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Who Produces Open Source Software

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FLOSS (FREE/LIBRE OPEN SOURCE SOFTWARE): A THEME FOR STUDYING CULTURAL DIFFERENCES

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ABSTRACT:

Geert Hofstede presented statistical evidence purporting to identify intercultural cooperation and its importance for survival in his scholarship work “cultures and organizations”. This article presents a study, which describes how differences in national culture can affect or influence the participation of programmers who produce Open Source Software (OSS). The four important dimensions of national cultures considered by Hofstede model namely Power Distance Index (PDI), Individualism Index (IAV), Masculinity-Feminity Index (MAS) and Uncertainty Avoidance Index (UAI) are selected and correlated with the Geographical Distribution of Developers Index (GDD) for testing the above hypothesis. It is suggested that there exists some correlation between the cultural factors and the demographics of programmers who participate in the open source movement. Finally, the manner in which these cultural factors impinge on the incentives of the programmers who are engaged in open source movement by writing codes for free are also discussed.

Key Words: Open Source Movement, FLOSS, Culture Difference and Hofstede Model

JEL Classifications: A1, J1, J2, K, L

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I. INTRODUCTION

The terms free/libre or open source software refers to software products which are distributed with the source codes under terms that allow users to: (i) use the software, (ii) modify the software and (iii) redistribute the software in any compoment¹ they like without requiring to pay the authors of the software a royalty or a fee for engaging in the listed activities. In contrast, most commercial software is proprietary software, and is distributed only with the object code so that competitors are prevented from reusing the source code² to develop software.³ From an economic point of view open source software production is viewed as a new radical process of producing software based on unconstrained access to source code as opposed to traditional closed and property-based approach of commercial world.⁴

In recent years there has been an enormous surge of interest in open source software development, which involves developers from many different locations, organizations and countries participating in the open source movement by sharing source code to develop and refine computer programs. The transformation of production of software from traditionally closed and property-based approach to open source production has altered the basic nature of software industry from both the supply and demand side.⁵ On the supply side, fundamental changes have occurred in the development process, reward mechanisms and distribution of development work and on the demand side, the alternatives traditionally available to organizations to buy or build have been supplemented with another credible alternative namely open source.⁶ The body of scholastic literature on open source is rapidly growing concentrating on the following questions: (i) why do programmers write open source software's for free? (ii) How do

¹ See, Joseph Feller et al., *"Perspectives on Free and Open Source Software"* (Cambridge: MIT Press, 2005) pp. xvi-xxxii.

² The original format in which the software developers write software codes, which is easy for trained programmers to read and understand is referred to as source code.

³ See, Jhy-An Lee, *"New Perspectives on Public Goods Production: Policy Implications of Open Source Software"*, 9 Vand. J. Ent. & Tech. L. 45

⁴ See, Andrea Bonaccorsi & Cristina Rossi *"Why Open Source Software can Succeed"*, 32 Research Policy (2003), pp. 1243-1258.

⁵ See, Brian Fitzgerald, *"The Transformation of Open Source Software"*, MIS Quarterly Vol. 30 No. 3 pp. 587-598 (September 2006)

⁶ Ibid at 587

hundreds of programmers who are dotted around the world effectively co-ordinate with each other to produce open source software in absence of any hierarchical structure? (iii) How is it possible to increase the diffusion of new technology given the presence of well established standard?

However, the question of asymmetrical distribution of developers amongst nation states who participate in the open source movement has received very less or no attention at all in the literature. This article tries to fill this gap by using Geert Hofstede model⁷, which is being extensively used in social psychology to study and understand the national and organizational cultural differences. Drawing on Hofstede's model this article tests the hypothesis as to whether differences in national/regional culture affects or influences the participation of programmers in producing Open Source Software. In other words, how does national/regional cultural distance between nation states answer or influence the distribution and participation of programmers in open source movement?

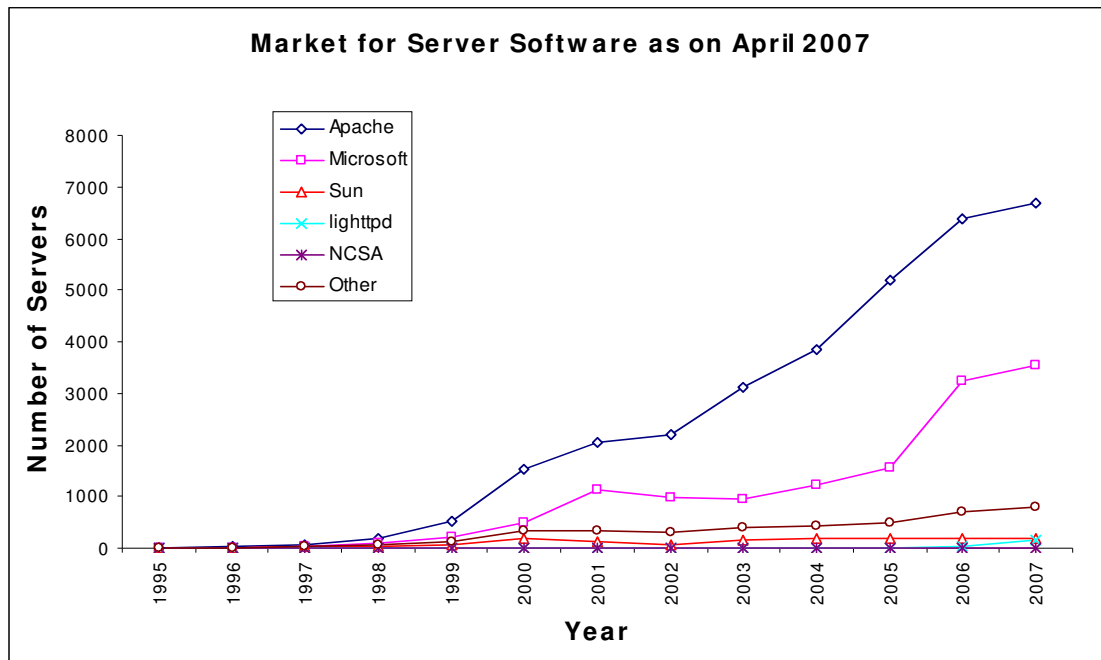
In Section II, this article evaluates the importance of open source movement by capturing the market share of open source software, highlighting the policy implications of various governments and finally by underlining the geographical distribution of developers who participate in production of open source software. In Section III, this article introduces Geert Hofstede model and its four important components namely Power Distance Index (PDI), Individualism Index (IAV), Masculinity-Feminity Index (MAS) and Uncertainty Avoidance Index (UAI). The four mechanisms for measuring cultural differences are explained in detail from formation to application mode. In Section IV, this paper tests the hypothesis using Geert Hofstede model by carrying out data analysis using well established statistical measures and consequently discussing the results. Section V concludes identifying the importance of this study and possible future extensions of this study.

