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Regional Integration: Europe, the Mediterranean and the World Economy

**Keynote Lecture**

## **Regional Integration and Cultures in the Age of Knowledge Creation— The Story of the Tower of Babel Revisited—**

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Good morning, ladies and gentlemen. Thank you very much, Mr. Chairman, for your kind introduction. I am very honored by this great opportunity to speak at the 53<sup>rd</sup> European Regional Science Association Congress in Palermo. Indeed, about half a century ago, before most of you existed, I watched a fascinating movie, “Gatto Pardo,” starring Alain Delon, Burt Lancaster, and Claudia Caldinale in the setting of beautiful Sicily. Since then, it has been my dream to visit Sicily someday. Thanks to the 53<sup>rd</sup> European RSA Congress, my dream has come true.

My presentation today is entitled “Regional Integration and Cultures in the Age of Knowledge Creation— The Story of the Tower of Babel Revisited—.” In connection with the main theme of this congress, namely, Regional Integration: Europe, the Mediterranean and the World Economy, my presentation today is concerned with the importance of diversity and culture in the sustainable development of the global economy based on innovation and the creation of new knowledge throughout the world.

### **1. Introduction**

Indeed, since the late 20<sup>th</sup> century, we have been witnessing the development of the so-called Brain Power Society. As we know, recently, revolutionary developments in Information • Communication Technology and Transport Technology have been promoting, on the one hand, the so-called globalization of the world economy in trade and investment, and, on the other hand, the development of the so-called Brain Power Society where the creation of new knowledge or innovation has become the major activity of most countries and regions throughout the world. Together, these have been bringing out the major reorganization of global economic • political • social systems.

In the context of Europe, since the collapse of the Berlin Wall, the unification of Europe has accelerated, and the European Union now contains 28 member countries. But, of course, the integration of this part of the world cannot stop there. Indeed, as Fernand Braudel, one of the greatest historians in the last century, has eloquently described, over more than 3,000 years, the civilization of this part of the world had evolved centering around the Mediterranean, surrounded by the

continents of Europe, Africa, and Asia.

Here, the interaction between the first nature geography and the second nature human geography has evolved into a unique part of the planet centered around the Mediterranean. About the history of the Mediterranean, of course, you know much better than someone like me who comes from Japan, and it is not my intention today to show my ignorance. But, I would like to remind you of one fact. That is, we are now in Sicily, and, as you know, Sicily played a central role in the development of the Mediterranean, in particular, from the 11<sup>th</sup> to the 14<sup>th</sup> centuries. As we can see in this slide, the island of Sicily is at the center of the Mediterranean, hence, Sicily naturally was the main crossroad for trade between Europe, Africa, and Asia through the Mediterranean. Furthermore, when the descendants of the Normans unified Sicily and southern Italy as a kingdom in the 11<sup>th</sup> century, this region became a melting pot of various cultures and races, accommodating all kinds of people from all of the regions surrounding the Mediterranean. In particular, in the 12<sup>th</sup> century, under King Ruggero II, Palermo developed as a major international hub of knowledge creation through the cross-fertilization of various cultures. Its population reached about 200,000, and many famous scholars visited Palermo at that time.

For us, as regional scientists, the most memorable person is the geographer Muhammad al-Idrisi, who created this world map in Palermo in 1154. As you can see, this represents the most advanced world map at that time. Indeed, if you compare al-Idrisi's map with this satellite photo, the two look largely the same. How could he draw such a precise world map? Actually, he was born in Morocco as a Moslem, was educated in Cordoba, Spain, and then travelled all around the Mediterranean coasts and Europe extensively. He stayed in Palermo for 17 years and created this map. This most advanced world map became possible for al-Idrisi because, as a Moslem, he was rather free from the influence of Christian doctrine on world geography, hence he was able to combine all of the knowledge on world geography by Europeans, Arabians, and Asians together with his own knowledge through the long period of exploration. We might call al-Idrisi the father of geography.

Anyway, given that Europe has evolved over a long time as a part of the greater, unified region surrounding the Mediterranean, I agree with the opinion of *The Economist* that Europe should look south. I know, of course, that many counties in the south at present are experiencing an agonizing transition period. But given that Europe is aging fast, while the United Nations estimates that the population of Africa will reach four billion early in the next century, there is a compelling reason to look south with a longer term perspective.

Now, coming back to the main line of my presentation, first, concerning globalization in terms of production and trade of traditional goods, everyone would agree that the lower the transport costs, the greater the efficiency, meaning that paradise for the traditional economy would be a world with zero transport costs.

