Knowledge Economics: Improving Theoretical Framework of Knowledge Transfer

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Abstract: This paper we seek to develop a knowledge transfer model from knowledge economic theory. Knowledge transfer is accepted as the end of the cycle in the knowledge process it is therefore important to have a knowledge transfer model from existing knowledge economic theory. Endeavoring to build this model the paper at firsts looks at the concept of knowledge transfer and then the model is built. The model is built on the fundamentals of time, of the properties of knowledge in the short and long term, very distinct properties, it is a step in the right direction.

Knowledge economics is the science that deals with the creation, distribution, and consumption of knowledge. Knowledge transfer is the end cycle of the creation of knowledge creation cycle. Knowledge transfer can be said to be the bridge between knowledge creation with the distribution and consumption of knowledge.

At its most basic knowledge transfer is just what it is, the transfer of knowledge from part A to party B. It occurs everyday in schools, knowledge is transferred from the teacher, lecturer to the students, that is knowledge transfer. Students in a yoga class receive instructions from a teacher that too is knowledge transfer. However in this paper we want to concentrate on the commercial aspects of knowledge transfer, I want to demonstrate the importance of knowledge economics towards building a useful model concerning knowledge transfer.

To understand the commercial aspects of knowledge transfer one needs to look at a presentation given by Bill Baker for the Raytheon Company in 2004. Bill Baker illustrated the core principles for Raytheon's success, these being:

1. Specify value in the eyes of the customer
2. Identify value stream and eliminate waste/variation
3. Make value flow at pull of the customer
4. Involve and empower employees
5. Continuously improve knowledge in pursuit of perfection

As can be seen by the fifth principle, Raytheon indeed is aware of the importance of knowledge in continuously improving products. What this paper eventually wants to be able o do is to give companies like Raytheon as well as emerging corporations the know how to know when is knowledge transfer at its most profitable and least risky and when is it likely to be less profitable and full of larger risks. However one must never forget usually, the higher the risks, the larger the rewards.

To quote Maria Forsman and Nikodemus Solitander, "both management scholars and economic geographers have studied knowledge and argued that the ability to transfer knowledge is critical to competitive success." This is because without knowledge transfer products will not be improved upon, what is needed is good knowledge transfer policy. Societies and companies with no knowledge transfer policy are soon out of business, and societies with no knowledge transfer policy are soon beggars, every society that is begging has no knowledge transfer policy. Therefore knowledge transfer is a very important concept recognized by both corporations and societies at large.

Knowledge transfer has in recent years been associated with universities, whereby universities try to commercialize their research and they set up divisions that take care of this process. It is sort of a glamorous career working for a knowledge transfer business unit at a university, akin to corporate financing in an equity fund or bank. The rewards can be very lucrative if one finds a particular good piece of knowledge to transfer. Many papers have been written about this process, and one of the best papers on this subject matter is written by Crespi, Geuna, and Verspagen for the University of Sussex.

Knowledge transfer itself is an easy concept to grasp, as can be seen from the paper written by Cowan, Soete, and Tchervonnaya in 2001. This paper is god but very difficult to understand like most modern

papers because it is full of quotes at every page, people in academia have been frightened off thinking originally and to get published one must quote as many people as possible, it is called discussing each others works. The paper shows simply what happens in knowledge transfer with a simple illustration that is given in the paper. Figure 1 is the exact copy of figure 2 in the paper written by Cowan and colleagues. It shows the knowledge transfer process.

What is interesting to note from figure 1 is that the illustration acknowledges that there are transfer channels. This means there are many institutional methods of transferring knowledge by implication.

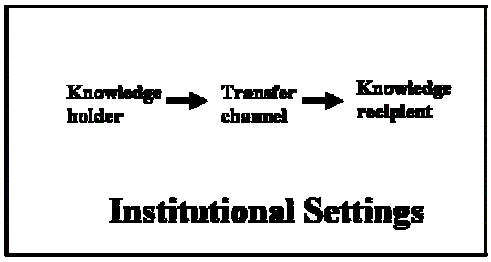

Figure 1

This paper will not seek to illustrate or discuss these transfer channels, that knowledge transfer exists, a model must include all channels of transfer, a science does not pick and choose, it must work with all models, otherwise it is no longer a science, as knowledge economics endeavors first and foremost to be scientific and therefore the model of knowledge transfer that will be created does not take into account such issues of what channel is being used. These channels according to Cowan being, suppliers, foreign direct investment, licensing, links with academy, training, intra – company strategic knowledge management, producer – consumer two – way knowledge transfer, patents, and a few others channels.

