The Variable Time: crucial to understanding Knowledge Economics

Khumalo, Bhekuzulu

Bhekuzulu Khumalo

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Abstract: Though time is a concept mostly associated with physics and philosophy, the concept of time is important to be understood in the discipline of economics. This paper attempts to highlight the importance of time in economics, particularly in knowledge economics, the discipline of economics that looks into the primary commodity, knowledge. The paper attempts to take into account the non linear time concepts that have been very important since Einstein published his papers back in 1905. Without understanding time in a comprehensive manner, it is not possible to have a firm grip on the process of the economic progression of all societies. A theory must hold true in all societies, the characteristics of time must be the same in all societies, as an atom must behave the same in similar laboratory conditions in all societies. This paper will illustrate that without understanding the variable time, it is not possible to fully comprehend knowledge economics.

A meaningful treatise of time as related to economics, and other would be sciences in the 'social science' arena would make the understanding of these disciplines more meaningful. Philosophy an art has the advantage of embracing disciplines that change our outlook on life, social sciences on the other hand, though clearly claiming to be sciences are far behind philosophy in adapting new understandings into their syllabuses. Without a clear understanding of the variable time it would be very difficult to understand knowledge economics, it would be safe to say that it would be very difficult to understand the progression of society in an economic sense and the reasons why so many societies keep on falling behind whilst others seem to race ahead.

Having failed to consider the importance of the variable time it is up to this paper to bring this concept in an economics paper. We shall start of with a simple definition of time from the dictionary, looking up time in the dictionary www.dictionary.com and looking under the American Heritage Science dictionary we get a definition of time as:

1. A continuous, measurable quantity in which events occur in a sequence proceeding from the past through the present to the future.
2.
    a. An interval separating two points of this quantity; a duration.
    b. A system or reference frame in which such intervals are measured or such quantities are calculated.

Clearly from the definition of time we understand time as a continuous forward moving process. We can not go back in time, we can not go back and change things we hate because time moves from the past, to the present, to the future. As investigators in a phenomenon we must always start with a definition. Having a definition we shall now strive to see why it is so important to understand time especially for knowledge economics and literally for any social science that endeavors to explain the progression of mankind.

As economics has failed to explore the variable time, our understandings of this variable will have to come from the field of science that was pioneered by the likes of Einstein, Stephen Hawking, Kip Thorne, and a philosopher such as Michael Lockwood, why, because these men bothered to look into the phenomenon of time.

The Independent Variable Time

Time moves ever forward, trend analysis is a very important feature of economics. The issue of time is taken for granted, it is an independent variable and a dependent variable usually increases over time, we expect economic growth to grow over time, we expect the population to grow over time this view coming back from the days of Malthus who believed that population grows at a geometric rate whilst agricultural output grew at an arithmetic rate. The vies of Thomas Malthus have been challenged largely as a result no less to explosion of use knowledge, food out put has largely kept up with the population growth in societies that respect knowledge, in societies that do not respect knowledge hunger is the order of the day. However Malthus' of time are still largely accepted. Time by this reasoning is independent, there is nothing we can do, the dependent variable grows with the changing of the independent variable time.

This view is prevalent in economics we see this in the expression of economic models. When we look at an economic model that includes the variable time be it t or a lag t-1, time clearly is always associated with an independent model. Let as take a simple model as demonstrated in figure 1, a simple model based on the function Y = X. This model though saying Y is equal to X also has a very meaningful meaning over and above the equality of the two variables. There is a clear establishment of dependence in the relationship. The variable on the left hand side is dependent on the variable on the right hand side of the equation. This fact is taken for granted by anybody who has done simple equations even before budding fifteen year old mathematicians understand this fact. By dependent we mean that Y changes in relation to changes in X, not the other way round. This makes sense as we see in figure 2 whereby the X has been replaced by t for time. It would seem nonsensical to say that t = Y implying that time changes in relation to Y as in figure 3.

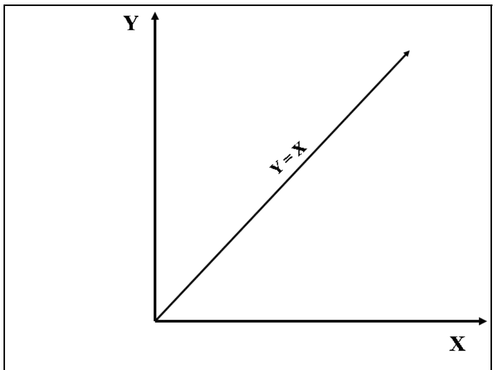

Figure 1

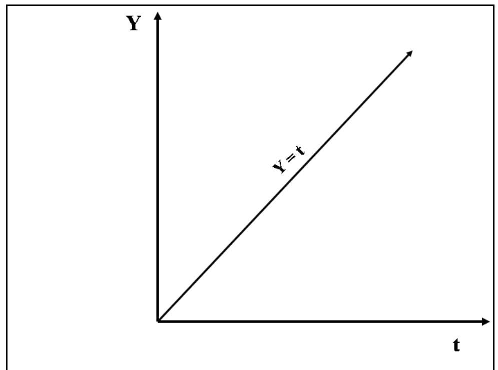

Figure 2

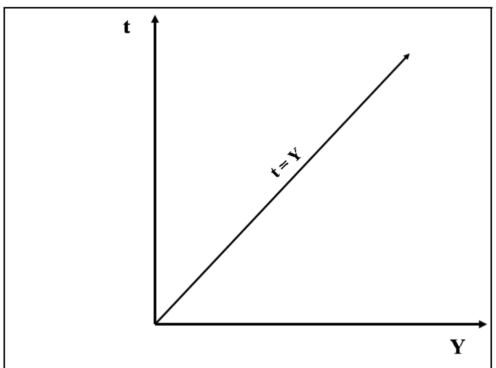

Figure 3

Figure 3 is interesting no matter how absurd. It just does not make sense, why? The reason is that once we take t as an independent variable it means that with changes to Y t changes, t does not influence the variable Y, it is changes in Y that cause time to change, this would not make sense in economics thus far because what people are interested in, I dare say even biologists, what scientists are interested in is changes over time, hence the establishment in economic models indeed biological and well as chemical models the importance of changes and growth over time. Time is taken as a linear progression, there is nothing we can do, it moves ever forward. Take a culture of bacteria, how much does it grow over time, how much does a substance crystallize over time, how much does the economic output change over time, how much knowledge does a society have over time, all logic that points towards the independence of the variable time, independent from our actions, seemingly independent from actions.

Figures 1 – 3 illustrate a linear function, but as we know functions are hardly ever in a linear relation, they can be quadratic, multi variable, logarithmic, exponential, binomial, there are all sorts of non linear relations that have been identified by mathematicians. An economic model is usually of the type that considers multiple variables such as, $Y = Y_{t-1} + X_1 + X_2 + \ldots + X_n$. Note the Y is dependent and depends on the variables of all the other independent variables to the right of the equals sign.

Returning to time we do not often see a function of the type illustrated by figure 3, we do not see time as the dependent variable, we always seemingly assume that something changes with time. With knowledge economics it is the same, thus far we assume that knowledge grows over time, however as illustrated in paper, "The Fundamental Theory of Knowledge", knowledge does not always increase with time, in many instances knowledge is lost with time, civilizations have come and gone throughout history, they came, gathered knowledge today archeologists and students of history are still trying to decipher the secrets of the Maya's, the Egyptians, the Babylonians, all knowledge that simply seemingly just vanished. Take the simple concept of supplying a city with clean water, with the collapse of Rome, so did this concept of supplying cities with clean water from a far disappear, the knowledge was seemingly lost. The people rebelled against all things Roman, they wanted to go to how things were before 'Roman Civilization' it would take a millennium to recover the knowledge they rejected.

But for now let us assume that in a stable society that adheres to the laws of knowledge as laid out in the book, "The Fundamental Theory of Knowledge", knowledge grows from time period to time period.

A second and important assumption that also needs to be made concerns the theory of relativity as attributed to Albert Einstein is correct, however as one will see from this paper that theory seems to be correct and taking the same principles to knowledge economics they are again re-enforced as correct. It is simplicity that allows us to truly understand concepts.

The Logic of Time

Figure 4 depicts two societies, society A and society B. Society A is represented by the mathematical expression Y = at and society B is represented by the mathematical expression Y = bt. Where;
Y = knowledge in knowls
t = time
a, b = rate of change, i.e. the slope of the functions, clearly from figure 4 a > b.
Knowls it must be recalled are units of knowledge as first laid out in the book "The Fundamental Theory of knowledge" and used to show how to calculate how much knowledge a society has in the paper "Measuring a Societies Knowledge Base".

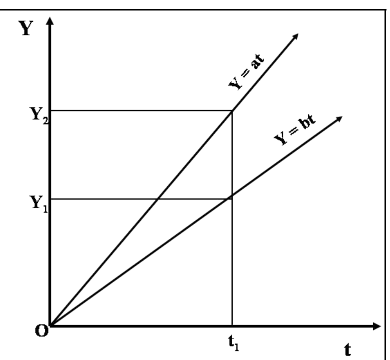

Figure 4

At O, both societies have the same amount of knowledge. At time t_1 society A has Y_2 amount of knowledge and society B has Y_1 amount of knowledge. Clearly society A has more knowledge than society B, one can say society B is behind society A, but behind in what terms, clearly not in time, they are both at time t1. We could take the two societies as two individuals A and B who are taking mathematical course. At time t1 student A has more knowledge than student B, but they are both in the same room at that instant, therefore in terms of time they are clearly at the same time, the only differentiation we can tell from figure 4 is the difference in knowledge. They could be sitting at the same desk for all we know.

Time has been described as a distance covered. This analogy has been used by civilizations throughout history. Before people started having proper measuring yards the used to measure distance by the time it took to get there, how far is the next village, it is half a days walk, how far is the army, it is three days away but at a heavy march it is two days away. With a heavy march it is two days away, clearly if one walked faster it was ascribed to somehow the distance getting shorter.