Next, concerning the development of the Brain Power Society, can we say similarly that for the production and transfer of “knowledge” broadly defined, the lower the communication barriers, the better the outcome? In other words, is paradise for the Brain Power Society a world of effortless communication with no communication barriers?

For example, in the context of European integration, from the viewpoint of culture, is it the ultimate goal of European integration that everyone becomes the same Perfect European such that everyone cooks...like a Brit; everyone drives...like a Frenchman; everyone is as humorous...as a German; as available...as a Belgian; as famous...as a Luxembourger; as patient... as an Austrian; and, everyone as talkative...as a Finn; as flexible...as a Swede; as discrete...as a Dane; and everyone as generous...as a Dutchman; as sober...as an Irishman; as technical...as a Portuguese; as organized...as a Greek; and everyone as humble...as a Spaniard; and as self-controlled...as an Italian?

Is this the ultimate goal of European integration? Mamma mia! If so, it would be the end of Europe! By the way, I borrowed these characterizations of a “Perfect European” from the cartoons by J.N. Hughes-Wilson. Thus, if you were offended, please blame him. Anyway, remember that the strength of Europe is that so many diverse cultures, languages, and people are gathered in a relatively small region.

That is, recall that the motto of European Union is “United in diversity.” In general, it is true that distance, space, and multiple languages erect barriers to communications, as you may remember the recent American movie “Lost in Translation” by director Sofia Coppola. On the other hand, exactly because of barriers for communications due to distance, space, and multiple languages, each region could develop its own unique culture and knowledge. Therefore, as explained next, if diversity is important in knowledge creation, then the net effects of the existence of such communication barriers on the long-run development of knowledge for the entire region and world could be a big positive.

## **2. Why are diversity and culture important for the Brain Power Society?**

First, let me explain why culture and diversity are important for innovation. Needless to say, the fundamental resource in the Brain Power Society is the individual’s brain power, that is, the knowledge in our brains. But, two brains that are exactly alike do not yield any synergy. It is the diversity in people’s brains within a society that creates synergy in innovation. Similarly, in the context of interregional and international cooperation for innovation, it is the diversity in culture that creates synergy in innovation activity.

Let me elaborate on these points. In the cooperative process of knowledge creation, the key factor is the diversity or the difference between people in their knowledge composition. For example, suppose that two persons,  $i$  and  $j$ , are cooperating in creating new ideas. The ellipse in the left hand

side represents the knowledge composition of person  $i$ , and the ellipse in the right hand side represents the knowledge composition of person  $j$ . If there were no overlap in the two ellipses, that is, if there were no common knowledge between the two persons, then it would be impossible to communicate, and hence no cooperation would be possible in creating new ideas. In contrast, if the two ellipses are completely overlapping, that is, if there were no differential knowledge between them, then there is no need to cooperate, and hence, no synergy. Therefore, in the cooperative process of knowledge creation, it is essential to have the balance of three components, that is, the common knowledge and the differential knowledge of each partner. By fusing the differential knowledge of two persons through the common knowledge, wonderful new ideas will come out.

About the creation of new ideas through the encounter of heterogeneous people and culture. In China, they say, “*Sān gè chòu pí jiàng dǐng gè zhū gě liàng.*” In Japanese, it is “*San nin yoreba monjuno chie.*” Roughly speaking, in English, this means, “With three ordinary persons together, splendid ideas will come out,” or “two heads are better than one.”

This saying, “With three ordinary persons together, splendid ideas will come out,” is true when the three persons are different from each other in terms of their knowledge composition. But, the question is, “Is it true in the long-run?” The danger is that even if two persons, for example, have sufficient differences in their knowledge composition when they meet for the first time, if they continue working together too long, then their common knowledge expands relatively while the differential knowledge of each person shrinks relatively, and thus the synergy becomes less and less. Eventually, “after three ordinary persons meet for three years, no splendid ideas will come out.” Indeed, in our actual academic life, we often see the case where two scholars become intimate friends and keep writing many joint papers. Initially, their papers are interesting, but their joint papers become less and less interesting in the long-run. We must be careful to avoid such a situation.

That is, in the close cooperation of heterogeneous knowledge workers, there is a fundamental antinomy. In the short-run, through close communications, their cooperation in knowledge creation becomes very productive through synergy. However, if the same people keep cooperating, in the long-run, their common knowledge relatively expands and hence the heterogeneity gradually diminishes, leading to less and less synergy, and their knowledge productivity goes down. For example, during the 1980s, the Japanese economy was still growing rather rapidly, and some people expected that the Japanese economy would overtake the U.S. economy soon, and become the number one in the world.