There is something very important that can be taken from the paper written by Cowan and her colleagues, knowledge does not become an asset unless it is needed by the firm, it does not immediately become an asset of a firm. Only useful knowledge will eventually be considered an asset to the firm, the rest is not useful. If it can not be translated into a certain point U that has more knowledge than the previous point U, then it is useless knowledge, not being useful it can not be considered an asset.

Knowledge Models

There are knowledge models out there, take the models that were developed by Romer and Jones that were develop in the 1990's. There is the R & D based growth model. This model has four variables, output (Y), capital, (K), Labor (L), and technology or knowledge (A). Like all the other knowledge production functions this model follows a Cobb – Douglas production function of: Labor can be allocated either to production, L_Y, or the production of new knowledge L_A, thus the economy is subject to the following resource constraint, $L_Y + L_A = L$.

The production function is given as:

$Y = K^{\alpha} (AL_Y)^{1-\alpha}$, where $0 < \alpha < 1$

This model is discussed adequately in the paper written by Yasser Abdih and Frederick Joutz. Being a Cobb – Douglas function these models based on such an assumption have structural problems, first of all;

1. How do we account for growth
2. The constraint $L_Y + L_A = L$ is misleading because of the previous proxy for knowledge. Such a model is assuming that technology is knowledge. This is a signal that the model builders did not understand knowledge. That capital, K, is knowledge, labor uses knowledge, all labor. This misunderstanding nullifies the whole model.

3. A model as above does not consider diminishing opportunity costs as will be explained later. The wealthier a society, the more the opportunity costs are reduced, however the above model would not explain this.
4. The model assumes that knowledge grows at the same rate, this cannot be so, the paper short and long term growth of knowledge shows that there are significant differences in the short run as compared to the long run. In the paper fundamental theory of knowledge it was explained that time can be lost, assuming constant growth assumes no time lost in knowledge generation. It assumes knowledge investigators are always right.
5. The model itself is very simplistic, it does not consider government policy, knowledge from outside, being simplistic it assumes that any society could adopt the model, impossible, knowledge also needs the right political attitude towards knowledge.
6. Assuming all knowledge is equal misses out the vitality of critical points of knowledge. Again this model and the previous models do not take this into account because the authors did not understand what a critical point of knowledge is.

Most of these models are built up from the Griliches model. Most of them are the result of misunderstanding of knowledge, this misunderstanding of knowledge can be firmly attributed to this statement made by John Houghton and Peter Sheehan, "The emergence of the knowledge economy can be characterised in terms of the increasing role of knowledge as a factor of production and its impact on skills, learning, organisation and innovation." This has been the fundamental stumbling block of building a knowledge model, this idea that knowledge is new, that civilizations throughout history ere not using knowledge somehow.

Griliches is one of the foremost pioneer in the knowledge production function, there are however several models for estimating knowledge, all are wrong because they did not understand that the bushmen uses knowledge to survive, it is impossible for humans to survive without knowledge. They are again wrong because most, if not all use R&D as the proxy for knew knowledge, these models include Perpetual Inventory method, Razzak and Margaritis, and Philips - Loretan type models. All these models have same weakness though not all are in the Cobb – Douglas function, they assume steady constant growth of knowledge, depending on labor, they do not understand that capital itself is created by knowledge, capital is not created by instinct, neither was a hut, or fire. All these measures in knowledge were designed to measure innovation, a fairly simple affair, just look at the patent records. As said before, these models are not useful in managing knowledge totally, they would be useful to develop a knowledge transfer model because of their shortcomings.

Model Based on the Short and Long Term Properties of Knowledge

Before moving into developing a model there are three important concepts that must be clearly understood, the first is a quote from Jon Dorbolo, a philosopher from Oregon, "The opening for philosophers is plain enough. Economics is in need of new theory; the new theory must be based in a study of knowledge; the study of knowledge is a traditional philosophical activity." Basing knowledge on economics means that knowledge must be acknowledged as the prime resource, the resource that allows us to identify other commodities. The very first step in any discipline to be fully understood, to make the subject matter scientific, we must be able to try to quantify, or find a manner in which mathematics can be used in the discipline. We must first and foremost unitize the subject matter, so that we can quantify it, this is the reason why people have been having a difficult time with dealing with the discipline of economics were knowledge is taken as a commodity. It is impossible to even to be gin to truly comprehend something that one can not even imagine quantifying.