⁷ From now on any reference to Geert Hofstede's model will be referred to his scholarship "Cultures and organizations"; **See**, Geert Hofstede, "*Cultures and Organizations*" (Glasgow: McGraw-Hill Publications, 1991); **See also**, Geert Hofstede, "*The Cultural Relativity of Organizational Practices and Theories*", Journal of International Business Studies, Vol.14 (2) pp. 75-89 (1983); **See also**, Geert Hofstede et. al., "*Measuring Organizational Cultures: A Qualitative and Quantitative Study Across Twenty Cases*", Administrative Science Quarterly, Vol. 35 (2), pp. 286-316 (1990)

II. IMPORTANCE OF OPEN SOURCE MOVEMENT (OSM)

A. FLOSS Market Share: The open source movement taking shape of creative commons⁸ has been very successful in developing software products like Linux, Apache and Sendmail, which are now serious competitors to conventional proprietary software's. Apache web server is a leading open source project and accordingly delivers majority of web pages viewed by internet users around the world. As per the most recent survey by Netcraft⁹ more than 60 percent of total servers employ Apache, rather than commercial alternatives from Microsoft and other firms (see, **Figure I**). During June 2007, the survey expanded the graph of server software publishers to include Google¹⁰.

Figure I: Market for Server Software*



* Source: Netcraft Web Server Search

⁸ Creative commons is a non-profit organization dedicated to free disseminations of copyrighted works, which attaches a notice to books and other materials that it distributes stating that, while users are free “to copy, distribute, display and perform the work”; See, Catherine L. Fisk, “*Credit Where Its Due: The Law and Norms of Attribution*”, 95. Geo. L. J. 49

⁹ See, <http://news.netcraft.com> (last visited on June 25, 2007)

¹⁰ Although not a server product like Apache or Microsoft-IIS, Google's services are an increasingly popular alternative platform for running a blog or simple web site (googlepages.com), or content that would have formerly been hosted on a desktop or networked file system (e.g. spreadsheets.google.com).

Linux¹¹ which is an open source operating system has garnered much of the commercial investment in the open source approach. In 1991, about ten people were using and modifying Mr. Torvald's original 10,000 lines of code; today there are an estimated seven million people using Linux and the code has grown to approximately 1.5 million lines.¹² Accordingly this open source operating system covers nearly 23 percent of the sever operating system market.¹³ Furthermore Linux is rapidly outstripping Microsoft's Windows program as the operating system most frequently embedded into products ranging from mobile phones to video recording devices.¹⁴

The open source projects namely Linux and Apache have forced proprietary softwares to respond vigilantly to ever-increasing commercial interest in the open source approach. The Forrester¹⁵ research finds that European firms have been actively adopting open source software over the last two years, and the overall share of companies using such systems amounted to 40 percent. The IDC's 2005 Western European Software End-User Survey of 625 firms also shows a significant increase in use, with over 40 percent showing "significant, some or limited" use of open source in operating systems sector and nearly 60 percent showing considerable use of open source in databases. The IDC survey was followed by the European Commission study¹⁶ on the economic impact of FLOSS on the European ICT sector. This study ascertains that open source software is of great importance to the digital industry in Europe and several other parts of the world. It recapitulates that open source software's have considerable market share in several fields,

¹¹ In 1991, a young Finish student named Linus Torvalds shared with the world his operating system "kernel". Torvalds openly shared the source code of his kernel and eventually decided to license the project using the open source GPL. Programmers across the globe became interested in Torvalds kernel and integrated it with existing programs to create a complete functioning operating system-GNU/Linux popularly known as Linux.

¹² See, Patrick K. Bobko, "Linux and General Public Licenses: Can Copyright Keep 'open Source' Software free?" 28 AIPLA Q.J. pp. 81-85 (2000)

¹³ See, Josh Lerner and Jean Tirole, "The Economics of Technology Sharing: Open Source and Beyond", Journal of Economic Perspectives Volume 19 (2) pp. 99-120 (2005)

¹⁴ See, Matthew D. Stein, "Rethinking UCITA: Lessons From The Open Source Movement", 58 Me. L. Rev. 157 (2006)

¹⁵ See, Forrester Study on OSS at <http://forrester.com/Research/Document/Excerpt/0,7211,34231,00.html> (last visited on June 27, 2007)

¹⁶ European Commission released a study on the economic impact of open source software on the European ICT sector. It was prepared by a consortium of research institutions led by UNU-MERIT's Rishab A. Ghosh. See, "The impact of Free/Libre/Open Source Software on innovation and competitiveness of the European Union", (<http://ec.europa.eu/enterprise/ict/policy/doc/2006-11-20-flossimpact.pdf>) (last visited on June 27, 2007).

including web servers and operating systems. The report further determines that the existing base of quality FLOSS applications with reasonable quality control and distribution would cost firms almost Euro 12 billion to reproduce internally and this code base is being doubled every 18-24 months over the past eight years. The notional value of Europe's investment in FLOSS software today is Euro 22 billion (36 billion in the US) representing 20.5% of total software investment (20% in the US).¹⁷

The EU study¹⁸ also shows that there has been considerable increase in the use of open source software in Asian countries¹⁹. In Japan, Linux servers have mainly been adopted by the insurance and services sector; however the adoption of the Linux on the desktop is much lower than the respective rates for servers. In Malaysia, the EU report identifies that 74 percent of the public sector organizations implement open source solutions. In China, 80 percent of the Chinese organizations use open source solutions.²⁰

B. Policy Implications of OSS: Stephen and Gynn²¹ in their report demonstrate that a majority of U.S. companies and government institutions are turning to open source software instead of using commercial software packages. Accordingly Jhy-An Lee²² in his scholarship provides empirical evidence as to how governments around the world have begun to think about both fostering the use of OSS in private sectors and encouraging OSS in public sectors by adopting various legislative and administrative strategies, which support development of OSS. In his empirical work he scrutinizes that as of September 4, 2006; at least forty-four countries have undertaken administrative or

¹⁷ Ibid at 46

¹⁸ Ibid at 25

¹⁹ According to IDC report for OSDL, Linux accounted for 14 percent of servers and 5 percent PCs in 2004 and is expected to grow to 25 percent and 9 percent respectively by 2008.

²⁰ ICBS, which is China's biggest bank serving 100 million individuals and 8.1 million corporate accounts through 20,000 branch offices across China, is assessing applications hosted on Linux servers on a daily basis.

²¹ See, Stephen Walli, Dave Gynn and Bruno Von Rotz, *"The growth of software in organizations"* (Boston: Optaors Publications, 2005); See also, Luc Hatlestad, *"LinuxWorld Showcases Open Source Growth, Expansion"* (<http://www.informationweek.com/story/showArticle.jhtml>) (last visited on June 27, 2007). Phillips' keynote of the tradeshow was most remarkable. He outlined how much Oracle has come to depend on Linux, and how the company plans to keep developing and deploying the technology, primarily in its grid-computing initiatives. Phillips also said open source experienced 32 percent unit growth and 31 percent revenue growth in 2004 as it began to move more deeply into the data center.