Many have similar expectations for China today. At that time, I was teaching at the Wharton School at the University of Pennsylvania, and people at the Wharton School were wondering what would be the secret behind Japan’s success. One answer at that time was that the secret of Japan’s success would be the so called “nominication,” or learning by drinking. That is, people working in companies in Tokyo do not go home directly after work. Rather, they go to a drinking place together,

and keep talking and communicating through sake or wine for a long evening. When Japan was in the process of catching up to the U.S. and European economies, I believe, "nominication," or learning by drinking, contributed to Japan's success.

But, in the early 1990s, Japan became one of the top countries in the world in terms of per capita GDP. Since then, what Japan needed is a more diverse group of people for exploring the cutting edge of the knowledge frontier and innovation. But, too much close communication among Japanese people made them too homogeneous for the purpose of cutting edge innovation. The question is now "How to resolve this fundamental problem?" We might be able to get a hint from the story of the Tower of Babel.

### **The story of the Tower of Babel (Chapter 11, Book of Genesis)**

In order to get a hint for resolving the fundamental antinomy between the short-run effect and the long-run effect in knowledge cooperation, let us recall the well-known story of the Tower of Babel.

According to the Book of Genesis, once upon a time, somewhere in the Mesopotamian region, there was a powerful empire, speaking a single language. But, people there got too uppity, arrogant, and they started building a giant tower reaching heaven, thus challenging God. God became angry and confounded their language by introducing many different languages, scattering them upon the face of all of the Earth, with each region speaking a different language. In this way, a united humanity was expelled from the paradise of effortless communication, and a multilingual and multiregional world appeared.

The question is: Was it a punishment or a blessing in disguise? In thinking about the answer to this question, let us notice that each region speaking a different language means that each region will eventually develop a different culture. Thus, the real question is whether the world with a single culture is better than the world with many regions with different cultures.

In investigating this question, let me pose a related question. We have been witnessing a great revolution in the development of information communication technology (ICT) recently. My question is, does ICT really enhance knowledge productivity? When thinking about this problem, we must differentiate the transfer or spillover of knowledge and information from the creation of information and knowledge. The development of ICT, without doubt, has greatly enhanced the transfer speed of knowledge and information.

On the other hand, each person has a limitation in absorbing new information and knowledge, just 24 hours in each day. But, we receive so much information every day, through newspapers, mass media, and the internet, resulting in the so-called information explosion. So, naturally, we have the mass media and search engines that will condense a very big amount of information into a very small amount of information or knowledge. For example, each person will actually see only the top three

or four items from a search engine, resulting in the expansion of the common knowledge. So it is not obvious whether the development of ICT will advance or diminish the creativity of people.

### **3. Diversity and creativity—soft evidences**

Next, let me present some soft evidences about the importance of diversity for creativity. The first soft evidence is the interesting article by Yoko Towada, an internationally renowned writer, that I recently read in the JAL Skyward, a free magazine of the JAL Group.

She was born in Tokyo but also lived in Germany for 26 years, writing both in Japanese and German. Half of her life was in Tokyo and the other half was in Germany. She won the Akutagawa Prize and Tanigaki Prize in Japan, the most prestigious literature prizes in Japan, but also the Lessing Prize and the Goethe Medal in Germany. In this article, there is a series of interesting questions and answers, but let me just mention two questions and answers.

The first question is: what about Japanese traditions? The answer is: Japanese traditions were of course familiar to me but seemed too close in terms of space and time. While I was in Japan, nothing evolved from it, neither curiosity nor desire.

The next question is: aren't you sometimes afraid of losing Japan? The answer is: No, on the contrary, while I was living in Japan, I never thought much about my own culture since it was there. For example, the Noh theatre became important to me only while here in Europe. It's the difference between the two cultures that makes me productive, not the Japanese culture as such. Incidentally, I remember when I went from Kyoto for the first time to the United States to study at the University of Pennsylvania in 1968. When I came back to Kyoto after four years, I was amazed to realize how beautiful Kyoto is. I think you will also have many similar experiences.