Knowledge was unitized, the unit was termed knowl and from there a theory was developed because knowledge could be understood in a manner that somebody like Giliches or Machlup could never understand, all because they did not unitize the subject matter. That is why we can not use the models they have developed for knowledge transfer, the models can not tell us what strategy to take at a certain time, and when is it best to have knowledge transfer, the end of the knowledge cycle. Remember here we are dealing with commercial knowledge, knowledge used in the creation of goods and services.

A second concept to understand can best be summed up by Alfred Marshall, "Economics has as its purpose firstly to acquire knowledge for its own sake, and secondly to throw light on practical issues. But though we are bound, before entering on any study, to consider carefully what are its uses, we should not plan out our work with direct reference to them." Before looking for applications for a theory, knowledge must be sought out for knowledge's sake. If you start out with looking for applications one is not likely to take the time to understand the subject matter fully, they will have a policy idea and that is likely to influence the way that they will undertake their investigation seeking out to justify policy. The theory will therefore not be fully developed and will likely to be inconsistent with previously proven facts in order to justify policy. Humans and scholars have known about electrons, photons, for many decades. Yet only now are humans starting to fully comprehend the power of light in applications for commercial use, fiber optics is a relatively new technology, and there are those working on developing light particles to replace electrons in microchips. What if people had said there are no applications why bother study light, we would miss out as humanity on the beauties that are now opening up that light particles will allow us to advance when it comes to the promises of the technology. Who knew the possibilities of genetic studies, helping in fields such as criminology. Knowledge can not be rushed. It is better to understand, once understood one may then look into the uses of the theory that has been developed. A charlatan begins out by looking for policy uses without fully comprehending what it is that they are dealing with, because no doubt their study will lead to defend their pre conceived notions.

One must not be afraid, especially if they are right. Once upon a time economists thought that Agriculture was economics, Adam Smith would talk about value coming from labor, where these people wrong, I would say no, that was the time they existed in, but they were making progress in the subject matter of economics. They used the tools that they had, given this however, if one was to use Adam Smith's theory of value today they would be wrong, because our understanding has grown so much. To quote Alfred Marshall one more time, "The full importance of an epoch-making idea is often not perceived in the generation in which it is made ... A new discovery is seldom fully effective for practical purposes till many minor improvements and subsidiary discoveries have gathered themselves around it." Having developed a theory we can now show its applications.

Knowledge Transfer Model.

Why would one desire a model? One desires a model first and foremost to understand a phenomenon, a model basically explains the relationship between variables. The model we shall develop shall be derived from the long and short term properties of knowledge. The properties were developed in the paper long and short run behavior of knowledge by Bhekuzulu Khumalo, indeed this paper is merely a follow up of that paper.

The advantages of the short and long term model shall be evident in themselves. We must remind ourselves what are the long and short term properties of knowledge.

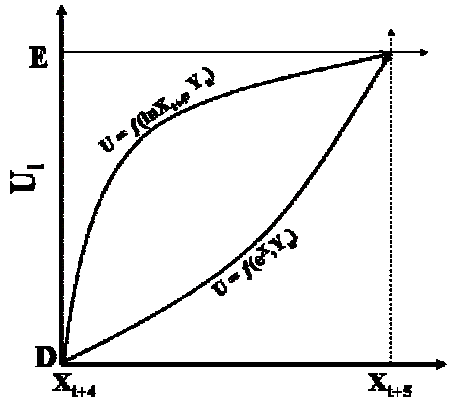

Figure 2

Figure 2 illustrates the long and short term behavior of knowledge, in this paper we shall not go into depth as this was already done in the paper "the long and short term behavior of knowledge." The long and short term can be both be for a specific industry as well as the society as a whole. But we must remind ourselves about the properties of the short run that differentiate them from the properties of the long run. Xt+4 is a law of existence, and so many uses can come out of that law of existence, they can not surpass E, the only way that society can pass E amount of use knowledge is if society discovers Xt+5. Given figure 2, the short run properties is given as:

$U = f(\ln X_{t+4}, Y_u)$ (1)

Where:

U = total use knowledge

$Y_u = f(Y_{t-1}, X_1, X_2, X_3, X_4, X_5, X_6) + Ka$ where:

Y_u = knowledge level

Y_{t-1} = knowledge level of last time period

X_1 = Economic Freedom

X_2 = Conversion rate

X_3 = Academic Freedom

X_4 = Research, Private and government.

X_5 = Literacy rate.