It is interesting to note that distance got its units as a need to standardize measurement. Through the long historical process we arrived at a meter, a meter was defined as "Historically, the metre was defined by the French Academy of Sciences as the length between two marks on a platinum-iridium bar, which was designed to represent $^{1}/_{10,000,000}$ of the distance from the equator to the north pole through Paris,"(www.wikipedia.com). This clearly took out any relation to time, therefore one could walk fast or slow, by implication one would still walk a measurable distance. Thus five kilometers was fixed, when asking distance now one no longer needed to say it is a half day walk they will tell you it is five kilometers, 5 000 meters. How fast you walked did not matter, if one was strong it was an hours walk and if one is strong it is an hours walk, if one is week it is half a days walk. The concept of time was removed from the definition of distance. However, it is interesting to note that scientists with more understanding of time have once again tied distance to time, the modern definition of a meter is defined as "the distance light travels in 1/299 792 458 of a second." (Mermin)

Returning to figure 4 both A and B are at the same time however A has gained more knowledge than B has. What has occurred. In the time between O and t_1, clearly A has done more work than B in seemingly the same time frame, that time frame being defined by being between O and t_1. For a better insight we must look at relativity. However we need to adapt the relativity investigated by man like Einstein, Thorpe, and Hawking to the needs of economics, and in this case to the needs of knowledge economics.

Take a principle of relativity, "the rate of flow of time depends on the state of motion of the observer: a clock in a moving laboratory appears to tick more slowly than a set of identical clocks distributed throughout a reference laboratory," (Will). This principle is important in understanding totally what has occurred in figure 4. Something that is moving, for something to move there must have been an initial force applied. Once that initial force is applied that something moves, when it moves time slows down. This is a scientific principle. A famous illustration is that of two twins, one remains on earth whilst another twin flies of into space at speeds close to the speed of light. When the twin who flew into space returns they will find the twin they left on earth several years older, why? Because the faster one goes the slower time moves. What does this imply.

The first implication for economists should be that the second twin, the twin who flew to space and returned but was significantly younger than the first twin, this twin can do more work than the first twin. Lockwood has a satisfying example of two twins he calls Lorna and Harriet. Lorna stays on earth and Harriet travels four light years out into space at a speed of four – fifths the speed of light and then she returns, she gets back after ten years on our earth time. With calculations that Lockwood performs it is found that whilst ten years have passed for Lorna, for Harriet only six years have passed. Therefore if Harriet leaves on her journey in say 2010 and returns in 2020, it will seem to her as if it is 2016.

Harriet has the ability to do more work than Lorna if their work rate is the same, because for Harriet time has slowed down. This must be grasped. Time has slowed down because of a motion that has been applied, in the case of Harriet the thrust produced by the rocket. We must now adapt these principles of force, speed, and motion to economics to explain what is occurring in figure 4.

This concept of time dilation is exists in real life out of the realm of theory. "The fact that length contraction and time dilation, as I have presented them, are relative to inertial frames might lead the reader to conclude that they can have no objective – that is say, *frame-invariant* – effects. But this would be a mistake, as the following example makes clear. There are particles called *muons* that resemble electrons but are heavier and unstable. They have an experimentally established *half life*: a time interval within which there is a fifty-fifty chance of any given intact muon decaying. Muons are constantly being created in the upper atmosphere, as a result of cosmic rays striking air molecules. It is known, roughly speaking, at what altitude, on average, these muons are created, at what rate they strike the earth, and how fast they move. But when this information is juxtaposed with the muon's half-life, as measured in the laboratory, a discrepancy appears. The figures are ostensibly telling us that a far higher proportion of the muons created in the upper atmosphere make it to the earth's surface, without decaying *en route*, than should reach the surface, given their half-life and the speed at which they are traveling. Relativistic reasoning can resolve this paradox. Since the muons are moving at an appreciable fraction of the speed of light, they are subject to substantial time dilation. As measured by our clocks, therefore, they decay at a significantly lower rate than the less rapidly moving muons studied in earthbound laboratories," (Lockwood).

From above paragraph we have a satisfactory explanation of what relativity can explain, though for more proves one would have to read extensively books written by scientists who deal with relativity on a daily basis.

The experiment with the muons demonstrates that the faster something goes, the more time dilates, and the more work that can be done. Looking at figure 4, clearly A has done more work than B. Work done in this case being to gather knowledge. We must differentiate between work done and effort. Effort only becomes work done when the aim of the effort is realized. If one for example wants to gather knowledge they might spend time on investigating, if however that investigation turns up no new knowledge, no matter how much time was spent, no matter how much effort was expanded, no work done would be the end the result.

As A has done more work in the same time frame, somehow, A had more time dilation in relation to the knowledge they were seeking, be A a society, a business unit, or an individual. When A and B compare their results, they will find that though in the same time period it seems as if A was operating at a slower time, as if A had more motion, motion been caused by a force. Assume that A and B are of equal intelligence, and at O had equal knowledge, they are the same physiologically in every way. It therefore can only be one cause of A been ahead of B, A has put more effort into the process. In this case by effort it is mean personal time into the process. Say in a day, A puts 9 hrs into the gathering of knowledge process whilst B on the other hand puts in 6 hours a day. All other things being equal that extra effort means per day, A will put more effort and therefore do more work than B. As work is proportional to effort, being similar in terms of physiology and starting knowledge as can be seen in figure 4 both start at knowledge equivalent to O.

The above explanation for figure 4 might seem obvious, but societies have failed to a large extent to head this advise. The less developed countries are essentially behind because they have not put in the effort to the knowledge gathering and use process as the more developed countries. It is a matter of effort. In a way this process of slowing down time and doing more work has been understood since Rostow laid out his take-off model. Basically this model states that there needs to be certain conditions for take off, unless a country finds huge oil fields, then take off should be easier, but even with countries with huge oil fields like Kuwait and Saudi Arabia, they are not industrialized, they hardly produce any original knowledge be that knowledge in the form of new laws of existence or improvement of products, or new products for that matter. Criticism of Rostow's model to a large extent is for criticisms sake and not constructive, a good criticism however is that he talks of mature economies, there is no such thing, economies are constantly growing and changing. The Take off stage a large amount of effort is need to get the economy 'moving'. The more it 'moves', the more work can be done.

Limits to Knowledge Increase

Let us forget about B for now, it is simple to understand that given figure 4 and certain assumptions that indeed time did slow down for A because A had greater motion than B. By dropping B, we can now analyze what is happening to A, are there limits to knowledge increase, what determines these limits, and what are the implications of these limits?

Let us take figure 2, a simple linear function, let us assume this linear function is the growth rate of knowledge in a society, any society, let us call this society, society A. To remind in figure 2, Y = knowledge in knowl, t = time, the time we are used to. As figure 2 is a linear function, knowledge growth occurs at the same rate, therefore for the society in question time moves at the same pace in terms of knowledge growth, after each time period equal amounts of knowledge are gathered. This is not realistic, the proper growth of knowledge was discussed in the paper “Short and Long Term Behavior of Knowledge.” What we merely want to do is illustrate the limits of the growth of knowledge.

Looking at table 1 we see a table with the independent variable time, t, the dependent variable knowledge, knowl, and the mean of gain in knowledge, or in simple terms the average gain of knowledge. The average/ mean gain of knowledge is the average of the knowledge rather than the total. For example take when the independent variable time is at 11. To work out the mean we simply add all the previous totals and divide by time. Therefore the mean when time is equal to 11 is:

(11 + 10 + 9 + 8 + 7 + 6 + 5 + 4 + 3 + 2 + 1)/ 11

= 66/11

= 6

Then we take the ratio of the mean over the amount of knowledge and turn it into a percentage and we see that at time t the ratio between the mean amount of knowl and the total knowl is 54.5%.

Why is this knowl/ mean ratio so important? It is important because it determines the increase in the knowledge base as compared to the mean. The lower this ratio the greater the difference the total knowledge will be to the mean showing an ability of knowledge to increase at a faster rate. In general however we can say:

Mean/ Knowl ratio = MK

MK <1/ 100% = increasing knowledge

MK > 1/ 100% = decreasing knowledge

In all linear functions this ratio approaches 50% or 0.5. Therefore the limit in a linear relation is that the difference between the mean and the total knowledge can never be greater than 50%. Though table 1 shows a simple linear relationship, the ratio is the same with all linear relationships.

Time	Knowl	Mean	Mean/ Knowl %
1	1	1	100.0
2	2	1.5	75.0
3	3	2	66.7
4	4	2.5	62.5
5	5	3	60.0
6	6	3.5	58.3
7	7	4	57.1
8	8	4.5	56.3
9	9	5	55.6
10	10	5.5	55.0
11	11	6	54.5
12	12	6.5	54.2
13	13	7	53.8
14	14	7.5	53.6
15	15	8	53.3
16	16	8.5	53.1
17	17	9	52.9
18	18	9.5	52.8
19	19	10	52.6
20	20	10.5	52.5

Table 1 Y = t

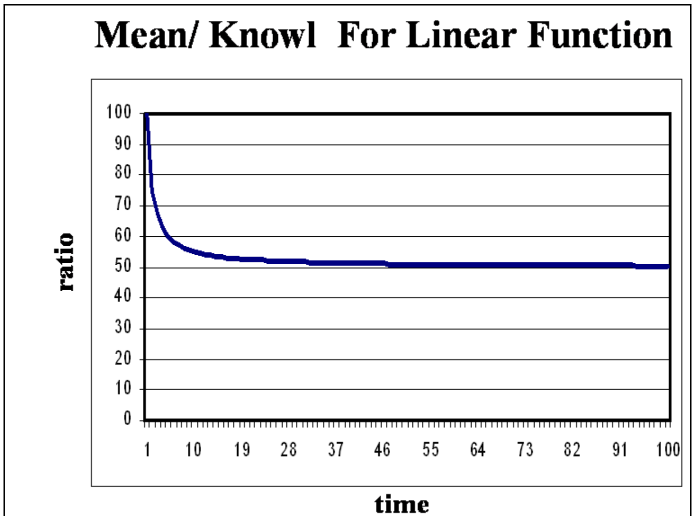

Figure 5

Figure 5 illustrates the graph of the mean/ knowl ratio as a percentage from t = 1 to t = 100. This is for any linear function, the figures above are taken from a function Y = 2t. As can be seen the ratio never goes below 50%, 50% as essentially an asymptote.