Let me pose another related question. As you know, the *shinkansen* in Japan opened on October 1, 1964, nine days before the Tokyo Olympics. And exactly in that morning, Mr. Seiki, pictured here, was a driver of the first *shinkansen* from Osaka to Tokyo. This is a recent article about his recollection at that time. He notes that in 1964 at the time of the opening of the *shinkansen*, the culture in Tokyo was very different from the culture of Osaka or Kyoto. He believes that the *shinkansen* contributed much to making Japanese culture homogeneous, in particular, making the west and the east homogeneous. Partly because of the *shinkansen*, Japan eventually became monopolar, not only in terms of politics, business, and the economy, but also culturally, dominated by Tokyo. Hence, the question is, has the *shinkansen* contributed to enhancing the creativity of the Japanese society or not?

Indeed, this figure, developed by Professor Hamaguchi at Kobe University, suggests that too much concentration of knowledge workers in Tokyo has been causing the decline of knowledge productivity in Japan as a whole recently.

The upper diagram shows that the population share of the Tokyo Metropolitan Area in Japan has been steadily increasing until today, from 23% in 1970 to about 28% in 2010. Note that the Japanese population today is almost 130 million, hence 28% means about 36 million people, which is by far the biggest agglomeration of people in a single metropolitan area in the world.

In the lower diagram, the horizontal axis represents the total number of patent applications in Japan in each year since 1982, whereas the vertical axis represent the share of Tokyo patent applications out of the total Japanese applications. This lower diagram shows that from 1982 to 2000, the total number of patent applications in Japan increased steadily, but since 2000, the total number of patent applications in Japan started decreasing steadily, while Tokyo's share in patent application in Japan kept increasing until 2008, and finally started decreasing just recently.

Recalling that Tokyo's population share in Japan has been increasing until today, this lower diagram means that, in the last decade, more agglomeration of the Japanese population in Tokyo has been accompanied with a decline in the total number of patent applications in Japan. This suggests that too much concentration of knowledge workers and cultural activities in Tokyo has been causing the Japanese people to become too homogeneous in terms of their knowledge composition, which in turn has caused the knowledge productivity of the Japanese people as a whole to decline.

Indeed, this figure illustrates the relative decline of Japanese knowledge productivity in terms of patent applications in comparison with other major countries or regions. As you can see, Japan was at the top until 2005, but it started declining in 2002. In contrast, the United States, China, and Korea have been growing rapidly in terms of patent applications. In particular, the United States surpassed Japan in 2006, and China is now at the top in 2011.

Next, this figure shows the change in the share of each major country in the international papers with American coauthors over the last 10 years. That is, among all of the papers written under the co-authorship of Americans in the United States and non-Americans residing outside of the United States, what is the share of each major non-American country?

As we know, today, the United States is the biggest international hub of academic activities, hence, this figure shows, roughly, how internationally connected is the academic activity of each non-U.S. country. It is not surprising that English-speaking countries such as England and Canada have high shares. But, Germany also maintains a strong academic connection with the United States.

In contrast, the Japanese academic connection with the United States has been relatively declining, indicating that the Japanese academic society is becoming relatively inward looking. The most surprising is China. In parallel with China's trend in the number of patent application in the previous slide, the share of papers co-authored with Chinese scholars is increasing at an astonishing speed just

like China's GDP.

Next, this diagram is based on the recent interesting article in *Papers in Regional Science* written by Professors Fritch and Graf from Jena University in Germany. They compare two representative research cities, Jena and Dresden, in the former East Germany with two representative cities, Karlsruhe and Aachen, in the former West Germany. Each city has about one million people with an elaborate network of research cooperation within the city or region. I don't have much time to explain how these links in the maps have been drawn. In comparing the two cities in East Germany and the bottom two in West Germany, we can see that, in East Germany, the links between the research institutions in each city is much denser.

According to the traditional explanation of the importance of knowledge-network density in research productivity, East German cities should have a higher productivity. But the actual result is exactly the opposite. In terms of per capita patent registration, West German cities have about twice as many as East German cities. How do we explain this surprising result? Because each person has the capacity for research cooperation, the dense internal linkage means the linkage with the outside world is rather weak. And that's the opposite state of West German research cities.

So, again, this result suggests that we should not concentrate too much on the internal research cooperation. Rather, we must make more open research links and cooperation.

Let me present next soft evidence about the importance of diversity for creativity. This is about the data on the National Institute for Material Science (NIMS) in the Tsukuba region in Japan. Tsukuba is a research town. Among the many research institutions in Tsukuba, NIMS has the largest number of foreign researchers, about 600. But NIMS originally didn't have this many foreigners. It is a result of intensive efforts by NIMS.

In 2004, the Ministry of Education designated NIMS as a center for young researchers. Then, in 2007, NIMS was designated as the International Center for Materials Nanoarchitectonics (MANA), an international research center for nanoarchitectonics. Since then, NIMS tries very hard to increase the number of foreign researchers. At the start of 2001, foreign researchers accounted for less than 4%, but now this number is approaching 25%.