²² See Jyn-An Lee, *"New Perspectives on Public Goods Production: Policy Implications of Open Source Software"*, 9 Vand. J. Ent. & Tech. L. 45 (2006)

legislative action in support of OSS development. These countries are geographically dispersed on different continents. Out of forty-four countries which have undertaken pro-OSS government policies, thirty three have had OSS-friendly policy announcements, eighteen have had OSS legislative action²³ and twenty countries have allocated public subsidies²⁴ for OSS development with considerable overlapping in both legislative and administrative actions. Even though different countries OSS policies have varying implications, the penchant to support OSS has become an international phenomenon.

C. Demographics of OSS Developers: The combined FLOSS (MERIT) and FLOSS-US (Stanford) report²⁵ was the first of its kind to document the geographical distribution of developers. According to this survey more than three fifth of the worldwide FLOSS developer community live in the EU, one fifth in North America and another one fifth or so live in other countries (see, **Table I**).

Table I: Geographical distribution of Developers (FLOSS Survey)*

AREA	PERCENTAGE OF DEVELOPERS
EU	63
North America	20
others	17

* Source: International Institute of Infonomics, University of Maastricht and Berlecon Research

²³ Brazil has led the way in global regulation movement toward requiring government use of OSS. The national legislatures of Belgium, Bulgaria, Chile, Colombia, Costa Rica, France, Italy, Peru, Spain and Ukraine also have bills mandating the use of OSS in all government offices and government owned companies; **See**, Jyn-An Lee, *Supra* note 3, at 61. The Bundestag of Germany passed a resolution regarding “Germany’s Economy in the Information Society” on November 9, 2001, promoting the use of OSS in the federal administration; **See**, David S. Evans & Bernard J. Reddy, “*Government Preferences for Promoting Open Source Software: A solution in search of a Problem*”, 9 Mich. Telecom. Tech. L. Rev. 313 at 322-23 (2003).

²⁴ Governments provide tax deductions or other grants to indirectly subsidize OSS projects. For example Singapore government has offered economic incentives, such as tax breaks for Linux related projects; **See**, Evans and Reddy, *Ibid*, at 378. Governments may also in encouraging OSS projects subsidize institutions or projects that co-ordinate OSS development or OSS adoption. For example, BerliOS, a mediator for OSS developers and customers, is co-funded by German federal government and private companies; **See** Klaus M. Schmidt & Monika Schnitzer, “*Public Subsidies for Open Source? Some Economic Policy Issues of the Software Market*”, 16 Harv. J. L. & Tech. 473 (2003).

²⁵ **See**, Rishab Ghosh et al., “*Free/Libre and Open Source Software: Survey and Study*”, the document is available at <http://www.infonomics.nl/FLOSS/report/> (last visited June, 27, 2007)

It is pertinent to note that surveys are not in every respect the precise method for determining geographic distribution of OSS developers as they are unsystematic samples which could have been subject to geographical biases.²⁶ Accordingly the EU study adopted the “census-type” approaches²⁷ by capturing the IP address of developers, which are physical Internet numbers mapped to geographical locations. SourceForge.Net²⁸, the world’s largest portal for OSS development was considered for determining the demographic distribution of developers. According to this study thirty nine percent of the developers who participate in OSS development are from North America, four percent of the participants are from Latin America, seven percent of the participants are from Asia, forty two percent of the participants are from EU and eight percent of the participants are from other countries (see, **Table II**).

Table II: Demographics of OSS developers (EU Study)*

AREA	PERCENTAGE OF DEVELOPERS
North America	39
EU	42
Latin America	4
ASIA	7
Other Countries	8

*Source: EU Study on ICT Sector (January, 2007)

Although SourceForge.Net may under represent Asian participation in absolute numbers, they nevertheless provide a precise depiction of the global influence on FLOSS development from Asia.²⁹ Moreover from an economic point of view it is useful to examine the supply of developers in global projects and portals such as SourceForge.Net

²⁶ See, Jane Greenberg et al., “Open source software development and Lotka's law: bibliometric patterns in programming”, Journal of the American Society for Information Science and Technology Vol. 54 (2) (2003), pp. 169-178.

²⁷ Census type approaches provide information on all case; see Supra note 16 at 37.

²⁸ SourceForge.net which is owned by SourceForge, Incorporation world's largest OSS development web site, hosting more than 100,000 and over 1,000,000 registered users with a centralized resource for managing projects, issues, communications, and code. SourceForge.net has the largest repository of Open Source code and applications available on the Internet, and hosts more Open Source development products than any other site or network worldwide. SourceForge.net provides free hosting to Open Source software development projects; See, “What is SourceForge.Net?” at <http://sourceforge.net/docs/about> (last visited June 27, 2007)

²⁹ See, Supra note 16 at 38.

as they are good indicators of the population of globally active developers. From the above explanations it is ascertainable as to why the data collated by the EU study is selected for testing the very hypothesis of this paper.

III. GEERT HOFSTEDE'S THEORY ON NATIONAL CULTURES

A. Importance of Studying National Cultures: A key issue for organization science for many years has been the influence of national cultures on organizational and national behaviors.³⁰ Individuals from different countries, generations, social class, jobs or organizations often think and act in ways, which puzzle others. What separates one from another is the culture in which he or she has grown up. As Hofstede summarizes, "culture in this sense is not the same as civilization; it encompasses much more deeply rooted unconscious values".³¹ Accordingly what some consider as normal is considered to be abnormal by others, as to what some consider polite is considered to be rude by others and as to what is rational to some is irrational to others.

There are many ways to describe and define a culture. Ferraro³² in his scholarship defines culture in terms of its parts or its components to include economic system, the family, education and the social control. Culpan³³ talks about culture in terms of economy, polity, religion and family. For Hall and Hall³⁴ culture is communication. This paper adheres to Hofstede's definition on culture³⁵, "*Culture is the collective programming of the mind which distinguishes the members of one group or category of people from another*". Culture in this sense is a collective phenomenon, because it is partly shared with people who live or lived within the same social environment. Accordingly culture is learned and not inherited. It derives from social environment and not from one's genes.

³⁰ See, Nancy J. Adler, "A Typology of Management Studies Involving Culture", Journal of International Business Studies, Vol. 14 (2) (1984), pp. 29-47; See also, "Richard W. Wright et al., "A Cross-Cultural Comparative Study of Managerial Job Attitudes", Journal of International Business Studies, Vol. 14 (2) (1983), pp. 115-129.

³¹ See, Geert Hofstede, "Cultures and Organizations", Supra note 7 at 2.

³² See, Gary P. Ferraro, "The Cultural Dimension of International Business", (New Jersey: Prentice Hall, 1990)

³³ See, R. Culpan, "Institutional Model of Comparative Management", Advance International Comparative Management Vol. 6 (1991), pp. 127-142.

³⁴ See, Edward T. Hall and Mildred Reed Hall, "Hidden Differences", (New York: Anchor Press, 1987)

³⁵ See, Geert Hofstede, "Cultures and Organizations", Supra note 7 at 5

Furthermore, Hofstede also distinguishes culture from human nature on one side and an individual personality on the other. According to him human nature is what all human beings have in common; it is inherited with one's genes; the human ability to feel fear, anger, love, joy, sadness, the need to associate with others, to play and exercise all belongs to this level of mental programming. In what ways one expresses fear, joy and happiness is tailored by culture. The personality of an individual on the other hand, is his/her unique qualities which he/she does not share with any other human being. It is based upon traits which are partly inherited with the individuals unique set of genes and partly learned.