Interesting to note from table 1 is the relationship between the mean and the total knowl. The mean is equal to:
(knowl + rate of increment)/2… (1)
Therefore at time 17 given table 1 the mean is:
(17 + 1)/ 2 = 18/2 = 9

Table 1 and figure 5 illustrate the properties of a linear relationship. This relationship rarely occurs in reality, in reality the relationship is more complex than a linear relationship. There are all sorts of more realistic relationships logarithmic, exponential, multi variable, polynomial, however in this paper we are merely interested in understanding the concept of time. A linear relationship shows that constant increases in knowledge mean that in terms of knowledge, time is flowing constantly.

Interesting to note here is the mean/ knowl ratio. Looking at table 1, one can clearly see that the relationship of knowl to time is linear, as well as the relationship of the mean to time, however, the ratio of the mean to knowl is not linear as illustrated in figure 5.

As most relations are not linear it is interesting to note the relationships of other mean/ knowl ratio. Looking at polynomials, let us take a simple polynomial to the power of 2, table 2 shows figures for a polynomial to the power of 2, $Y = t^2$.

Time	knowl	Mean	Mean/ Knowl %
1	1	1.0	100.0
2	4	2.5	62.5
3	9	4.7	51.9
4	16	7.5	46.9
5	25	11.0	44.0
6	36	15.2	42.1
7	49	20.0	40.8
8	64	25.5	39.8
9	81	31.7	39.1
10	100	38.5	38.5
11	121	46.0	38.0
12	144	54.2	37.6
13	169	63.0	37.3
14	196	72.5	37.0
15	225	82.7	36.7
16	256	93.5	36.5
17	289	105.0	36.3
18	324	117.2	36.2
19	361	130.0	36.0
20	400	143.5	35.9
30	900	315.2	35.0
40	1600	553.5	34.6
50	2500	858.5	34.3
60	3600	1230.2	34.2
70	4900	1668.5	34.1
80	6400	2173.5	34.0
90	8100	2745.2	33.9
100	10000	3383.5	33.8

Table 2 $Y = t^2$

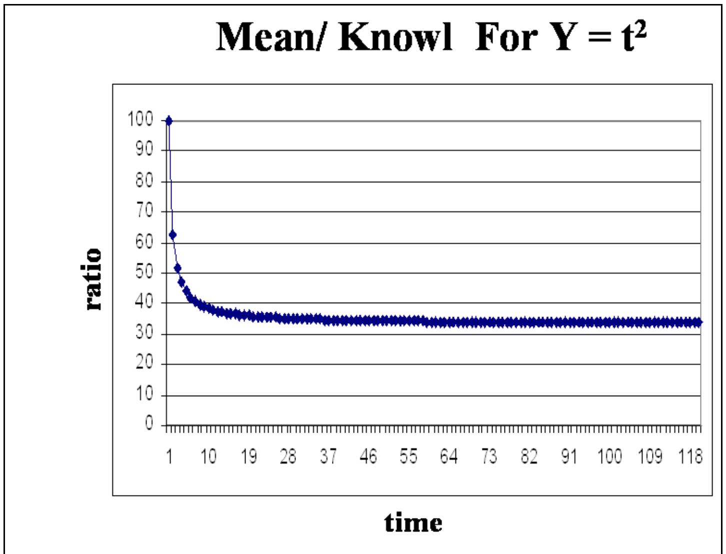

Figure 6

Given a polynomial function to the second power, the mean knowl ratio approaches 0.33 or 33% or a third. This means that the total amount of knowledge never increases above three times the mean. Been below 50% it means that the difference is increasing faster than a linear rate. The mean/ knowl ratio being at 33% however still limits the increase in growth of knowledge. However been below 50% means that time is no longer constant, each time period means that more knowledge is added than the last time period. Only when

50% is the asymptote does it mean time is constant. An asymptote below 50% means slowing time as more work is done per the same time period.

A linear function is a polynomial to the power of 1. Accept this and it will make what is to come easier to understand. The MK, mean/ knowl ratio below gives the asymptotes for various polynomials. As one can see, the higher the degree of the polynomial, the lower the MK ratio as expected the greater the time dilation because one is gathering more knowledge than the mean.

As can be seen from table 3 there is a set pattern, the asymptote of the MK is defined by the degree of the polynomial. The asymptote of the mean/ knowl ratio is simply the degree of the polynomial plus one and this becomes the denominator, and the numerator is always one. A polynomial such as:
$a_nx^n + a_{n-1}x^{n-1} + \ldots + a_2x^2 + a_1x + a_0$ will have an asymptote of
1/ (n+1).
We are dealing with positive numbers as t can not be negative the way that we understand it thus far, we can not physically go back in time though mentally we can assume.

Degree of Polynomial	Asymptote of MK	
	Percentage	fraction
1	50.0	1/2
2	33.3	1/3
3	25.0	1/4
4	20.0	1/5
5	16.7	1/6
9	10.0	1/10
10	9.1	1/11
99	1.0	1/100

Table 3

There are two functions that are fundamentally linked to knowledge, the exponential, e, natural logarithm, ln, and other logarithmic functions.

The exponential function has the distinction of having the asymptote of the MK ratio at 0. This means the mean can be very low as compared to the knowl value gained at the present. This shows that a lot of knowledge can be gained in the next period as compared to the present period. As this is the property of knowledge in the long term, in the long term what is there is the unknown, all the properties of existence and with each gain of knowledge it adds more fuel to give us greater speed dilating time even further if we keep up the same work rate. With more laws of existence known the more products that can be created, more importantly however the easier it is to see existence and visualize the future, and visualize what ought to be out there.

Time	Knowl	Mean	Mean/ Knowl %
1	2.718281828	2.7182818	100
2	7.389056099	5.0536689	68.393972
3	20.08553692	10.064292	50.107157
4	54.59815003	21.197756	38.825044
5	148.4131591	46.640836	31.426348
6	403.4287935	106.10549	26.300923
7	1096.633158	247.60944	22.579059
8	2980.957987	589.278	19.768075
9	8103.083928	1424.1453	17.575349
10	22026.46579	3484.3773	15.819048
30	1.06865E+13	5.635E+11	5.2732552
50	5.18471E+21	1.64E+20	3.1639529
70	2.51544E+30	5.685E+28	2.2599662
90	1.2204E+39	2.145E+37	1.7577514
110	5.92097E+47	8.515E+45	1.4381602
130	2.87265E+56	3.496E+54	1.2169047
150	1.39371E+65	1.47E+63	1.0546506
170	6.76179E+73	6.292E+71	0.930574
190	3.28059E+82	2.731E+80	0.8326188
210	1.59163E+91	1.199E+89	0.7533218
250	3.7465E+108	2.37E+106	0.6327902
300	1.9424E+130	1.02E+128	0.5273251
400	5.2215E+173	2.07E+171	0.3954937
500	1.4036E+217	4.44E+214	0.3163948
700	1.0142E+304	2.29E+301	0.2259962
Table 4 $Y = e^t$			

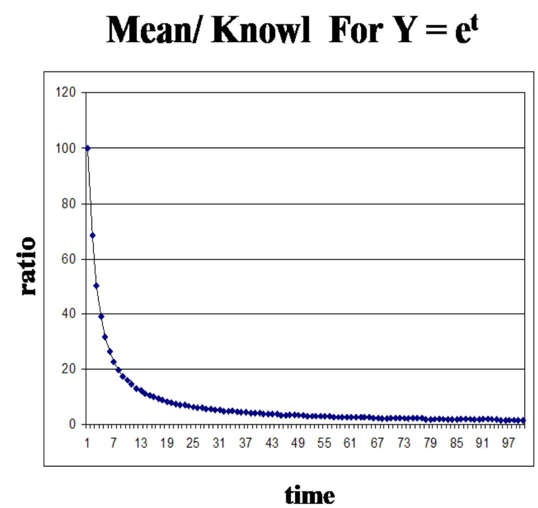

Figure 7

Looking at figure 7 and table 4 we see the ratio is applied to an exponential function, time dilation keeps growing limited by an MK of zero. An exponential function demonstrates one of the more powerful growths of knowledge, but there is a limit to defines the growth of knowledge as demonstrated by the MK ratio. This illustrates that the knowledge is not instantaneous, there is a process, only when MK ratio equals zero is knowledge growth instantaneous. Though in the long run we have a exponential growth, we are far from the stage where the MK ratio is close to zero, close to zero time dilation itself becomes meaningless time would literally be standing still, the increase in knowledge per time period would become so much greater than the mean that the mean would only be a fraction of the real knowledge of the society, person, or whatever type of unit, business or otherwise.

When looking at table 4, at time 30 knowledge = 1.06865E+13knowl, this means 1.06865 X 10^{13} knowl.

It must be kept in mind that these are just examples, in real life there are many constraints to gathering knowledge, it is not a straightforward exponential relation, the long term growth of knowledge is defined by:
$Y = f(e^x, Yu)$ … 2 where
Yu serves a constraint. To see explanations one needs to read the long and short term properties of knowledge.

Logarithmic functions on the other hand have their own properties unique from all the previous functions we have dealt with thus far. We shall first look at the natural logarithm, ln. We can see its properties in table 5 and figure 7.