As a result, what happened to NIMS? This is the world ranking of research institutions in terms of citations in the field of material science. Before NIMS starting the real promotion of inviting foreign researchers, between 1994 and 2004, it was ranked 18th in terms of citations in materials science. However, after promoting internationalization, inviting many young foreign researchers, its ranking in terms of citations between 2007 and 2011 moved to 4<sup>th</sup> place. The top rank is the Chinese Academy of Sciences, but this is a nationwide institution. The second is the Max Planck Society, but it is also a German-wide institution. So, among individual institutions, the Massachusetts Institute of



Technology (MIT) is the top and NIMS is second. This represents the result of NIMS's internationalization. Furthermore, among the top 10 papers at NIMS in terms of citations, eight were written by foreign researchers and Japanese together. Among the top 31 papers, 24 were written by Japanese researchers and foreign researchers together. This represents a good example in showing how the diversification of knowledge workers has increased productivity in a research institution.

Next, concerning the cultural diversity and economic performance, there is an increasing number of papers recently. The results of international comparisons are not necessarily conclusive. But, in the context of the comparison of different areas within the same advanced country or integrated region studies agree that there is a significant positive correlation between the cultural diversity and economic performance.

For example, Ottaviano and Peri in a 2006 paper compare U.S. cities and concluded that U.S.-born citizens are more productive in terms of their wages. Similarly, Bellini, Ottaviano, and others compare European regions in terms of cultural diversity and economic performance. The left figure shows the shares of foreigners in European regions in 2001, with darker regions having higher shares of foreigners. The right hand side shows the composition of foreign populations in 12 European countries. As you can see, the United Kingdom has large shares of Africans, Asians, and Americans, whereas France has a very large share of Africans. They show that diversity is positively correlated with productivity such that higher diversity causes higher productivity.

As the final empirical topic on cultural diversity, as you know, the issue of “cultural exception” is becoming a stumbling block in recent EU-U.S. trade talks. Last June, France successfully lobbied the EU to exclude cultural industries such as film, music, and television from the EU-U.S. trade talks. The United Nations Educational, Scientific and Cultural Organization (UNESCO) also reaffirmed the sovereign right of governments to adopt measures to protect and promote the diversity of cultural expressions. It is understandable that many countries want to protect their own cultural industries against big countries.

However, recently, Ferreira and Waldfogel at the University of Pennsylvania studied the global music consumption and trade since 1960 to the recent years, and found, as shown in this figure, that contrary to growing fears about large-country dominance, substantial bias towards domestic music exists, and that this bias has increased sharply since the 1990s. As we can see from the figure, the home bias has much more weight than common languages and distance that are rather constant. They conjecture that the rapid development in ICT over the last half century helped the consumption of domestic music more than for foreign music. This study is only about the music industry. But, in general, I guess that the fear about large-country dominance in cultural industries is rather exaggerated. The important policy issue is how to enhance the creativity of cultural industries in each country or region, not how to protect them against foreign exports. Indeed, who cares about “Die Hard 10”? Let’s compete in creativity, not in protection. When every country and region

becomes more creative in the promotion of its own culture, the entire world would become richer culturally.

#### **4. Modeling the Dynamics of the Brain Power Society**

Next, based on the long introduction so far, let me briefly present my recent research work on modeling the dynamics of the Brain Power Society. In this model, the question is how the diversity of knowledge workers and the local culture develops endogenously, how it is related with the growth rate of knowledge in the whole society, and how it is related with the growth rate of world economy. However, because I do not have much time today, I will not talk about economic growth, but concentrate on the question of how the diversity of knowledge and local culture affects the growth rate of knowledge in the whole society.

The following presentation is based on my recent research work with Marcus Berliant at Washington University in St. Louis. The first paper is Knowledge Creation as a Square Dance on the Hilbert Cube. I will explain about square dance later. The next paper represents the fusion with the endogenous growth theory and the dynamics of knowledge diversity. And recently, we extended this single-region model to a multi-region model, introducing culture and diversity in knowledge creation, on which my discussion today is based.