B. Dimensions of National Culture: American anthropologists namely Ruth Benedict (1887-1948) and Margaret Mead (1901-1978) popularized the message that all societies, modern or traditional, face the same problems; only the answers differ. Accordingly Alex Inkeles and Daniel Levinson³⁶ published a broad survey of the English language literature on national culture. The survey suggested issues, which qualify as common basic problems worldwide, with consequences for the functioning of societies, of groups within those societies, and of individuals within those groups, namely: (i) relation to authority (ii) conception of self, in particular: (a) the relation between individual and society, and (b) the individual's concept of masculinity and femininity (iii) ways of dealing with conflicts.³⁷

The four basic problems defined by Inkeles and Levinson and empirically found in the IBM data³⁸ formed the dimensions of cultures³⁹ for Hofstede. Accordingly Hofstede named the dimensions as Power Distance (from small to large), Collectivism versus

³⁶ See, Alex Inkeles and Daniel Levinson, "*National Character: The Study of Modal Personality and Socio-Cultural Systems*", in the Handbook of Social Psychology, 2nd edition, Vol. 4 (Reading MA: Addison-Wesley, 1954)

³⁷ See, Geert Hofstede, "*Cultures and Organizations*", Supra note 7 at 13

³⁸ Hofstede studied the values of people in over 50 countries around the world, by collecting the survey data of individuals who worked in the local subsidiaries of one large multinational corporation IBM. From one country to another the survey almost perfectly matched the sample size. The individuals who participated in the survey are similar in all respects except nationality, which makes the effect of nationality differences in their answers stand out unusually clear; See, Geert Hofstede, "*Cultures and Organizations*", Supra note 7 at 13

³⁹ Dimensions are aspects of culture that can be measured relative to other cultures.

Individualism, Femininity versus Masculinity and Uncertainty Avoidance (from weak to strong) for his study.

1. Power Distance Index (PDI): According to Hofstede Power Distance⁴⁰ is defined as “the extent to which the less powerful members of institutions⁴¹ and organizations⁴² within a country expect and accept that power is distributed unequally”. For measuring the degree of inequality in society, Hofstede constructed the Power Distance Index for each of seventy four and three regions from the IBM data. The PDI was calculated for each country from the answers of IBM employees in the same kind of positions on the same survey questions.⁴³

The three survey questions used for creating the PDI index were: (i) how frequently, in your experience do the following problem occur; employees being afraid to express disagreement with their managers? (Answered by non-managerial employees, with mean score on a 1-5 scale from ‘very frequently’ to ‘very seldom’) (ii) Subordinates perception of their boss’s actual decision-making style (choices include description of an autocratic or of a paternalistic style or none of these alternative) (iii) subordinates preference for their boss’s decision-making style (percentage preferring autocratic or of a paternalistic or on the contrary, a style based on majority vote).⁴⁴ The PDI scores thus composed and because of the way they were calculated represents relative and not absolute positions.

In summary PDI scores inform us about dependence relationships in a country. In small power distance countries there is limited dependence of subordinates on bosses and a preference for consultation that is, interdependence between boss and subordinate.⁴⁵ In large power distance countries there is considerable dependence of subordinates on

⁴⁰ See, Geert Hofstede, “*Cultures and Organizations*”, Supra note 7 at 28

⁴¹ Institutions are the basic elements of society like family, school and the community.

⁴² Organizations are the places where people work.

⁴³ See, Geert Hofstede, “*Cultures and Organizations*”, Supra note 7 at 23-29

⁴⁴ A statistical procedure called factor analysis was used to sort the survey questions into groups, called factors or clusters for which mean scores or percentages appeared to vary together. This mean that if a country scored high on one questions from the cluster, it also could be expected to score high on the others, or not high but low for questions carrying the opposite meaning See, Geert Hofstede, “*Cultures and Organizations*”, Supra note 7 at 23-47

⁴⁵ See, Geert Hofstede, “*Cultures and Organizations*”, Supra note 7 at 23

bosses.⁴⁶ Large power distance countries thus show a pattern of polarization between dependence and counter dependence. In these cases, the emotional distance between subordinates and their bosses is large; subordinates are unlikely to approach and contradict their bosses directly.⁴⁷

2. Individualism Index (IDV): According to Hofstede this new dimension is defined as follows, “Individualism pertains to societies in which the ties between individuals are loose: everyone is expected to look after himself or herself and his or her immediate family. Collectivism as its opposite pertains to societies in which people from birth onwards are integrated into strong, cohesive in-groups, which throughout people’s lifetime continue to protect them in exchange for unquestioning loyalty”.⁴⁸

The survey questions on which individualism index was constructed was based on a set of fourteen ‘work goals’, of which the most important work goals includes (i) Personal time (whether the job leaves sufficient time for your personal and family life) (ii) Freedom (whether the job leaves considerable freedom to adopt ones own approach to the job) (iii) Challenge (whether the job includes challenging work to do) (iv) Training (whether the job gives sufficient opportunities to improve and learn new skills) (v) Physical conditions (whether the job provides with good physical working conditions) (vi) Use of Skills (whether the job fully uses ones skills and abilities).⁴⁹ Although, the above questions from the IBM questionnaire do not totally cover the distinction between individualism and collectivism in a society. The correlations of the IBM Individualism country scores with non- IBM data about other characteristics of societies and countries wealth⁵⁰ confirm or validate the claims that this dimension from the IBM data, which covers seventy four countries and three regions, does, indeed, measure individualism.⁵¹

In summary IDV scores inform us about the prevalence of individual interest. The countries with high IDV scores represent people living in societies, where individual

⁴⁶ See, Geert Hofstede, “*Cultures and Organizations*”, Supra note 7 at 27

⁴⁷ See, Geert Hofstede, “*Cultures and Organizations*”, Supra note 7 at 28

⁴⁸ See, Geert Hofstede, “*Cultures and Organizations*”, Supra note 7 at 52

⁴⁹ See, Geert Hofstede, “*Cultures and Organizations*”, Supra note 7 at 49-77

⁵⁰ See, Geert Hofstede, “*Cultures and Organizations*”, Supra note 7 at 49-77

⁵¹ See, Geert Hofstede, “*Cultures and Organizations*”, Supra note 7 at 52

interest prevails over the interests of the group and countries with low IDV scores represent people living in societies where the interest of group prevails over the interests of the individual. Even though, both the individualist and collectivist society are integrated wholes, but the individualist society is loosely integrated and collectivist society is tightly integrated.