Time	Knowl	Mean	Mean/ Knowl %
1	0	0	N/A
2	0.693	0.347	50.000
3	1.099	0.597	54.364
4	1.386	0.795	57.312
5	1.609	0.957	59.493
6	1.792	1.097	61.199
7	1.946	1.218	62.587
8	2.079	1.326	63.747
9	2.197	1.422	64.737
10	2.303	1.510	65.598
11	2.398	*1.591*	66.355
12	2.485	1.666	67.029
13	2.565	1.735	67.634
14	2.639	1.799	68.182
15	2.708	1.860	68.682
16	2.773	1.917	69.141
17	2.833	1.971	69.564
18	2.890	2.022	69.955
19	2.944	2.071	70.320
20	2.996	2.117	70.660
40	3.689	2.758	74.766
60	4.094	3.144	76.784
100	4.605	3.637	78.985
200	5.298	4.316	81.463
300	5.704	4.716	82.688
500	6.215	5.223	84.038
1000	6.908	5.912	85.587
2000	7.601	6.602	86.855
3000	8.006	7.008	87.530
4000	8.294	7.295	87.958
5000	8.517	7.518	88.271
9000	9.105	8.106	89.024
10500	9.259	8.260	89.206

Table 5 Y = lnt

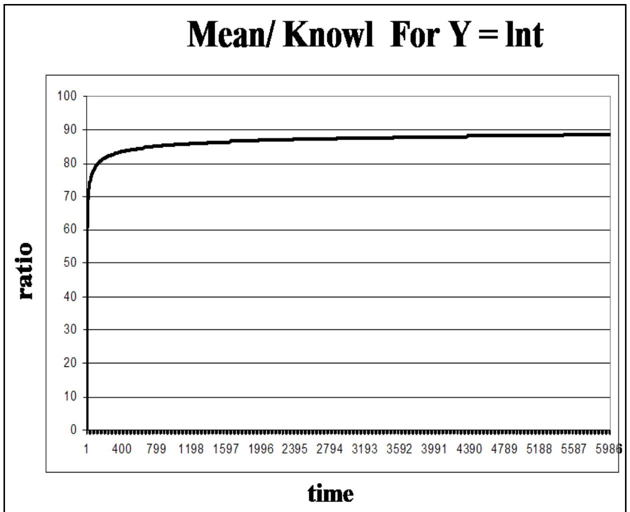

Figure 8

Firstly, as can be seen from figure 8, the MK ratio for a natural logarithmic function, in fact for all logarithmic functions rises from 50% and has an asymptote at 90% or 0.9. This is odd in that one would have initially expected the asymptote to be at 100% as opposed to the asymptote of the MK ratio for an exponential function at 0. The rising MK ratio of as illustrated in table 5 and figure 8 illustrate what is expected, that new knowledge grows smaller and smaller as compared to the mean, this invariably is the short term properties of knowledge, time dilation gets smaller and smaller, never though quite actually standing still.

Surprisingly due to the fact that the asymptote for the natural logarithm is 90%, knowledge gain never approaches zero gain as would be the case if the asymptote was 100%. However there is considerable slow down in the gain of knowledge, there is a considerable slow down in time.

Interesting again is the properties of all logarithmic functions. They all have identical MK ratios for the same t values as can be seen in table 6. This is a significant fact, this means that no matter what logarithmic function defines knowledge growth, be it the natural log or a log of base 10, 2, or 5, having identical MK ratios means that all logarithmic functions literally show the same degree of the gain of knowledge, what might appear more in lower bases is actually a parallel in terms of time. This incidentally is the same behavior for linear functions. Table 6 shows the mean/ knowl ratio for logarithmic functions, this serves to illustrate that the ratios are all the same.

Time		Mean/ Knowl Ratio			
	Log2	ln	Log5	Log10	Log15
1	0.00000	0.00000	0.00000	0.00000	0.00000
2	50.00000	50.00000	50.00000	50.00000	50.00000
3	54.36433	54.36433	54.36433	54.36433	54.36433
4	57.31203	57.31203	57.31203	57.31203	57.31203
5	59.49272	59.49272	59.49272	59.49272	59.49272
6	61.19917	61.19917	61.19917	61.19917	61.19917
7	62.58666	62.58666	62.58666	62.58666	62.58666
8	63.74670	63.74670	63.74670	63.74670	63.74670
9	64.73736	64.73736	64.73736	64.73736	64.73736
10	65.59763	65.59763	65.59763	65.59763	65.59763
100	78.98500	78.98500	78.98500	78.98500	78.98500
300	82.68816	82.68816	82.68816	82.68816	82.68816
1000	85.58682	85.58682	85.58682	85.58682	85.58682
3000	87.53043	87.53043	87.53043	87.53043	87.53043
5000	88.27120	88.27120	88.27120	88.27120	88.27120
10500	89.20556	89.20556	89.20556	89.20556	89.20556

Table 6 Comparing MK Ratios of Logarithmic functions

Time dilation depends on the function that applies, as has been seen from the above functions, time dilation is not equal as each function has frequently properties inherent to itself. The lower the mean knowl ratio the greater the possibilities of time dilation, however there must be enough effort applied by the society to truly benefit from the properties of knowledge.

Given that the process of gathering knowledge is a human effort, the more effort we put into the process the more effort we are likely to get out of it. The more knowledge we have the easier the process of gathering knowledge becomes, given that knowledge is not limited by a linear function as demonstrated in the paper the “Short and Long Term Behavior of Knowledge.” As it is our efforts that eventually determine the speed of gaining knowledge, the faster we gain knowledge the more time is dilated it means our efforts affect the rate of time, the work done affects the rate of time. This surely destroys our concepts of a linear time, there are aspects of time that are not linear, and these aspects are determined by us. The USA as well as Zimbabwe, Laos, are all in the same time frame 2008, even in 2050, there will be in the same time, but the USA has far greater knowledge than Zimbabwe, why? Because the USA has put effort into the process of gathering knowledge, by putting effort into the process time dilated, they did more in a year, in a day than Zimbabwe did. The Pygmies in the Congo exist like their ancestors did 1000 years ago, not a day has passed, time literally stood still as they put no effort into the knowledge process. It is simply about effort.

As time dilation depends on our efforts, it means that time is not a totally independent variable, time in many aspects itself is a dependent variable.

Marginal Gain of Knowledge

The marginal gain in knowledge is important in that it shows us the actual change in the rate of knowledge as compared to the last time period. The change in the marginal gain of knowledge shows us how much more the change is each period. This paper is only meant to make us understand the concept of time as it is applied to economics, specifically knowledge economics. The models constructed are very simple in order to aide our investigation. Let us take a simple model, Y = 2t, or say Y = 2X a very simple linear model. Figure 9 illustrates the marginal gain of knowledge for a simple model Y = 2X.

time, X	knowl, Y	MG	ΔMG
1	2	**2**	**2**
2	4	**2**	**0**
3	6	**2**	**0**
4	8	**2**	**0**
5	10	**2**	**0**
6	12	**2**	**0**
7	14	**2**	**0**
8	16	**2**	**0**
9	18	**2**	**0**
10	20	**2**	**0**
11	22	**2**	**0**
12	24	**2**	**0**
13	26	**2**	**0**
14	28	**2**	**0**
15	30	**2**	**0**
16	32	**2**	**0**
17	34	**2**	**0**
18	36	**2**	**0**
19	38	**2**	**0**
20	40	**2**	**0**

Table 7: Marginal Gain of Knowledge for Y = 2X

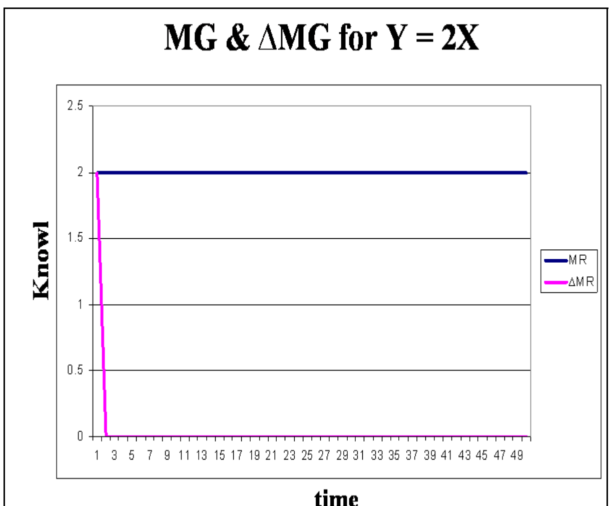

Figure 9

When we look at table 7. the figures that compile the graph for figure 9, we can see how we calculate the marginal gain in knowledge for Y = 2X. The marginal gain in knowledge is as explained above simply the level of knowledge in time t_n minus the amount of knowledge in time t_{n-1}. Thus at time 17, the marginal gain in knowledge is 34 – 2 = 2. In a linear relationship as in the case of Y = 2X one will the marginal gain of knowledge is constant implying that time is constant, the rate of work being done is constant. This constant time is further illustrated by the fact that the change in the marginal gain of knowledge, ΔMG, is zero.

One can find a pattern in the marginal gain of knowledge for Y = 2X, for any linear model, the marginal gain is:
MG = dy/dx … 3
In the case of Y = 2X this is simply 2.

Most economists would say the MG is expected to be dy/dx and this in itself is not revealing. It is revealing because we are looking at the concept of relativity of time, constant work done suggests no change in motion, therefore no change in time dilation. But models are not necessarily linear, would the derivative hold in non linear models. Let us look at some polynomial functions, let us next look at say a relationship such as $Y = X^2$, how does the concept of time behave in such a case.