Before going to the model, let me explain about square dance. If you are from United States, you might know it. The square dance was very popular in the U.S. frontier. When people were migrating from the east to the west, at night they camped around the fire and enjoyed square dancing. Square dancing basically requires eight people. Each couple dances with his or her partner and then quickly exchanges partners. In the formation of eight persons, there is so much variety. If you go to access the internet, you have a printout of 20 pages of formation immediately. Incidentally, I recently wrote three papers with Marcus Berliant. But we meet only three or four weeks per year. And the rest of the time, I work with other people, while Marcus Berliant also works with other people. Thus, we are essentially performing international square dancing in developing new papers. I think this is very typical in regional science and economics.

In fact, these figures from Peter Gordon's recent paper (2013) indicate that most people in regional science are doing square dancing in developing new papers. The upper diagram indicates that among the papers published recently in the *Journal of Regional Science*, about 60% are collaborative papers. And, the bottom diagram shows that, among the collaborative papers published in 2010 and 2011, 45% are based on international collaboration, and about 30% are written by authors in different cities. Thus, in the field of regional science, a lot of square dances among long-distant partners have been going on recently. By the way, I checked other major journals in economics, and found, for example, that in the *American Economic Review* in 2012, 82% of the papers are co-authored, and in *Quarterly Journal Economics* in 2012, 88% of the papers are co-authored.

Formalizing such an academic square dance in the real world, let me explain the basic idea of our culture and diversity model in the case of two regions. Suppose we have region A, maybe Japan, and region B, for example, the United States. Let us assume that each region has the same number of knowledge workers or researchers. Of course, within Japan, or region A, they can communicate more easily, so intra-interaction is very dense. Likewise, region B also has very dense intra-interaction. But between the two regions, because of the travelling time and cost, interregional research-cooperation is not easy. (Here, for simplicity, we are not considering migration.)

Furthermore, there is much weaker knowledge transfer from the United States to Japan and vice versa. For example, few Japanese people read American newspapers, and few Japanese people watch American television. So if we take two typical persons in region A, their common knowledge is relatively large. The same thing happens to region B or the United States.

In contrast, if we take one person from region A and one person from region B, then naturally their common knowledge is relatively much smaller. This means that, within each region, the common knowledge is big, but internationally or inter-regionally differential knowledge is big. In this context, knowledge creation in the whole human society will take place as follows. For creating incremental innovations, each region can achieve it within each region utilizing its large common knowledge. But when exploring the cutting edge of the science frontier, for example, new biotechnology or real new software, diversity in knowledge workers is essential. In this case, international cooperation becomes very important. Because each region has a different culture, there is a large diversity between regions. In this way, the very existence of spatial barriers in communications will contribute to enhancing the productivity of knowledge creation for the whole society. That's the basic story, but let me explain a little bit more in detail.

Here we consider a simple knowledge production function. At a given time, we assume that each person can, for example, as a regional scientist, write papers in isolation. But, alternatively, you can work together with somebody else and write joint papers. Therefore, there are two alternative ways of creating new ideas. First, in the case of isolation, let's assume a very simple knowledge production function. That is, the number of new ideas produced per unit of time is just proportional to the size of this person's knowledge. And the alpha ( $\alpha$ ) represents the proportional parameter. So in each time, proportionally to the size of his or her own knowledge, new ideas come out. Further, assume that among new ideas produced, a certain percentage represents the explicit knowledge that becomes patents absorbed by other people as public information. But the rest becomes tacit knowledge, kept alone by this person, accumulating as differential knowledge. This is the case of a single isolated person.

Next, let us consider two persons cooperating in the same region. As I said, for cooperation in knowledge creation, the balance of three components is important. Considering this point, we consider the knowledge production function by two persons,  $i$  and  $j$ , in which the three components

of their whole knowledge are multiplied by each other: The three components are the size of their common knowledge, the size of the differential knowledge of person  $i$  from  $j$ , and the size of the differential knowledge of person  $j$  from  $i$ .

However, instead of simply multiplying the three components, let me put power  $\theta$  on the size of common knowledge. The parameter  $\theta$  represents the importance of common knowledge in research cooperation. If  $\theta$  is close to 1, this means that common knowledge is very important in this particular type of innovation. In contrast, if  $\theta$  is close to 0, this means the diversity is very important in knowledge creation. But here  $\theta$  is a fixed parameter.

Next, in the case of interregional cooperation between two persons, we multiply  $\tau$  (tau) by the original knowledge production function, where  $\tau$  is less than one. For example, when  $\tau = 0.8$ , the productivity decreased 20% because travelling take a lot of energy, time, and money. But if the matching is good, they will work together, realizing interregional research cooperation.

We have three variables in the knowledge production function. Let me reduce the number of variables by normalization because the production function is linearly homogeneous. I divide three components by the total size of the knowledge of the two persons, and use proportions instead of sizes. But the three proportions sum up to one. So I have only two variables.