3. Masculinity Index (MAS): Hofstede labeled this dimension as Masculinity and Femininity because it was in this dimension that the men and women among the IBM employees scored consistently different across fifty countries and three regions in the IBM data.⁵² Based on the information about the distinctions between the societies this dimension is defined as follows, “Masculinity pertains to societies in which social gender roles are clearly distinct (i.e., men are supposed to be assertive, tough and focused on material success, whereas women are supposed to be more modest, tender and concerned with the quality of life); femininity pertains to societies in which social gender roles overlap (i.e., both men and women are supposed to be modest, tender and concerned with the quality of life)”⁵³.

In summary MAS scores informs us as to whether the societies try to minimize or maximize the social sex role division. Hofstede explains societies with maximized social sex role division “Masculine” and those with a relatively small sex role division “Feminine”.⁵⁴ Although this index forms an integral part of Hofstede’s study, the present study finds the MAS index irrelevant for testing the hypothesis.

4. Uncertainty Avoidance Index (UAI): Hofstede defines Uncertainty avoidance as the extent to which the members of a culture feel threatened by uncertain or unknown situations.⁵⁵ This was the fourth dimension of culture captured from the IBM project. Each country and region in this project was assigned UAI scores.

The UAI scores were computed with close scrutiny of following questions which produced stable country differences, namely (i) Job Stress (mean score on a scale 1-5) (ii)

⁵² See, Geert Hofstede, “*Cultures and Organizations*”, Supra note 7 at 82

⁵³ See, Geert Hofstede, “*Cultures and Organizations*”, Supra note 7 at 83

⁵⁴ See, G. Hofstede, “*The Cultural Relativity of Organizational Practices and Theories*”, Supra note 7 at 85

⁵⁵ See, Geert Hofstede, “*Cultures and Organizations*”, Supra note 7 at 112

Agreement with the statement that company rules should not be broken (this question was labeled 'rule orientation' with mean score on a scale 1-5) (iii) percentage of employees expressing their intent to stay with the company for a long-term career.⁵⁶ Even though the interpretation of the association between questions 1-3 at the country level is not logical, Hofstede assumes that all three questions are expressions of the level of anxiety that exists in a particular society in the face of an uncertain future.⁵⁷

In summary UAI scores informs us as to how society deals with the reality question of future, because the future is unknown and uncertain. Accordingly, the countries with weak UAI score socialize their members into accommodating the uncertainty and also tend to accept each day as it comes. They will also take risks easily, they will not work very hard, and they will be relatively tolerant of behavior and opinions; whereas in countries with strong UAI scores societies socialize their people in trying to beat the future, because the future remains essentially unpredictable. In these societies, there will be a higher level of anxiety, emotional quotient and aggressiveness. It is also witnessed that countries with large UAI scores have institutions that try to create security and avoid risk.⁵⁸ Furthermore in countries with strong UAI scores, societies find religions which claim absolute truth and there also a scientific tradition looking for ultimate and absolute truths, as opposed to a more relativist and empiricist tradition.⁵⁹

From the above study it becomes apparent, that although culture is integrated it is identifiable by its logical components or dimensions. In this paper culture is viewed as a key determinant of the values, preferences and beliefs of individuals and societies and, consequently the argument persists that differences in these values, beliefs and preferences play a key role in shaping up informal institutions. It is also reviewed by Greif⁶⁰ that different cultures generate different sets of beliefs and preferences regarding how people behave, which can alter the set of equilibrium for a given specification of institutions. In the next chapter an attempt is being made to study as to what beliefs,

⁵⁶ See, Geert Hofstede, "*Cultures and Organizations*", Supra note 7 at 109-137

⁵⁷ See, Geert Hofstede, "*Cultures and Organizations*", Supra note 7 at 110

⁵⁸ See, G. Hofstede, "*The Cultural Relativity of Organizational Practices and Theories*", Supra note 7 at 83

⁵⁹ See, G. Hofstede, "*The Cultural Relativity of Organizational Practices and Theories*", Supra note 7 at 87

⁶⁰ See, Avner Greif, "*Cultural Beliefs and the Organization of Society: A Historical and Theoretical Reflection on Collectivist and Individualist Societies*", 102 *Journal of Political Economy* (1994) 912-950.

values or preferences allow programmers from a given country to participate in the open source movement and what beliefs, preferences and values disallow programmers from participating in the ever increasing market for OSS. In other words what components of culture encourage participation in open source movement?

IV. FLOSS: A THEME FOR CULTURAL DIFFERENCES STUDY

A. Data and Methodology: There are very few studies⁶¹ which have actually measured the cultural distance between countries with perceptible scores and the most of the work in this area is survey based. I have selected the Hofstede model and accordingly the scores computed in his model for more than one reason; firstly Hofstede's work has been the first of its kind and the most extensive one with persuasive conclusions covering seventy four countries and eighty eight thousand survey samples; secondly, the components or dimensions for measuring the cultural distance used by Hofstede has been accepted by many scholars⁶² in the field of socio psychology; lastly the seventy four countries so studied and selected by Hofstede for different countries matches the EU study on the demographic distribution of developers for different regions.

The scores for seventy four countries recognized by Hofstede's study is selected, analyzed and grouped into four regions encompassing thirty four countries by capturing their mean averages. The four regions so grouped for this study includes; North America (USA and Canada); Latin America (Argentina, Brazil, Chile, Costa Rica, Equador,

⁶¹ **See**, Kluckhohn, F. and Strodtbeck, F., "*Variations in Value Orientations*", (Illinois: Row Peterson Publishing Co., 1961); **See also** Ronen, S. and Shenkar, O., "*Clustering Countries on Attitudinal Dimensions: A Review of and Synthesis*", *Academy of Management Review* 10(3) (1985) pp. 435-54; **See also**, Hall, E.T. and Hall, M.R. "*Understanding Cultural Differences*" (Massachusetts: Intercultural Press, 1990); **See also**, Schwartz, S.H., "*Beyond Individualism/Collectivism: New Cultural Dimensions of Values*", in U. Kim, H.C. Triandis, C. Kagitcibasi, S.-C. Choi and G. Yoon (eds.) *Individualism and Collectivism: Theory, Method, and Applications*, (London: Sage Publications, 1994) pp. 85-119; **See also** Martha L. Maznevski et al., "*Cultural Dimensions at the Individual Level of Analysis*", *International Journal of Cross Culture Management*, Vol. 2(3) (2002) pp. 275-295.

⁶² **See**, Helmy H. Baligh, "*Components of Culture: Nature, Interconnections, and Relevance to the decisions on the Organization Structure*", *Management Science*, Vol. 40 (1) (1994), pp. 14-27; **See also**, Chao C. Chen et al., "*How Can Co-operation be Fostered? The Cultural Effects of Individualism and Collectivism*", *The Academy of Management Review*, Vol. 23 (2) (1998), pp. 285-304; **See also**, John J. Lawrence et al., "*Individualism and Confucian Dynamism: A note on Hofstede's Cultural Root on economic growth*", *Journal of International Business Studies*, Vol. 26 (3), (1995), pp. 655-669; **See also**, Vijay Pothukuchi et al., "*National and Organizational Culture Differences and International Joint Venture Performance*", *Journal of International Business Studies*, Vol. 33 (2) (2002), pp. 243-265.