X_6 = knowledge existing in other societies but not available in society

Ka = 1 000 knowl of knowledge needed to survive.

Do not confuse $X_1 - X_6$ with the laws of existence they are just variables as explained above.

Y_u is not U, Yu is use knowledge as concerning variables $X_1 - X_6$, the function U includes the laws of existence.

The long run properties of knowledge are:

$U = f(e^X, Y_u)$ (2)

It has been explained why the properties are as they are in the long run and in the short run. These properties would not be known if we had not started without the right premise. It is because of these two unique properties that we can build a knowledge transfer knowledge.

In the commercial field, knowledge transfer is the transfer of knowledge from the holder to a recipient for commercial purposes, corporations do it with R & D departments, however it is universities that are now doing it more and more, universities are now commercializing their research, this model is useful both for the university start up, corporate R & D as well as for government policy influences. The model is very simple.

In general we would be right to say the short/ middle term properties of knowledge are:

$U = f(\ln X_i, Yu)$ (3)

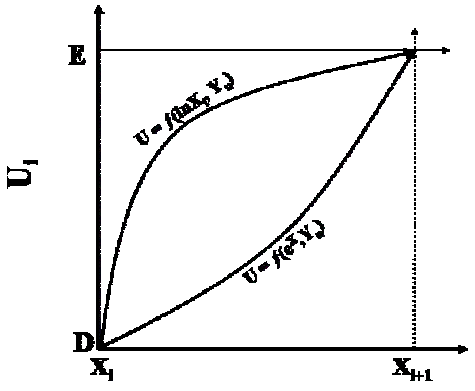

Figure 3

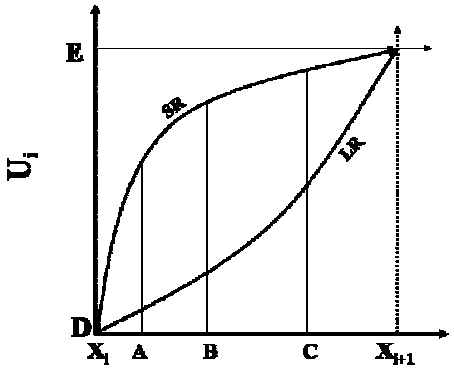

Figure 4

Figures 3 and 4 are identical to figure 2 with the exception that with figure 3, $U = f(\ln X_{t+4}, Y_u)$ has been replaced with the general expression for the short/ middle term $U = f(\ln X_i, Y_u)$. In figure 4 the short run has simply been termed SR and the long run simply with LR. Looking at figure 4 we see that between X_i and X_{i+1} there are three zones of knowledge, A, B, and C. At each level of knowledge represented by A, B, and C, there are different knowledge transfer principles that are involved. These principles would not be evident with past models because they could not differentiate between the short/ middle run of knowledge and the long run characteristics of knowledge, they just assumed constant growth. Figure 5 shows their common mistake, because they started from the long premise, they could not comprehend that the long and short run occur simultaneously, hence the old fashioned view of the short, middle and long run as illustrated in figure 5.

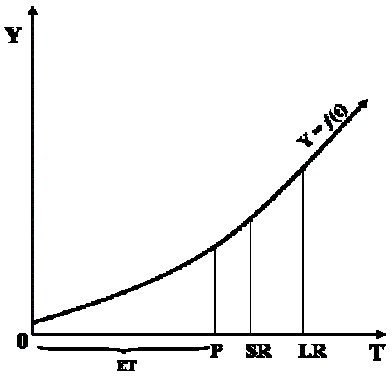

Figure 5

Figure 5 is how economists traditionally look at trends. We have a simple function in figure 5, $Y = f(t)$, a phenomenon Y is dependent on time. This is very simplistic to illustrate a common mistake and why the short run long run model will always be more efficient than knowledge functions of the past, all because they did not unitize knowledge, they did not consider the effects of time, indeed they did not understand how time works and that time need not be an independent variable, (this is for another discussion).

In figure 5, P represents the present, SR represents the short run and anything after LR is the long run. ET is everything that is before the present, it is elapsed time. We know elapsed time, we know what has happened in the past, we are very accurate with hindsight. SR can more or less be predicted, it is not to far into the distant future and after LR our predictive ability become more or less educated guess work. What we have with understanding the short and long run behavior of knowledge is that there is a function for the long run and a function for the short run, because phenomenon, especially knowledge behaves in very different ways, our present is the long run for somebody thirty years ago, or even ten years ago in some instances.