In order to reduce one more variable, I assume for simplicity that the size of the knowledge of each person is the same. Then, since the size of common knowledge is the same by definition, the proportion of differential knowledge is the same for two persons. In this symmetric situation, the knowledge production function can be represented by a single variable,  $m^d$ , the share of differential knowledge. Notice that when two persons are in cooperation, the per capita output is one half, and hence we divide  $a_{ij}$  by two. Furthermore, since the real input is  $n_i$  (the size of each person's knowledge), we also normalize the output by  $n_i$ . Hence, in the symmetric case, the normalized knowledge production function can be expressed by a single variable,  $m^d$ , the share of differential knowledge of each person. By definition,  $0 \leq m^d \leq 0.5$ .

In this figure, considering the symmetric case, the horizontal axis represents the share of differential knowledge of each person, and the vertical axis shows the normalized knowledge productivity. The top curve represents the knowledge productivity of each person when the two persons work together in the same region. Depending on the share of differential knowledge, we have different values of productivity. As shown in this figure, the productivity curve is single-peaked, achieving the highest level at the bliss point  $m^B$ . That is,  $m^B$  represents the best matching in terms of the share of differential knowledge of two persons. In the case of inter-regional research cooperation, the productivity will go down proportionally to parameter  $\tau$ . For example when  $\tau$  is 0.8, 20% will go down. Finally, when each person works in isolation, productivity is represented by the horizontal blue line.

Next, for simplicity, let me assume that at the initial time zero, the size of knowledge is the same for all research workers. Then, we can show that at any time on the equilibrium path, the size of the knowledge is the same for all workers. Therefore, the pair-wise symmetry in knowledge composition is maintained on the equilibrium process. We must note, however, that pair-wise symmetry does not mean that every pair has the same share of differential knowledge. For example, within Region A, two persons keep the symmetry, but their common knowledge is relatively large. But for the pair with one in Region A and one in Region B, the share of common knowledge will be much smaller than for the intra-regional pair. Anyway, we assume that, at each time, each person will form a pair by selecting the best matching partner in terms of knowledge productivity. But if they keep the same pair too long, they are enlarging the common knowledge too much. So each person will sequentially change partners like in square dancing.

### **5. The Story of the Tower of Babel revisited**

Given this explanation of the two-region model of diversity and culture, let us revisit the Story of the Tower of Babel. Let us assume that before the expulsion from the paradise of effortless communication, we have all of the  $2N$  people in one empire, enjoying effortless communication. It is good to enjoy effortless communication, but, on the other hand, so much common knowledge is being accumulated. In this context, parameter  $C$  is important, which represents the capacity for absorbing common knowledge in comparison to the creativity of each person. Here we assume that  $C$  is large, so too much common knowledge is being absorbed. As a consequence, the equilibrium point in the paradise of effortless communication is given in the red point in the figure, meaning much lower productivity than the bliss point.

Next, let us go to the Phase 1, and assume that God expelled  $2N$  people from the paradise, and divided them into two regions, with each region having  $N$  people and a different language. Then what happened? Just after the expulsion, not much happened because each region still has a very large number of people, half of the previous one but still very big. Just after the expulsion, each region inherits the same culture. Given this situation, since the inter-regional cooperation decreases the productivity, naturally, people in each region cooperate only internally. Furthermore, interregional knowledge spillover is naturally weak. Therefore, soon or later, each region develops its own culture.

Eventually, we move to Phase 2 where the interregional difference in knowledge composition becomes large enough so that the productivity in the interregional cooperation becomes comparable to that in the intraregional cooperation. Therefore, each person starts cooperating internally as well as inter-regionally.

This figure explains the situation of Phase 2 in another way. Each person in each region uses a certain proportion of time,  $\phi^*$ , for intraregional knowledge cooperation. But the rest of the time,  $1-\phi^*$ , is used for the inter-regional knowledge cooperation. So each person is utilizing effectively

large common knowledge within the same region and large differential knowledge between the two regions. That's why they can gradually move upwards both in the intraregional and interregional productivity curves.

Eventually in Phase 3, they reach the highest point in terms of the interregional productivity curve, which I call the New Eden. Now, every person achieves a much higher knowledge productivity than in the original effortless communication paradise. Therefore, as shown by the two equations, the growth rate of knowledge of each person at the New Eden is much higher than that in the original effortless communication paradise.

