is (or should be) spent on trying to

maximize net pleasure. Too much time spend doing this can reduce total pleasure and have other negative consequences as pointed out by Earl (2013). Earl (2013) argues that ‘excessive’ deliberation by hunting and gathering tribes would have had a negative effect on their biological fitness. He maintains that sensory rewards serves an evolutionary role by diverting people from thinking too much about what they are doing in situations in which deliberation might interfere with survival or reproduction. (Earl, 2013, p. 1263)

Furthermore, Winterhalder and Kennett (2009)stress the need to take account of risk-sensitive behaviors 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 optimizing behavior by individuals or groups. It is clear that Neolithic societies varied considerably in their social organization 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 behaviors 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 optimizing 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 behavioral 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 behavioral ecology.

The analysis of optimal behavior is a key feature of both mainstream economic modelling and behavioral ecology. However, in both cases, there is difficulty in deciding accurately on what is being maximized or minimized, that is identifying the relevant objective function, and there is a temptation to assume that a single variable is being maximized or minimized. For example, profit maximization by firms is a standard assumption in neoclassical economies, and maximizing 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 behavior and may fail to identify ‘successful’

behaviors(Tisdell, 2013, pp. 138-141). As the ecologist Marion Dawkins (1986, p. 21) stresses, efficient feeders may not be optimizers 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 maximized relative to the amount of labor 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 maximizing 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 maximize their net energy returns from hunting and gathering because they take into account their social benefits from engaging in such activities. 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 behavior, 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 optimizing 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 maximize their chances of survival and foster economic growth. This assumes that survival of the fittest depended on the fittest being optimizers. However, in reality, chance rather than rational optimization 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 optimizers 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 behavioral 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 appear not to fully appreciate the variety of behavioral 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 optimization 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 behavioral 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. There are also other models of behavior, such as those of Ryan and Deci (2000) and Aunger and Curtis (2013), which could be relevant to this transition but which have yet to be applied to this issue.

Why such societies adopted a satisficing rather than an optimizing approach to the economic change and the nature and dynamics of this satisficing behavior requires further consideration. Furthermore, apart from considering whether satisficing behavior is of a prospective or reactive nature, different types of apparent satisficing behavior need to be considered. For example, there are at least three types of circumstances which can give rise to behavior that appears to be of a satisficing nature. 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 benefit; 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 behavioral ecologists need to pay greater attention to the limitations of the concept of economic man and should allow for a greater diversity of human behaviors (some of which are being revealed by advances in experimental and psychological economics) than those behaviors singled out by Winterhalder and Kennett(2006; 2009) for functional applications in anthropology.

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. Nevertheless,

this theory has not been tested and it leaves out of account several factors which appear to have been important influences on the behaviors 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 behavior. In our view, human (economic) behaviors are diverse, are significantly influenced by prevailing social structures 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 optimization models proposed by human behavioral ecologists seem to be too narrow in their perspective and they need also to be supplemented by additional theories. Although human behavioral ecologists have proposed specific optimization models to explain the possible foraging strategies of hunter-gatherers, they have not articulated the particular type of model developed by Weisdorf. Despite this, Weisdorf's model is compatible with the type of approach favored by human behavioral ecologists. Behavioral 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 social impediments to economic change.

Winterhalder and Kennett mostly rely on optimization and neoclassical microeconomic concepts, such as marginalism, to explain the behaviors of hunter-gatherers and their transition to agriculture. They also state that transaction costs could be relevant but do not give examples. Transaction costs are central to the theories of neo-institutionalism (Coase, 1937; Williamson, 1975) and reflect economic constraints arising from processes of social organization. Therefore, the economic concepts which Winterhalder and Kennett see as important for understanding the matters under investigation are wider than the set utilized by Weisdorf. Nevertheless, neo-institutional economics only considers narrow features of social embedding of human behavior. This is because at

least three types of factors influence social embedding. These are:

- Impediments arising from group (social) decision-making, such as transaction costs and problems of conflict resolution (see for example, Olson, 1965; Tisdell, 1996, Ch. 8).
- The extent of social (cultural) determination of human preferences.
- The nature of social approval/disapproval of different types of human behavior.

Weisdorf does not consider any of these factors in his theory and Winterhalder and Kennett recognize (1) but not (2) and (3). While Thurnwald and Polanyi stress the importance of cultural embedding, factor (2), they do not pay attention to (1) and do not give due consideration to the processes which bring about changes in (2) and (3). So we find that these theories either pay no attention to social embedding or only take into account limited features of social embedding of human behavior. Holistic theories need to take into account all of these factors. This, however, is a daunting task and may explain why all existing theories about the reasons for economic transition in relation to human behavior are partial in nature.

Social embedding is clearly a complex phenomenon. Its depth depends on the structure of existing social organizations and methods of administration, communal customs and beliefs and ingrained social rituals. These are all potential barriers to economic evolution. They influence the social and individual transaction costs in bringing about major economic transitions. They also seem likely to limit the scope for exercising collective rationality in choosing economic development paths, especially rational behavior of the type associated with neoclassical economics. Although social embedding occurs in modern societies, we appear to be more aware of its presence in ancient and ‘primitive’ economies. D’Altroy (2015) for example, provides a considerable amount of information on the nature of social embedding in the Inca empire.

In short, it has been argued that behavioral theories which rely on optimizing economic behavior and marginalism in order to explain the transition from hunting and gathering to agriculture are far too narrow. This is a result of their adoption of a partial reductionist approach to trying to explain socio-economic evolution. A larger picture is

needed to explain the genesis of socio-economic change. Among other things, they overlook diverse forms of satisficing behavior and fail to take account of social embedding. As well, the dynamics of the 'formation' of behaviors and the presence of social irreversibilities (resulting in path-dependence and which can occur in processes of human development) are given no consideration.

To conclude: In our view, social structures, the nature of economic activities and behaviors are interdependent. Therefore, they need to be simultaneously taken into account in theories of socio-economic evolution and in analyzing the nature of economic behaviors. It has been argued that to date microeconomic theories and those proposed in human behavioral ecology as well as those based on the extreme embedding of ancient economics in social structures provide incomplete explanations of the evolution of Neolithic societies. These theories are not yet satisfactory for reasons outlined in this article. Further work is needed to develop relevant theories which encompass the interdependent influences of both social and economic factors.[9]

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