Figure 10 and table 8 illustrate a simple model for marginal gain in knowledge, MG, defined by a relationship of $Y = X^2$. We are keeping the models simple in order to help us understand the concept of time.

time, X	knowl, Y	MG	ΔMG
1	1	**1**	**1**
2	4	**3**	**2**
3	9	**5**	**2**
4	16	**7**	**2**
5	25	**9**	**2**
6	36	**11**	**2**
7	49	**13**	**2**
8	64	**15**	**2**
9	81	**17**	**2**
10	100	**19**	**2**
11	121	**21**	**2**
12	144	**23**	**2**
13	169	**25**	**2**
14	196	**27**	**2**
15	225	**29**	**2**
16	256	**31**	**2**
17	289	**33**	**2**
18	324	**35**	**2**
19	361	**37**	**2**
20	400	**39**	**2**

Table 8: Marginal Gain of Knowledge for $Y = X^2$

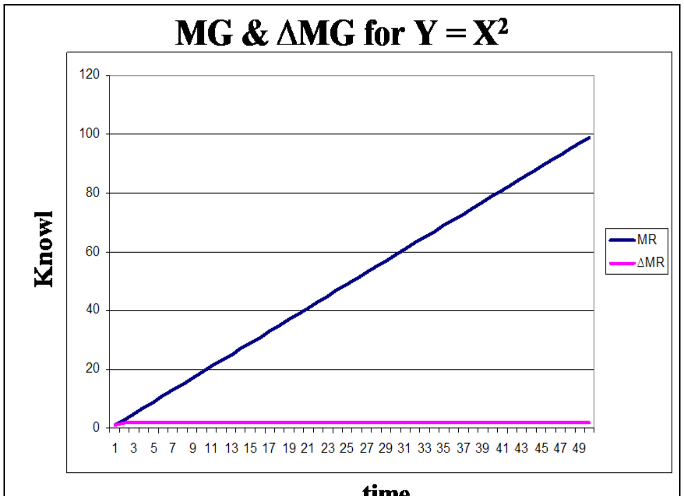

Figure 10

The marginal gain of knowledge for the simple model of $Y = X^2$ is different from the linear model. First of all the MG is increasing, it is not constant, this increase immediately tells us that time is no longer constant. The next time period, knowledge increases more than it increased the time before, suggesting time dilation because more work is being done at a faster rate than the time period before. This fact that there is time dilation is illustrated by the fact that the change in MG is no longer zero but a number greater than zero it is for the example illustrated in figure 10 and table 8, 2. The change in MG can be seen more clearly in figure 11.

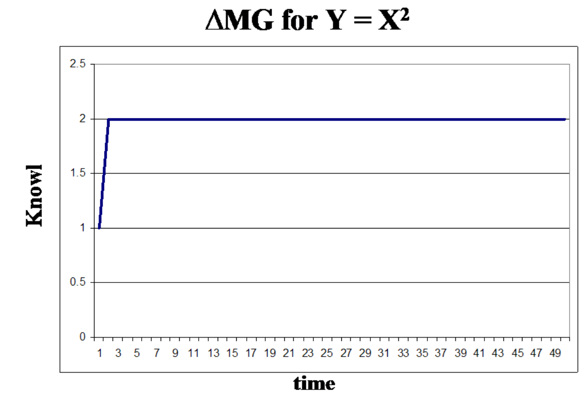

Figure 11

That the change in MG for $Y = X^2$ is equal to 2 illustrates that for each increasing time period, there is enough time dilation do more work equivalent to 2 knowl of knowledge, that is why the marginal gain in knowledge is no longer constant but increasing by 2. Looking at figure 11 and table 8, indeed as well as table 7 we see that though constant the initial change in marginal gain is different then the rest. Take figure 11, change in marginal gains in knowledge initially is 11 then it settles to 2, this is because of the initial motion in the knowledge process, it then settles to a linear pattern.

The marginal gain of knowledge in the case of $Y = X^2$ is:
$MG = dy/dx - 1$ … 4
$= 2X - 1$.
Note that the marginal gain in knowledge is no longer simply the derivative, there is a constant -1. This demonstrates that the marginal gain of knowledge though a function of the derivative is not equal to the derivative.

Let us consider one more simple polynomial, let us consider Y = X3, remember we are keeping this models simple in order to understand time. This simple model is further illustrated by table 9 and figure 12.

time, X	knowl, Y	MG	ΔMG
1	1	1	1
2	8	7	6
3	27	19	12
4	64	37	18
5	125	61	24
6	216	91	30
7	343	127	36
8	512	169	42
9	729	217	48
10	1000	271	54
11	1331	331	60
12	1728	397	66
13	2197	469	72
14	2744	547	78
15	3375	631	84
16	4096	721	90
17	4913	817	96
18	5832	919	102
19	6859	1027	108
20	8000	1141	114

Table 9: Marginal gain of Knowledge for $Y = X^3$

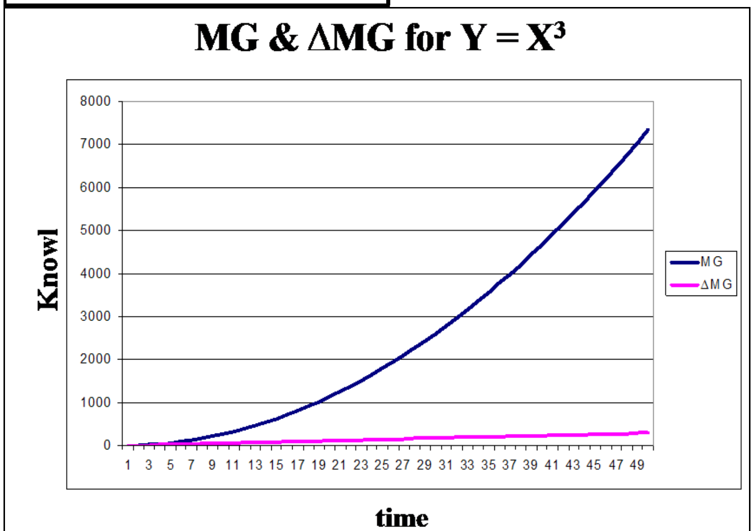

Figure 12

Due to the increase in the degree of the polynomial there is a marked change in the behavior of the marginal gain of knowledge, it no longer is linear. If one were to find a fit for the function of the marginal gain of knowledge when $Y = X^3$, they will find that it is:

$MG = dy/dx – 3X +1$ … 5

$= 3X^2 – 3X + 1$.

As can be seen from figure 13, the change in the marginal gain of knowledge itself is no longer constant but increasing as opposed to what was illustrated in figure 11. Due to the change in the degree of the polynomial, the work rate is increasing at a faster rate.

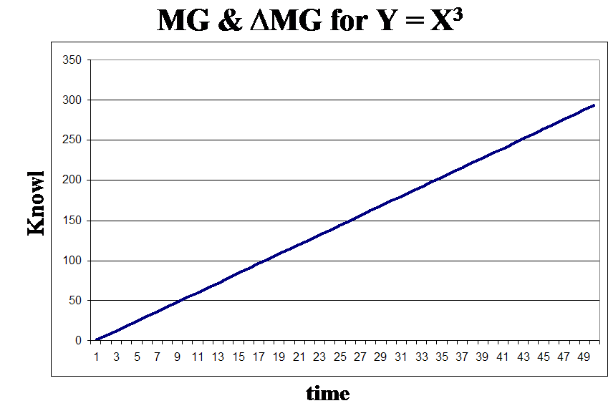

Figure 13

Polynomials with a degree higher than three obviously mean time is increasing at an ever faster rate, as would be expected. These polynomials will not be looked into, however diagrammatic illustrations will be provided, in figures 14 – 17 for the marginal gain of polynomials with degrees of 4 and 5 just to make it clear for us how time is affected, the degree of time dilation.

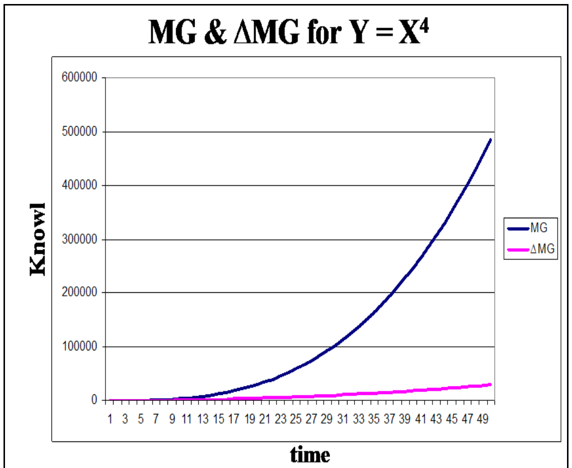

Figure 14

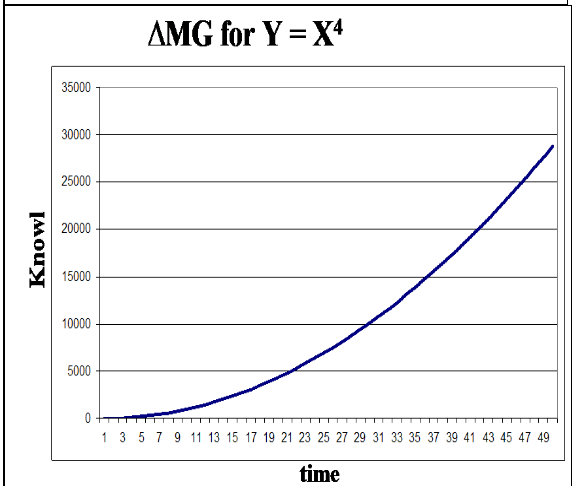

Figure 15

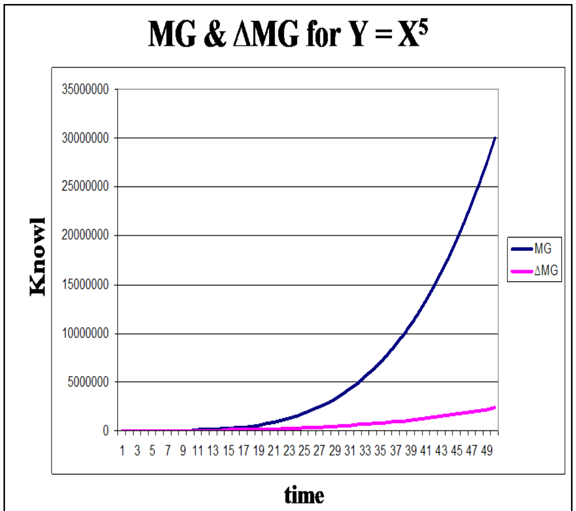

Figure 16

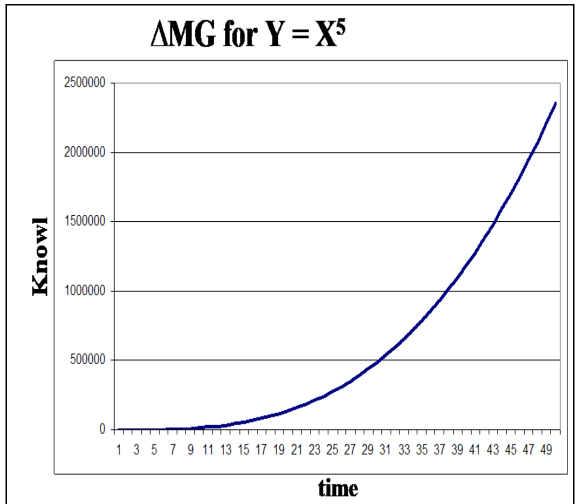

Figure 17

The functions that determine the marginal gain of knowledge for polynomials greater than 3 are not as clear cut as for polynomials of degree three or less.