Guatemala, Mexico, Panama, Peru, Salvador, Uruguay and Venezuela); Europe (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden and United Kingdom) and Asia (India, Japan, China and Korea). This method of grouping of scores is adopted for all four dimensions and even though they may not represent the regions conclusive positions, it is argued that the computed scores establish some relative positions as to the cultural distance across four regions (see, **Table III**). Accordingly the grouped data is then correlated with demographic⁶³ distribution of developers.

Table III: PDI, IDV, UAI, MAS and GDD scores for 4 Regions*

REGIONS	PDI SCORE (X)	IDV SCORE (Y)	UAI SCORE (Z)	MAS SCORE (V)	GDD (A)
Europe	42.3	64.6	66.1	45.5	42
North America	39.5	85.5	47	57	39
ASIA	67.8	33	70	64	7
Latin America	69.8	21.7	85.6	46.7	4

* Scores grouped and computed from Hofstede's model

B. Hypothesis: Cultural differences amongst the programmers from different regions lead to measurable differences in their participation in the open source movement. In other words national cultural differences influence the participation of programmers in development of OSS.

National cultures distinguish similar people, institutions and organizations in different countries. The present study demonstrates what dimensions of national culture affects or influences the developers to participate in the open source development.

C. Results: The Purpose of this study was to compare the geographical distribution of developers from four regions with their respective scores on dimensions of culture. The regions which score high on the PDI score low on programmer's participation (see, **Appendix I**). In other words the dimensions namely PDI and GDD tend be strongly

⁶³ See, Supra note 16 at 38

negatively correlated (-0.99) (see, **Table IV**); the regions which score high on the IDV score high on the programmer’s participation as well (see, **Appendix I**). In other words the dimensions namely IDV and GDD are strongly positively correlated (0.93) (see, **Table IV**); the regions which score low on UAI score high on the programmer’s participation (see, **Appendix I**). In other words the dimensions namely UAI and GDD are strongly negatively correlated (-0.76) (see, **Table IV**); the relation between the MAS and GDD are ignored for discussion.

Table IV: Correlation of PDI, IDV, UAI and MAS v/s GDD variables

VARIABLES	‘r’ VALUES	‘p’ VALUES
PDI v/s GDD (XA)	-0.991359633	0.0086
IDV v/s GDD (YA)	0.931655691	0.0683
UAI v/s GDD (ZA)	-0.764774317	0.2352
MAS v/s GDD (VA)	-0.251620563	0.7484

D. Discussion: Previous studies on open source development have been very reluctant to capture or provide answers for the disproportionately low degree of participation by Asian and Latin American countries compared to Europe and North American countries in the global open source projects. The present study contributes to this gap by directly comparing the dimensions of cultural distance between regions which encourage developers to participate in the open source development on regions with their relatively low level of participation in the global open source projects. The most relevant dimensions for understanding individual’s participation in open source movement are Power Distance, Individualism and Uncertainty Avoidance index.

Power distance is considered as the most decisive dimension of culture measuring power inequalities between regions across organizations and providing answer as to what organizational set up is preferred for the prevalence of open source development in the present study. Individualism and Uncertainty Avoidance index are important national cultural dimensions for understanding the theories of motivation amongst the programmers across the regions, which have a tendency to influence or affect their participation in the open source movement. The discussions are carried out in detail

below by studying and understanding each national cultural dimension and its consequences on the participation of the open source movement.

1. Organization Level (Power Inequalities): To explain the strong negative correlation (-0.99) that exists between the power distance index and geographic distribution of developers and significant 'p' value (0.0086) one needs to understand the organizational and work characteristics of developing open source software.

The FLOSS survey⁶⁴ on developers establishes that the development of open source software is not a matter of leisure work at home. Accordingly the survey broadly classifies the pool of developers into employed and unemployed programmers. The survey also makes available that fifty two percent of the open source software developers also develop proprietary software. This finding is also consistent with the study of Karim R. Lakhani⁶⁵, which records that fifty eight percent of the programmers who participated in the survey were directly involved with the information technology industry. The recently concluded EU study⁶⁶ also makes an attempt to capture that the contribution coming from organizational level includes software companies, universities, foundations and development groups. What is perhaps predictable and consistent with the above findings and study is that, large amount of contribution to the open source development are coming from organizations be it software companies, universities, foundations or developmental groups.

From the above discussion it becomes more important to understand as to what organizational set up motivates programmers to participate in the open source movement. Many studies⁶⁷ have concluded that, although open source projects display a setup of hierarchical organization, there seems to be no direction from the entrepreneurs towards

⁶⁴ See, Supra note 25

⁶⁵ See, Karim R. Lakhani and Robert G. Wolf, "Why Hackers do what they do" in Perspectives on Free and Open Source Software, edited by Joseph Feller et al., (Massachusetts: MIT Press, 2005); See also, Karim R. Lakhani and Eric Hippel, "How Open Source Software Works: Free User-to-User Assistance", 32 Research Policy 923 (2003)

⁶⁶ See, Supra note 16 at 51

⁶⁷ See, Andrea Bonaccorsi and Cristina Rossi, "Why Open Source Software can Succeed", 32 Research Policy 2003, pp 1243-1258; See also, Georg Krogh and Eric Hippel, "Special Issue on Open Source Software Development", 32 Research Policy (2003), pp. 1149-1157; See also, Yochai Benkler, "Coase's Penguin or Linux and the Nature of the Firm", 112 Yale L. J. (2002), pp. 369-446;

the agents, on the contrary what happens in the open source paradigm is that the role within the hierarchical organization are not strictly assigned and enforced. In other words it looks like FLOSS developers enjoy to work independently in a highly modularized self-organizing structure where the hierarchical system is just an inequality of roles, established for convenience. This production and distribution of OSS, where large numbers of programmers invest their time in developing the software and who are generally not paid for the work and take no directions from their entrepreneurs provide interesting notions to the conventional theory of firm⁶⁸.

What culture dimensions influence such organizational set-up? It is argued that the small power distance situation provides us with some direction in finding the answer. In summary the PDI scores at the work place inform us about dependence relationships prevalent at the organizational level in a country. In large power distance situation superiors and subordinates consider each other as existentially unequal; the hierarchical system is felt to be based on this existential inequality. In small power distance situation subordinates and superiors consider each other as existentially equal; the hierarchical system is just an inequality of roles, established for convenience. The present study provides us with some results to this extent. From the results it is very clear that the countries within EU and North American region supply more number of programmers to participate in the open source development compared to countries in regions Asia and Latin America. In other words the regions which score high on the power distance score low on programmer's participation and vice-versa (see, Table III & Table IV).