Figure 5, the traditional model in no way allows us to compare phenomenon, it does not give us a tool that will be helpful in analyzing phenomenon to decide on what action to take, for this we must return to figure 4. Figure 4 illustrating the short and long run becomes very helpful in developing a model for knowledge transfer, the clue is given by how knowledge is behaving at A, B, and C.

At A, I figure 4, short term knowledge is growing faster than the long term trend, in mathematical notation we can say:
$dU/ dX_i > dU/ dX$
The rate of change of short term knowledge is greater than the rate of change of the long term knowledge. This would be an opportune time to allow the knowledge transfer process to occur. The industry is growing compared to the long term trends, the technology can be considered to be fairly new and there are rapid advancements. This is consistent with theory that was developed in the paper, "Knowledge Theory and Investment: Enhanced Investment Decision Based on the Properties of Point X." The most suitable time to carry out knowledge transfer, the least riskiest would be when short term knowledge is growing at a faster pace than the long term trend of the growth of knowledge. This indicates, but does not necessarily mean

that the industry is growing, but we can safely assume that when the short term growth of knowledge is faster than the long term growth of knowledge, technology is been replaced at a faster rate than the long term trend.

Returning to figure 4, it is now we consider B. At B, disregarding the accuracy of the diagram, let us say that the change in knowledge in the short term is equal to the long term trend of change, that is to say:
dU/ dXi = dU/ dX.
The risks involving knowledge transfer are now more riskier than when the short term growth was growing at a faster rate than the long term growth. The risks though greater should be considered still acceptable, this is because the technology being offered still has some time to go before it becomes obsolete. This is the reason why A and B are less risky, it all has to do with the concept of the technology becoming obsolete. Nobody wants to introduce technology at the end of that technologies cycle. Competition from other players in that sector would be too much because they already have economies of scale. There is no point in introducing last years micro chip technology for example next year when one knows that generally every two years the capability of microchips doubles.

We are strictly looking at commercial knowledge transfer for commercial purposes, itself being the least riskiest type of knowledge transfer. The risk involved in research where illustrated in Table 2 in the paper "Knowledge Theory and Investment: Enhanced Investment Decision Based on the Properties of Point X," this table 2 has been reproduced as table 1 in this paper.

	Type of Research	Risk	Type of Investor	Priority for Private Investment
1	$X_i \longrightarrow X_{i+1}$	Highest	Government, Foundations, higher education	least
2	$X_i \longrightarrow U_i$	Middle	Same as above, as well as private	Some
3	$U_i \longrightarrow U_{i+1}$	Lowest	Private	Highest

Table 1

We are dealing with the improvements of products, we are essentially talking about type 3 research. Looking at figure 4 above we can see that at A, we are at the closest to point X_i, that is to say closest to when $X_i \rightarrow U_i$ has taken place, a more risky type of research. AS we move away from A to B, we are moving towards another break through, this will be understood when we look at what is happening at C.

At C in the illustration given by figure 4:
$dU/ dX_i < dU/ dX$.
At C, the growth of use knowledge in the short term is slower than the overall long term growth of knowledge. This is the riskiest moment of type 3 research as illustrated by Table 1. When the growth in the short term is slower than the long term trend, it means the growth of knowledge is slower and what is now needed is a break through for a new law of existence to be discovered to start the upward spiraling cycle anew represented by X_{i+1}.

Why is C as illustrated in figure 4 the most riskiest time for knowledge transfer? The reason is that at C, if knowledge transfer does take place, those undertaking the knowledge transfer process need to take into account several more risk analysis than say at A. At C, they must consider the ability of the staff, will the knowledge being transferred be able t be improved upon, as the short term growth is slower than the long term growth, the ability of the staff to improve the product becomes more paramount, because the players already involved have established brand names and economies of scale. To break into a market with established players, if the product can not be improved upon it will just fizzle out. It is not just about the knowledge, having knowledge be it an established firm or a new firm, the question of sustainability must

always be considered. Introducing technology at the end of a cycle is riskier than introducing knowledge through knowledge transfer at the beginning of the cycle. Risk associated with research type 3 as illustrated in table 1 can be further elaborated upon with table 2. Table 2 is really merely a condensation of what we have been discussing in the above paragraphs.