Having understood this phenomenon, time dilation with polynomials, let us look at the exponential and the logarithmic models. Again to understand time we remain as simple as possible, there is no use confusing ourselves whilst we investigate, scientific investigations must be kept as simple as possible in order for us to understand.

When we get to the exponential we see time first dilating slowly then speeding up at a very fast rate. Remember that this is merely a pure exponential function, it has no constraints and having no constraints it is very much a great exaggeration. But it gives us the power to understand the influence of the exponential on time dilation. It is important to understand what is occurring is merely time dilation, time is slowing down allowing more work to be done. Figure 18 shows what occurs, the marginal gain of knowledge when knowledge gain is defined as an exponential function, as one can see the gain in knowledge is fast, time dilates to a great degree.

time, X	knowl, Y	MG	ΔMG
1	2.72	2.72	
2	7.39	4.67	1.95
3	20.09	12.70	8.03
4	54.60	34.51	21.82
5	148.41	93.82	59.30
6	403.43	255.02	161.20
7	1096.63	693.20	438.19
8	2980.96	1884.32	1191.12
9	8103.08	5122.13	3237.80
10	22026.47	13923.38	8801.26
11	59874.14	37847.67	23924.29
12	162754.79	102880.65	65032.97
13	442413.37	279658.59	176777.94
14	1202604.23	760190.86	480532.27
15	3269017.22	2066412.99	1306222.13
16	8886110.08	5617092.86	3550679.87
17	24154951.48	15268841.40	9651748.54
18	65659965.46	41505013.98	26236172.59
19	178482290.41	112822324.95	71317310.97
20	485165165.21	306682874.80	193860549.85

Table 10: Marginal Gain of Knowledge for $Y = e^t$

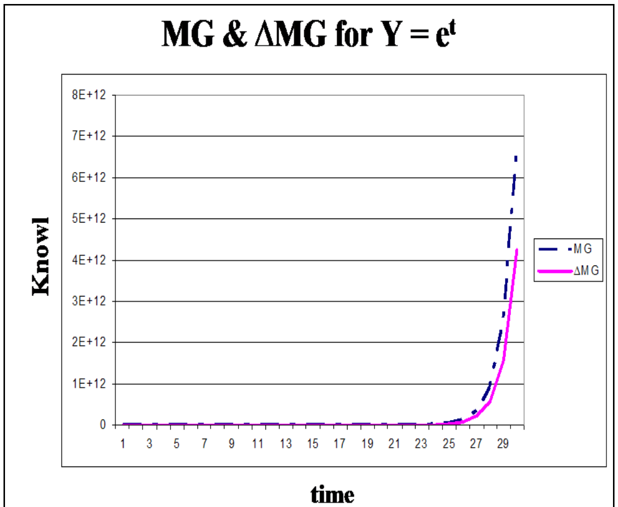

Figure 18

It is the logarithmic functions that make an interesting investigation, for we see that the marginal gain is actually decreasing, and in general the change in marginal gain of knowledge is negative, with an asymptote of zero. We can see this for the natural logarithm, ln, in figures 19 and 20 as well as table 11.

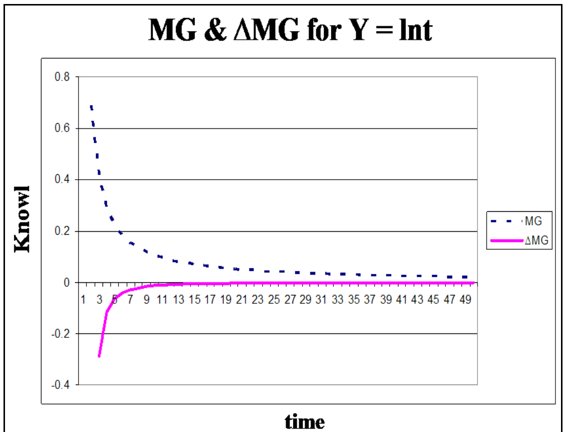

Figure 19

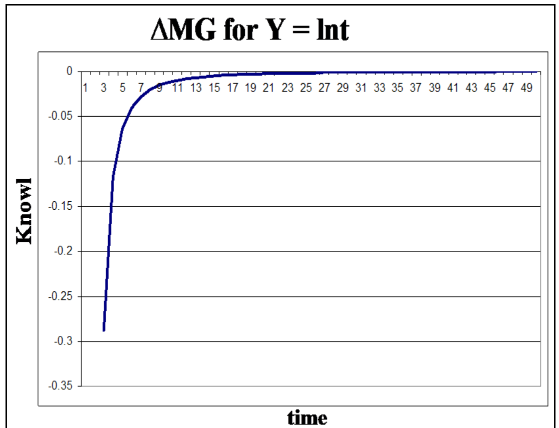

Figure 20

time, X	knowl, Y	MG	ΔMG
1	0.000		
2	0.693	0.693	
3	1.099	0.405	-0.288
4	1.386	0.288	-0.118
5	1.609	0.223	-0.065
6	1.792	0.182	-0.041
7	1.946	0.154	-0.028
8	2.079	0.134	-0.021
9	2.197	0.118	-0.016
10	2.303	0.105	-0.012
11	2.398	0.095	-0.010
12	2.485	0.087	-0.008
13	2.565	0.080	-0.007
14	2.639	0.074	-0.006
15	2.708	0.069	-0.005
16	2.773	0.065	-0.004
17	2.833	0.061	-0.004
18	2.890	0.057	-0.003
19	2.944	0.054	-0.003
20	2.996	0.051	-0.003

Table 11: Marginal Gain of Knowledge, Y = lnt

As can be seen from figure 19, both the marginal gain in knowledge and the change in the marginal gain in knowledge have an asymptote of zero, 0. However the marginal change is positive whilst the negative change in the marginal gain pulls down the positive marginal gain. Though negative, the change in marginal gain in knowledge is a decreasing negative. Therefore in a logarithmic model, time is essentially speeding up, less work is been done per time period because of this speeding up of time effect. The same properties are seen with a logarithm of base 10, these properties are basic to all logarithmic models. Figures 21 and 22 illustrate a simple logarithmic model to base of ten, as an illustration to show that the basic properties of the logarithmic models are the same. The decreasing but positive marginal gains in knowledge, as well as the negative but increasing change in marginal gain.

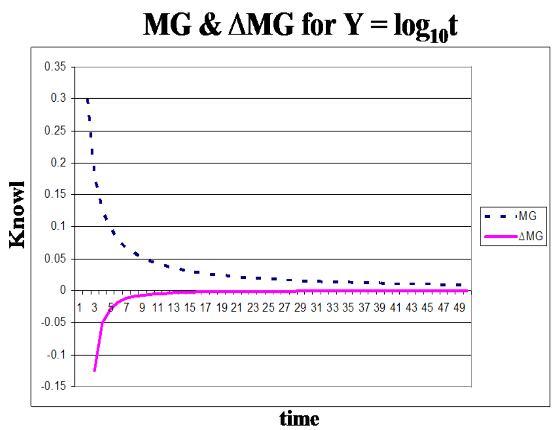

Figure 21

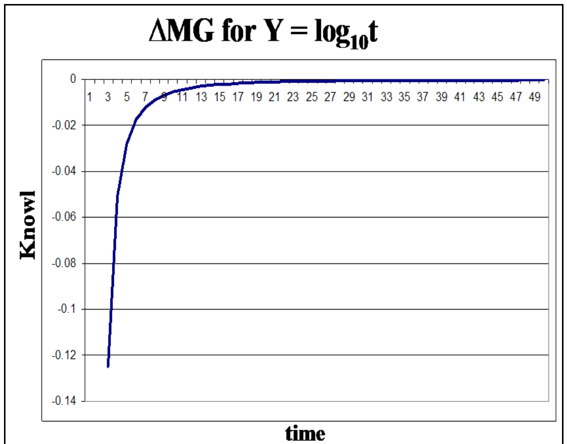

Figure 22

time, X	knowl, Y	MG	ΔMG
1	0.000		
2	0.301	0.301	
3	0.477	0.176	-0.125
4	0.602	0.125	-0.051
5	0.699	0.097	-0.028
6	0.778	0.079	-0.018
7	0.845	0.067	-0.012
8	0.903	0.058	-0.009
9	0.954	0.051	-0.007
10	1.000	0.046	-0.005
11	1.041	0.041	-0.004
12	1.079	0.038	-0.004
13	1.114	0.035	-0.003
14	1.146	0.032	-0.003
15	1.176	0.030	-0.002
16	1.204	0.028	-0.002
17	1.230	0.026	-0.002
18	1.255	0.025	-0.002
19	1.279	0.023	-0.001
20	1.301	0.022	-0.001

Table 12: Marginal Gain of Knowledge, Y=log10t

The statement made in the above paragraph, *therefore in a logarithmic model, time is essentially speeding up, less work is been done per time period because of this speeding up of time effect*, is very important for our understanding what has occurred in reality. That is exactly what has happened in the world, some societies time has moved to fast in terms of knowledge, hence they have remained at the same level of development and knowledge base for the last hundred years. The hunter gatherers of the Amazon who have had no contact with other societies one would be right to say time moves to fast, they have not had the time to gather knowledge over and above the basic knowledge of surviving as hunter gatherers. All societies it must be remembered exist at the same time. This paper for example was written in July 2008, at that time all societies existed in 2008 even though some societies at that point of the linear time, solar time to be more exact, had more knowledge than other societies.