From this study it can be understood that the prevalence of strong power distance (culture dimension) in the hierarchical organizational of countries does not encourage programmers to participate in the open source movement and further they would end up

⁶⁸ The transaction cost theory of firm propounded by Ronald Coase is one of the earliest and the most important strands of economic analysis to the theory of the firm. Accordingly the firm is defined by a series of relationships between an entrepreneur and various factors of production, some of which are agents. The entrepreneur directs the activities of the firm, and the agents agree to be directed by the entrepreneur rather than negotiating each action they perform; See, Ronald. H. Coase, "*The Nature of Firm*", *Economica* Vol. 4 (16) (1937), pp.386-405

depressing the intellectual, aesthetic and pleasure based motivation, which seems intrinsic and driving factors for the programming community to participate in the open source movement. Consequently it becomes important to study the culture dimensions which influence the motivational factors of programmers and accordingly persuade their participation in the open source movement.

2. Individual Level (Motivational Factors): In proprietary software development, profits provide a sufficient incentive to innovate, which does not exist in the open source community. So the central question is what motivates programmers to write open source software's for free? Emerging body of literature in Industrial Organization⁶⁹ demonstrates that software developers have sufficient incentives or rewards to participate in OSS development. Following the theoretical perspectives of Maslow⁷⁰, the incentives to participate in the open source development has been classified to include intrinsic⁷¹ and extrinsic rewards⁷². Having fun or enjoying one-self when taking part in an activity is at the core of the idea of intrinsic motivation.⁷³ Accordingly, Jurgen Bitzer⁷⁴ et al., study

⁶⁹ See, Alexander Hars and Shaosong Ou, "Working For Free? Motivations for Participating in Open Source Projects", 6 Int'l J. Electronic Comm. 25 (2002) (this paper categorizes internal and external motivations through a survey research) ; See also, Guido Hertel et al., "Motivation of Software developers in Open Source Projects: An Internet-Based Survey of Contributors to the Linux Kernel", 32 Research Policy, pp. 1159-1177 (2003) (the paper explores the motives of 141 contributors to the Linux kernel); See also, Justin Pappas Johnson, "Open Source Software: Private Provision of Public Good", 11 Journal of Economy and Management Strategy 637 (2002) (this papers shows why programmers participate in OSS development using economic models); See also Karim R. Lakhani and Eric Hippel, "How Open Source Software Works: Free User-to-User Assistance", 32 Research Policy 923 (2003); See also Josh Lerner and Jean Tirole, "Some Simple Economics of Open Source", 50 Journal of Industrial Economics 197 (2002) (this paper captures signaling incentives and motives behind OSS development); See also, Andrea Bonaccorsi and Cristina Rossi, "Why Open Source Software can Succeed", 32 Research Policy 2003, pp 1243-1258

⁷⁰ See, Maslow. A. H., "Motivation and Personality" 2nd edition (New York: Harper, 1970); See also, Deci, E.L., "Effects of Externally Mediated Rewards on Intrinsic Motivation", Journal of Personality and Social Psychology, Vol. 18 (1971) 105-115; See also, Deci. E.L., "Intrinsic Motivation, Extrinsic Reinforcement and Inequality", Journal of Personality and Social Psychology, Vol. 22 (1972) 113-120; See also, Dyer. L. and Parker D. F., "Classifying Outcomes in Work Motivation Research: An Examination of the Intrinsic Extrinsic Dichotomy", Journal of Applied Psychology, Vol. 2 (1975), 455-458; See also, Lawler. E. E., "Job Design and Employee Motivation", Personnel Psychology, Vol. 22 (1969), 426-435.

⁷¹ Intrinsic rewards are obtained when activities are "engaged in for their own sake or when activities are engaged in for includes no apparent reward except the activity itself"; See, Murray. E.J., "Motivation and Emotion" (New Jersey: Prentice Hall,1964) at 64

⁷² Extrinsic rewards, on the other hand, are those rewards for which "there is no inherent connection between the activity and the reward"; See, Supra note 71 at 64

⁷³ See, Deci, E.L., "Effects of Externally Mediated Rewards on Intrinsic Motivation", Supra note 70 at 114

⁷⁴ See, Jurgen Bitzer et al., "Intrinsic Motivation in Open source movement", Journal of Comparative Economics 35 (2007) pp. 160-169

shows how intrinsic motives such as homo ludens payoff and gift culture benefits play a very important role in the development of open source software.

What culture dimensions encourage such intrinsic motives in an individual? It is argued that there seems to be some connection between the factors of motivation and the individualism and uncertainty avoidance dimensions of culture. In summary IDV scores inform us about the prevalence of individual interest, which possibly stands as an explanation for incentives to participate in open source movement. This is also discernible from our study; the highest number of programmers stem from countries within regions, where individuals find a need to full fill their obligations towards themselves (see, Table III).

Other cultural dimensions relevant for discussing factors of motivation are Uncertainty avoidance index. Uncertainty avoidance originally deals with a society's tolerance for uncertainty and ambiguity; it indicates to what extent a culture programs its members to feel either uncomfortable or comfortable in unstructured situations. Countries with low UAI scores tend to let people to achieve something by giving them challenges and enriching their jobs if they contain no challenges. The idea of achievement implies two things: a willingness to take some risks and need to perform, which are basically drawing factors of UAI scores and integral part of any open source development. Interestingly the present study finds that countries with low UAI score tend to encourage programmers to participate in open source movement and vice-versa (see, Table III). From the above discussion it can be suggested that there exists some relationship between the culture dimensions and the demographics of programmers who participate in the open source movement.

E. Limitations and Observations: The present study has several limitations that should be considered whilst interpreting the results. The index so constructed for four different regions is a rather simplistic aggregate of Hofstede's scores on thirty two countries and hence are subject to same criticisms⁷⁵ which are leveled against Hofstede model, e.g.,

⁷⁵ See, Drenth, P.J.D., "Cross Cultural Organizational Psychology: Challenges and Limitations", in Irvine, S. H. and Berry, J.W. (eds.), Human Assessment and Cultural Factors (New York: Plenum Press, 1983);

non-exhaustiveness, reliance on single company data, four dimensions being insufficient to measure culture difference and that nations are not the best units for studying cultures. This study also makes the assumption of homogeneity and equivalence of countries culture dimension within regions. This assumption is required for more than one reason; firstly, the study is made to capture the asymmetrical distribution of programmers between EU and North American region in one side and Asia and Latin American region on the other side; secondly, the scores of countries within region show a similar proclivity in the scores and hence taking their mean averages is the best method for studying the culture dimensions of a given region; lastly, there seems to be very less variance between the average score of the region and the countries score within the region.

In spite of these limitations, this study is amongst the very few that has tested the influence of national cultural distance on participation of programmers in open source movement. In this paper, the direct and indirect influence of cultural differences on participation of programmers has been examined by capturing their behavioral process in the open source development. As such it provides interesting results which could have important research and practical implications for understanding and managing the development of open source software.