By the way, going back to Phase 2 for a while, it is not difficult to understand why inter-regional knowledge diversity increases gradually. But why does intraregional knowledge diversity also increase gradually? This is because, as shown in this figure, inter-regional K-interactions take place in a particular manner. Let us imagine, for example, Japanese economists working together with their American counterpart economists. In this case, Japanese economists are not working equally with every economist in the United States. In practice, American economists and Japanese economists form many different groups, such as the Harvard group, Yale group, Chicago group, Stanford group, etc. In each group, they closely work together because of group externalities. Within the same group, they enjoy strong group externalities, while intergroup externalities are relatively weak. Then, since all economists divide into a large number of groups, Japanese economists also develop heterogeneity among themselves. This is why the interregional cooperation also promotes the intraregional knowledge diversity.

Incidentally, this way of interregional knowledge cooperation is very similar to a Chinese dinner party. In a Chinese restaurant, a certain number of people sit around each different table. And, in front of each person, we have a dish. But at times, we must regularly rotate the table or dishes. This is somewhat similar to the case of interregional research cooperation. Each American economist sits in front of a Japanese economist. While eating the knowledge of each other, they create new ideas. But after a certain time, they switch partners. In both Chinese restaurants and interregional research cooperation, they perform square dancing while enjoying both intra-group and inter-group externalities.

This example shows that the growth rate of the knowledge of the whole society at the New Eden is about three times higher than that at the original paradise of effortless communication. That is, by breaking the one region into two, the whole society can achieve a big improvement in knowledge creation over the one region case. This can happen even when the interregional cooperation is rather costly (i.e.,  $\tau=0.6$ ).

Let us recall our original question: Was the expulsion from the paradise of effortless communication to a multiregional, multilingual and multicultural world a punishment or a blessing in disguise? The

results of our model suggest that, quite possibly, it was a blessing in disguise.

## **6. Conclusion: Let hundreds of towers bloom**

Now, in moving to the conclusion, you might think that I am against towers. But, I am not against all towers. Indeed, I love towers. I am only against the tower constructed by a single empire. On the contrary, let hundreds of towers bloom all over the world, with each tower representing a unique local culture. Indeed, a countless number of wonderful towers have been built throughout the world. In Palermo, of course, there are many towers, castles, and cathedrals. But, I like this rather modest monastery, San Giovanni Degli Eremiti built by Ruggero II in 1142.

Talking about towers in Italy, we cannot avoid mentioning the Leaning Tower of Pisa, very well controlled like an Italian! Big Ben/Elizabeth Tower in London, Eiffel Tower in Paris, Cologne Cathedral in Köln, the City Hall in Leuven, Tower of Belém in Lisbon, the Great Windmill in Netherland, the Parthenon in Athens, the Taj Mahal in India, the Shwedagon Pagoda in Yangon, the Empire State Building in Manhattan, the Trump Tower in Manhattan, the Great Wall in China, the Original Pearl Tower in Shanghai, the Toji Temple in Kyoto, and the Kyoto Tower in Kyoto. I could continue forever. But, let me just show that animals can also build towers.

For example, this ant tower is about 7-meter high. In terms of human proportion, it is about 5000-meter high. But still I like the tower made of human beings, and this is exactly the tower made of human beings in Tarragona, Spain. You can see how many people in each story. In the bottom, about 1,000 people, in the second story about a hundred people, the third story has about 30 people...and we have a human tower of nine stories. And you can see that in the bottom are the very strong men, in the middle are the young men, and in the top two stories are the young girls because at the age of around 10 years old, girls are mentally and physically stronger than men. This tower represents a real human collaboration.

Now let me finish my presentation by closing with words borrowed from the famous book by August Losch, *Die Raumliche Ordnung der Wirtschaft*, or *Spatial Order of Economy*, published in 1940. As you know, Losch, born in 1906 and died in 1945, is a giant scholar in the field of location theory. This wonderful picture was taken in 1935 when he was just 29 years old. Let me read the Epilogue on Space in the last page of the book: "If everything occurred at the same time there would be no development. If everything existed in the same place there could be no particularity. Only space makes possible the particular, which then unfolds in time. Only because we are not equally near to everything; only because everything does not rush in upon us at once; only because our world is restricted, for every individual, for his people, and for mankind as a whole, can we, in our finiteness, endure at all. Space creates and protects us in this limitation. Particularly is the price of our existence.

Thank you. Merci. Danke schön. Dank u wel. Merci. Danke schön. Kiitos. Tack. Tak. Dank u. Go

raibh maith agat. Obrigado. Ευχαριστώ. Gracias. Grazie.