This should not be confusing to anybody who has read a bit about the concept of time. Quoting Klaus Mainzer, “Historical cultures, like individuals, developed different internal times in the course of their evolution.” Societies, indeed individuals though existing in the same global time/ proper time have developed different internal times. This is a principle that is accepted in studies of relativity, and needs to be understood in a social context.

It would not be wrong to say the USA is ahead of Mozambique in terms of knowledge, considering both knowledge of the laws of existence as well as use knowledge, the creation of products for sale in the market. The USA is truly ahead, but this is because of time dilation. How much is the USA ahead of Mozambique, this is simple, take all the knowledge and products that the USA creates and subtract the same of what Mozambique creates, remembering from the paper, Measuring a Societies Knowledge Base", all knowledge at its most simple is the same, all laws of existence are equal in knowledge, by the same logic, all products are equal to all laws of existence, and all products are of equal value in terms of knowl.

Any discipline must move ahead with the times, once more quoting from Mainzer, "liberal ideas about the state and the economy espoused by John Locke, David Hume, and Adam Smith were developed against the background of the time concepts of Newtonian physics. Contrary to the Cartesian mechanics of levers and gears that inspired the physiocrats, Newton's gravitational theory envisions forces acting over a distance, forces that cause freely floating celestial bodies to interact and develop a sustained state of equilibrium. Similarly, Adam Smith argued that just as gravity acts invisibly in physics, so will an "invisible hand" establish the market equilibrium between supply and demand , leading to a "natural price." To arrive at this conclusion, Smith presupposed that – because of their nature – all economic agents will seek to maximize their profits." We must always consider new truths that add to our knowledge base, we must be grateful to Einstein for explaining relativity and time dilation in helping us to understand why some societies and individuals seem to be ahead in time, yet can not be ahead in time because we are all in the same proper time, its because of effort they have put into the process, the effort that started a process of gathering knowledge.

Time the Dependent Variable

Human understanding of time in disciplines like economics, sociology, anthropology, biology, has been taken as an independent variable that we as humans can not influence. Time it must be understood is dependent on motion, we have daytime and night time due to the earth's motions, minutes and hours are based on the motions of the earth, all our ancient and modern measurements of time are largely based on the motions of the earth. Even those ancient people who believed that the earth was the center of the universe based time on motion they based their time on what they believed was the motions of the sun and moon. Time has always been understood as related to some motion.

Though time has always been considered in relation to a motion, this motion had nothing to do with human beings, thus time has always been considered as a constant movement into the future. In exactly sixty seconds a minute will pass, after 60 minutes have passed and hour would have passed, after 24 hours have passed a day would have passed, and there is nothing anybody can do about it, that is time, in a modern sense it is about the earth rotating around the sun. what human action can possibly stop the earth on its predestined movement around the earth, the answer is no human action will stop the earth rotating around its own axis, as well as around the sun.

If one looked at time primarily from the view point of the above paragraph then it would nullify relativity, but relativity has proved to be correct through means of experiments. Let us take the example of the twins who go to space that was discussed earlier on in this paper. Twin 1 remains on earth and Twin 2 goes into space at speeds approaching the speed of light. The second twin returns and finds that the first twin is older, what has occurred. The most important thing is that the second twin went into a space ship and a force was applied at the second twin went at speeds close to the speed of light. This force must be created by humans, therefore human endeavors will cause the second twin to age at a pace slower than the first twin, thus humans can directly affect time theoretically.

When discussing time dilation with knowledge above, how time slows down for one society and it does not for another, what causes that? It is human action that causes that. Therefore, human action can directly affect time at some levels.

A society gains knowledge because of the desire of humans, a society refuses knowledge because of the norms of that society. Time dilation occurs because of human desires to seek knowledge. This human effect on time can only be seen when taking time as an independent variable, that time dilation occurs, be it theoretically like the twin flying of to space and returning and finding their sibling older or in reality, practically in knowledge economics were time dilation has been discussed above.

The changing pace of time due to human activity can be easily illustrated with simple diagrams. Take figure 23 as an example. In figure 23 we have a society gathering knowledge, for simplicities sake, take one knowl to mean one law of existence, remember that a knowl is an arbitrary figure and it is given as 250 to compensate for future growth in our understanding of knowledge, to avoid in the future of dealing with half knowls and other fractions of knowl. But in this case our understanding of knowledge is not that great yet so for illustrations sake 1 knowl equals one law of existence. Figure 23 illustrates a position where by it takes 7 units of time to get 5 units of knowledge. These units of time can be annual. To get to the first unit of knowledge it took 1 unit of time. To get to the second unit of time it took 2 units of time, therefore the society arrives at the second unit of knowledge at time 3. The third unit of knowledge is arrived at in one unit of time, therefore the third unit of knowledge is arrived at the fourth unit in time. Then the next unit of knowledge takes two time units to be arrived at, therefore we arrive at the fourth unit of knowledge after 6 units of time. The next unit of knowledge is arrived at after 1 unit of time, therefore the society illustrated in figure 23 arrives at the fifth unit of knowledge after 7 units of time.

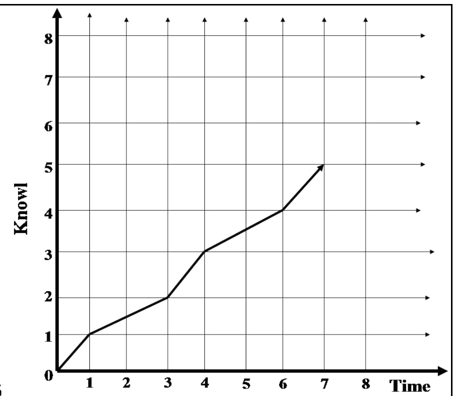

Figure 23

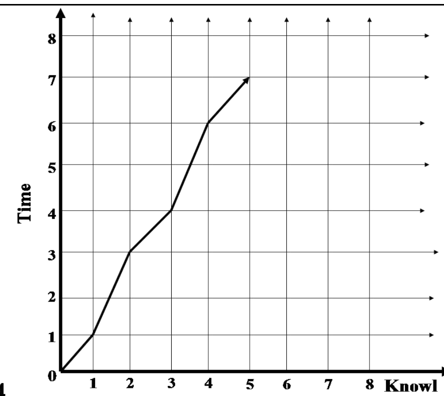

Figure 24

Making time the dependent variable, that time changes with the amount of knowledge we gather rather than how fast the earth spins around the sun, then we see and confirm what we have been arguing, the slowing and speeding up of time. The slowing and speeding up of time is just as we expected. When a society, individual, or institution is gaining knowledge at a faster rate time slows down, and when a society is gaining knowledge slowly time speeds up. This should be expected, otherwise relativity would be wrong, a principle must hold everywhere for it to be a fact, time is important in most disciplines, the concepts in physics to be true must hold in economics and they hold as can be seen from figure 24 a very simple illustration.

Comparing what we have in figures 23 and 24 we can see how time is speeding up and slowing down, depending on how much work human beings are doing, work in this case been the gathering of knowledge. The two diagrams will be compared to step by step.

> In figure 23, between 0 and 1 unit of time we gained 1 unit of knowledge. In figure 24 for 1 gain of knowl we gained one unit of time. At this point we can not tell the speed of time as the graph is just beginning.
>
> In figure 23, the next unit of knowledge was gained in 2 units of time, clearly the gain of knowledge has slowed time. When we look at figure 24, for the gain of 1 unit of knowledge from 1 unit to 2 units it takes 2 units of time, this can be seen by the steeper change in the graph, time has speeded up.
>
> In figure 23, the third knowl of knowledge, 1 unit of knowledge, was gained after I unit of time, knowledge is being gained faster seemingly, but when we look at figure 24 we

get what we expect from our understanding of time dilation, we see time slowing down between unit 2 and 3 knowl. The slowdown is represented the change in the gradient of the graph in figure 24. The steeper the graph, the faster time is flowing, and the less the gradient, the more time slows. Figure 25 illustrates this concept more clearly. Where it is marked with F it means that time is fast and where it is marked with S, it means time is slow.

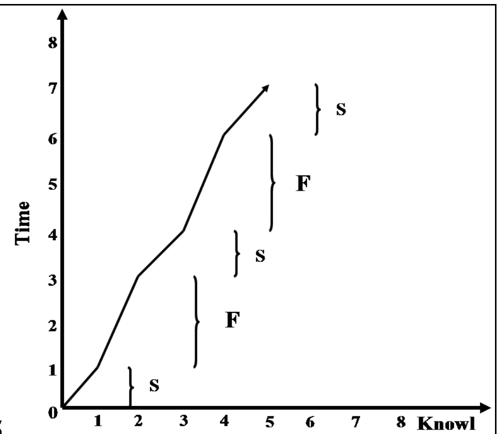

Figure 25

Looking at figure 25, we can more easily understand how the rate of time keeps changing due to human activity. This it must be understood will not change how fast the earth rotates around the sun, that will continue to be the same, but societies internal times are different. Time dilates because of greater motion, time dilation allows for more work to be done, in the case of knowledge economics, for more knowledge to be gathered.

Figures 24 and 25 and their explanations demonstrate for us the concept of time dilation. We know that so called proper time is linear, why do we say it is linear. We say it is linear because of the way our universe operates. At regular intervals the earth spins around its axis, approximately at a rate that we have divided into 24 equal parts and we call these parts an hour. As human beings we understand this concept and are comfortable with it, When the earth returns to its spot on the axis, 24 hours have passed, similarly, after approximately 365 days, when the earth has approximately turned on its axis 365 times, the earth would have completed its orbit around the sun, this is the internal time of the earth and we call it our proper time and it is largely linear. How then do we make our time internal, internal in the terms of a society in the subject matter dealing with the economics of knowledge, or say in the discipline of knowledge economics?