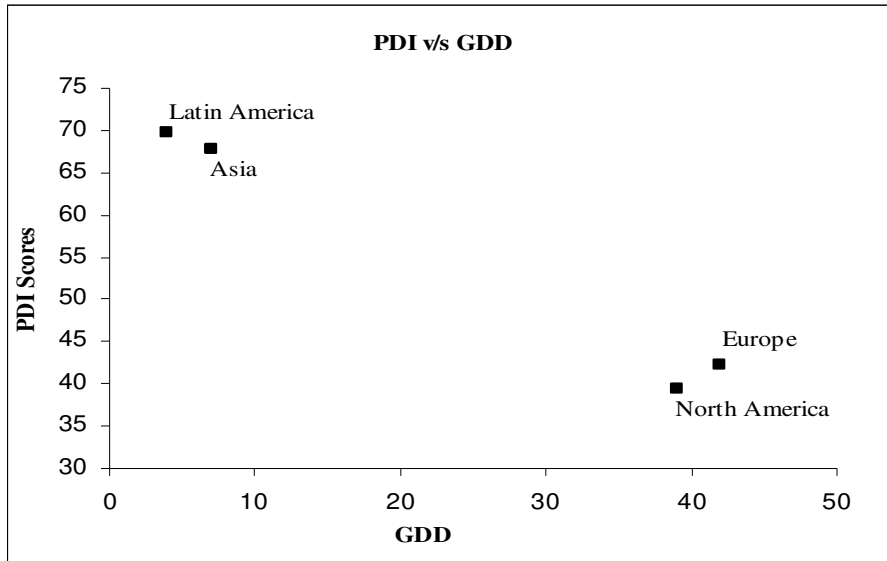
V. CONCLUSION

This paper very clearly exemplifies the importance of open source movement and explains, that open source movement will sustain in a long run not because of the incentive paradigm but because of the strong culture dimensions embedded in the development of the open source software. Going forward it will be very interesting to study as to how these strong culture dimensions formulate informal institutions, which will further support the ever increasing surge of open source movement. Lastly, making this study country wise could supply us with better results and enhanced observations.

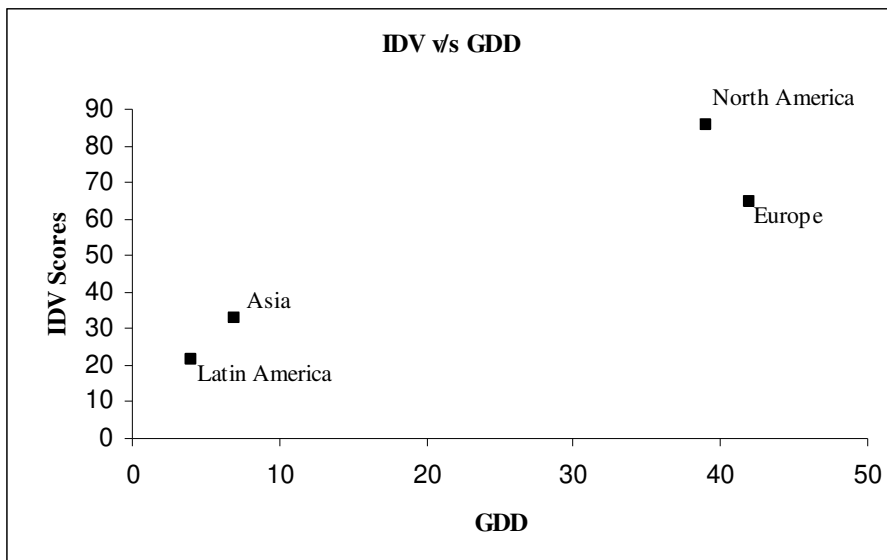
See also, Goodstein, L.D., and Hunt, J. W., “*Commentary: Do American Theories apply abroad?*”, *Organizational Dynamics*, Vol. 10 (1), pp. 49-62; **See also**, Schwartz, S.H., and Bilksy, W., “*Towards a Theory of the Universal Content and Structure of Values: Extensions and Cross-Cultural Replications*”, *Journal of Personality and Social Psychology*, Vol. 58 (5), pp. 878-891

Appendix I: PDI, IDV, UAI scores on GDD

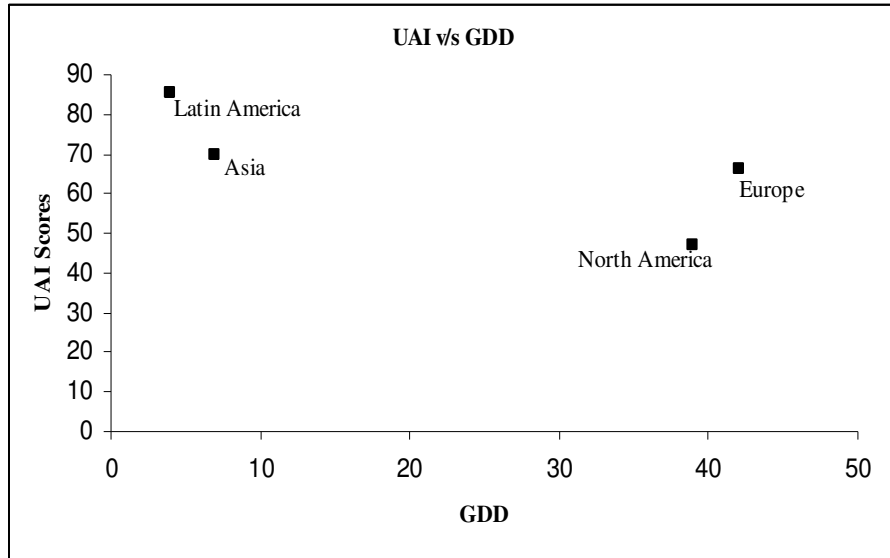
A. PDI v/s GDD



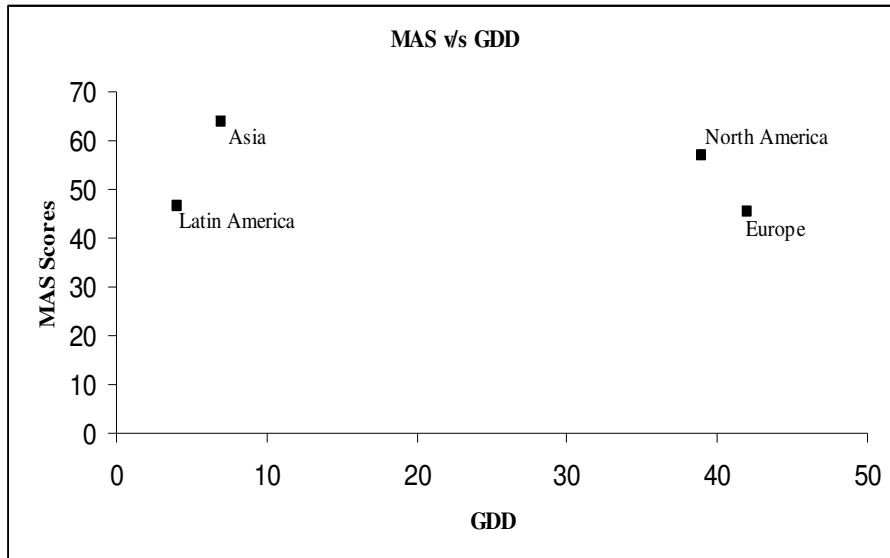
B. IDV v/s GDD



C. UAI v/s GDD



D. MAS v/s GDD



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