Breaking Down Risk Associated with $U_i \rightarrow U_{i+1}$

Condition	Risk Level	Mathematical Notation
Short < Long	highest	$dU / dX_i < dU/ dX$
Short ≈ Long	medium	$dU/ dX_i \approx dU/ dX$
Short > Long	lowest	$dU/ dX_i > dU/ dX$

Table 2

When short term changes are lower than the long term changes, we must consider that, will the firm be able to reach the next point Xi, because at this stage it is no longer about improving product U_i as such with known laws, unknown laws will have to be discovered, does the firm after transferring this knowledge have that capability.

It is about understanding the concept of time. How fast time is moving must affect the knowledge transfer decisions, to transfer or not to transfer. Looking at figure 4, or better still looking at table 2 we can see what is occurring with time. When the short term knowledge increments are smaller than the long term knowledge incremental, it means that time right now has slowed, technology advances are not spectacular. Let us go back in time when there were few products, take a spear maker from the middle ages, or a maker of the bow and arrow. The spear, the bow and arrow have been basically the same for thousands of years. There would be established iron smiths who would deal with the manufacture of spears, and established bow makers that a central government would take their supplies from.

The spear having remained the same for a very long period of time if one wanted to enter the spear making trade they would need to come up with a better product, a very difficult thing to do given the simplicity of the spear, a better product would be a gun. The gun would represent a fundamental leap in technology, because also entering the spear market, one would have to compete with the established iron smiths to make an identical product. With the spear the weapon stayed the same for thousands of years, time in terms of spear technology literally stood still. Yes humans grew older and died and new generations came about, but the mode of production, as well as the product itself remained the same for thousands of years until the industrial revolution.

Time, when time slows it is very risky to enter a business, this is represented by the short term increments being smaller than the long term increments. Taking table 2 above, time is at its fastest when the short term increments are greater than the long term increments, that is to say when $dU/ dX_i > dU/ dX$.

Illustrations are a method of making it easier for us to understand a concept, especially in diagrammatic form. Figure 6 helps to illustrate and hopefully will convey the message that has been discussed above. The concept is fairly simple, when is it best for knowledge transfer to occur. Looking at figure 6 we can see that there is the zone where we can say $dU/ dXi \approx dU/ dX$, that is to say the changes in the long run expression and the short run expression are almost equal. To the left of this neutral zone we have the least riskiest condition for knowledge transfer. The dependent variable concerning figure 6 is the rate of change of use knowledge, U being use knowledge. As can be seen from figure 6 whilst the rate of change in the short run slows as we move towards X_{i+1} that of the long run is increasing.

This paper is developing a theoretical framework, theoretical frame work that would never have existed, impossible to imagine without understanding the concept of time as related to knowledge as well as the need to unitize knowledge, everything must start from the right premise, one can not try to change a model for accounting for example to account for knowledge, one must start right from the beginning and build a sound theoretical frame work. Figure 6 is now demonstrating what occurs when starting with the right premise. To the right of the neutral zone, the risks associated with knowledge transfer become higher, there is now pressure due to competition to find another law of existence, not just any law but a critical level that will open up a whole new world of applicability. Critical levels will discussed thoroughly in the paper "Point X and the Economics of Knowledge." X_i and X_{i+1} are critical levels of knowledge. However do not forget and it must clearly be accepted that between point X_i and point X_{i+1} there lies knowledge, non critical points of knowledge.

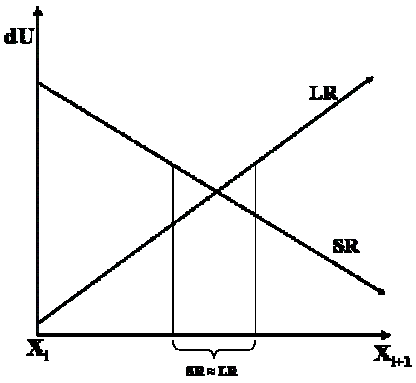

Figure 6

We have drawn up a theoretical framework for knowledge transfer, when best it is for knowledge transfer to occur. However looking at figure 6, though on the right of the neutral zone it is riskiest for knowledge transfer, it is known and accepted that the higher the risks the higher the rewards as well as knowledge transfer is encouraged to occur at any stage given the right circumstances. If a firm can discover Xi+1, then that firm has really not faced the risks of slowing time, of stagnation.

Knowledge Economics and thereby knowledge transfer still have a lot of work, but at the least we are now coming from the right theoretical framework, a theoretical frame work consistent with previous economic theory. We have now a theoretical framework for knowledge transfer from a sound theory in knowledge economics.

A very terrible mistake is when out of fear one tries to build a model out of the wrong premise but desiring so much to be published ignores the obvious wrongs because they want to quote as many people as possible.

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