Internal Time of Society in Knowledge Economics

Instead of saying one time unit is a relation to the motion of the earth, we can say that one time unit is equal to the motion of our gathering of knowledge, examples are best when they are simple and clear, we say one time unit is equal to our motion of gathering one unit of knowledge, this will give us our real internal time. Figures 24 and 25 are what an observer sees taking time in relation to the motion of the earth, there is time dilation as expected. However when we take time to the internal rhythm of a society, individual, or any institution involved in and needing new knowledge to survive we find that our internal times return to being linear, everybody's internal time is different, moving at different speeds for every individual, business unit or institution. To make internal time linear we merely have to define it, say one unit of time passes for every unit of knowledge gained. The thing that we take as proper time has one great advantage that makes it possible for all humanity to take it as proper time, the constant seemingly never ending rhythm of the earth spinning on its axis and the earth orbiting the sun. Therefore to make our internal time have meaning, we must assume that a society is looking for knowledge, a society respects knowledge. It is this internalization of time that leads us to say some societies are ahead, some societies are behind as we will see as we continue our journey into time.

Having defined internal time in terms of knowledge as one unit of time is equal to a change in one unit of knowledge taking how much knowledge we have gathered in figures 23 – 25, internalizing this time we end with figure 26. Figure 26 is correct in every sense of consistency, a vital law of knowledge as laid out and discussed in the paper, "Point X and the Economics of Knowledge." However internal time is disjointed from the real time because our internal time can have no time dilations as we see in figure 26, it would be wrong to superimpose for example figure 26 over figure 24 and arrive at figure 27, figure 27 does not make sense neither is it consistent with previous theory. Figure 27 starts from the wrong premise that somehow our internal time has to do with the rhythm of the solar system, it does not, it has to do with our own internal time and can not be compared to figure 24 unless new evidence in known theory come up.

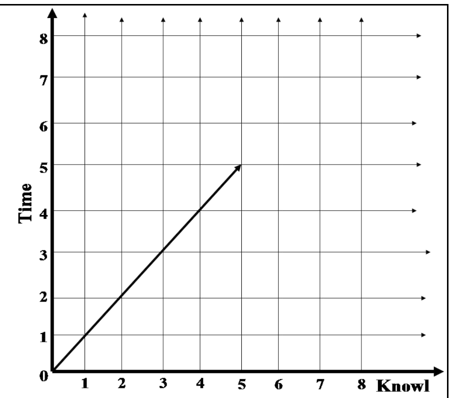

Figure 26

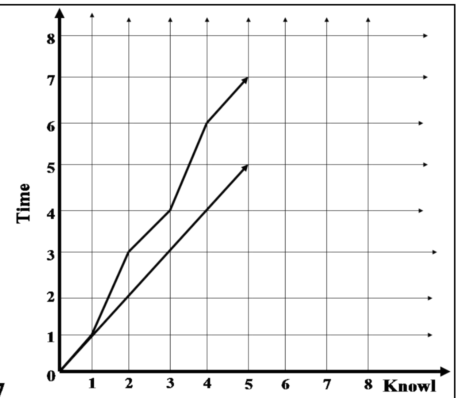

Figure 27

Figure 27 gives the illusion that our internal time is slower from the real solar time, but that would be comparing apples to chameleons. If one says comparing apples to oranges a smart aleck will say but they are both fruits, better to say comparing apples to chameleons, or something ridiculous like that, do not do it, they do not compare.

Why can we not compare figure 26 to figures 23 – 25. The reason being the process can only be one way, we can get our internal time from figures 23 – 25, but figure 26 can not be reversed to figure 24 or 25. Look at table 24 again. Just by looking at figure 24 we can tell that the total amount of knowledge gained is 5 units and having defined our internal time as determined by the change of knowledge, a unit for unit exchange will leave us with 5 units of time. However the same can not be said for looking at figure 26, all we can tell is the internal time and nothing else, that is why the process is only one way.

An internal time can be said to be linearized, that is to say made linear, but itself will keep on changing. Internal time is not static it depends on the past, if for example in the next period fig 24 shows time increasing to 10, this will greatly affect the linear time, the slope of the linear time, changing figure 26 almost doubling the gradient.

Looking at figure 28 we see that to get to 5 units of knowledge there are many different routes, but all will have the same linear time, that linear time being represented by figure 6. Figure 28 is taken from the very first step with time being the dependent variable, our normal time. We are doing this merely for illustrations sake.

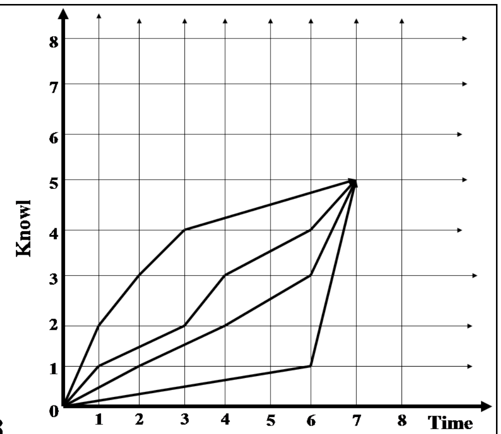

Figure 28

Figure 28 shows four societies, one of the societies being the society that was being used as an illustration from figures 24 – 26. All the societies in figure 26 have identical internal times for the point in time illustrated in figure 28. The internal time is determined by how much knowledge a society or individual has at that moment, no matter what pace they are gathering knowledge, no matter how much time dilation there is at the moment in considering real time, time dilation is a part of real time.

Internal time has no time dilation, incidentally keeping up with consistency, when there is significant slowing down of time so that a society or individual is capable of doing more work, that more work will mean that that society that has real time dilation will have a higher internal time, it will seem ahead, that is why one say some societies are ahead of other societies, because of the internal times, but all societies exist in the same real time. If it is six o'clock in a room, it is six o'clock for everybody in that room, that is the real time, however the internal times of each person in that room will be different, people will have different amounts of knowledge.

At this stage the concept of time has been dealt with thoroughly, there still is one more crucial point to understand, the reversibility of time, for us to understand knowledge economics thoroughly, indeed to understand economics in general, societies at large, we need to consider a subject matter that is now beginning to get serious attention from physicists, the question of the reversibility of time.

The Reversibility of Time

To start this subtopic it is best to start with a quote from Sean M. Carroll in an article he submitted to Scientific America, a magazine for those interested in scientific topics, it was an article entitled, "Does Time Run Backward in Other Universes?" "Among the natural aspects of the universe, one stands out: time asymmetry. The microscopic laws of physics that underlie the behavior of the universe do not distinguish between past and future, yet the early universe – hot dense, homogeneous – is completely different from today's – cool, dilute, lumpy. The universe started off orderly and has been getting increasingly disorderly ever since. The asymmetry of time, the arrow that points from past to future, plays an unmistakable role in our everyday lives: it accounts for why we cannot turn an omelet into an egg, why ice cubes never spontaneously unmelt in a glass of water, and why we remember the past but not the future. And the origins of the asymmetry we experience can be traced all the way back to the orderliness of the universe near the big bang."

Time seems to be constantly moving forward, it would not make sense if it moved the other way, been born old and die as babies. There are two measurements of time, there is the real time, and there is the internal time. All time is defined by a motion, there must be some sort of change for time to exist, change implies some sort of motion and therefore some sort of force has been applied to cause that motion. Without a force been applied there can never be motion. When we are looking at knowledge economics, let us return to figure 26, internal time was defined as a gain of unit for a one unit gain in knowledge, this was internal time specific to knowledge. Therefore when we are talking of knowledge, internal time is what we seek to answer, can internal time run backwards, can it be reversed. In the case of knowledge the answer is yes, internal time can run backwards.

Take society A, it is developing, then one day the political leadership of that society decides to destroy the economy for reasons known to them, usually that they fear knowledge. Then one day the last heart specialist in that country decides to leave to countries that are more respectful of knowledge. That means that society A no longer has a heart specialist, but they had one before the chaos. They have lost that knowledge, time therefore has been reversed in terms of knowledge, particularly concerning heart specialists. We have seen many countries lose knowledge and therefore reversed in time, Cambodia under Pol Pot purposefully killed intellectuals, Mugabe in Zimbabwe drove out anybody who was against him or they would die, Zimbabwe lost a lot of knowledge, with the collapse of Rome, Europe rejected knowledge, went into the dark ages, time literally reversed. After colonialism, Africa has battled with European concepts believing knowledge comes from Europeans, like the Europeans before who rejected anything Roman because Romans where colonizers, the same happened with post independence in Africa, in the same fashion, rejection of Europe Africa has led itself into a 'dark age'.

Reversal of time does not mean returning to hunter gatherers or caveman, it means losing knowledge. Take the concept of light bending that was given credit to Einstein, yet the theory was postulated to my shock nearly 100 years before Einstein by another German by the name of Johann Georg von Soldner, how far mankind would have been had people taken von Soldner seriously, politics and society can reject or accept knowledge usually because of who it is from. The knowledge that von Sldner gave to the world was lost for a hundred years. Einstein could revive his theories only because he had other brilliant theories, one suspects if Einstein only discussed bending light it would have been rejected.

A society of course does not want a situation whereby there is time reversal, that is a true decline in a society, it causes much suffering and weakens a society.

Conclusion

Understanding time its behavior is vital to understanding knowledge economics. Without understanding the concepts developed by Einstein, especially the concept of relativity, we would not understand time dilation, without understanding time dilation it is not scientifically possible to understand why some societies have more knowledge, it is about motion, gathering knowledge involves a motion, we must apply hat force so that we gather that knowledge. It is about time dilation, the slower time seems to be moving the more knowledge shall be gathered. It truly is about time. Interestingly enough, the more complex societies become, the more specialization there is, the more knowledge is gathered in that particular field. However people must understand that all disciplines are connected, a narrow view will not bring about an increase in knowledge, however understanding that principles developed in other disciplines can be useful will lead to a greater understanding of our society.

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