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Determinants of Participation in Global Volunteer Grids: A Cross-Country Analysis

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Abstract: Volunteer Grids, in which users share computing resources altruistically, play a critical role in fostering research. Sharing and collaboration in Volunteer Grids is determined by many factors. These determinants define the participation in Grids and the amount of contribution to such Grids. Whereas previous studies focused on explaining researchers' and countries' willingness to share resources in Volunteer Grids based on social sharing theory, this research argues that without the appropriate technological capabilities, countries or researcher cannot implement their willingness. Based on the literature review, this paper defines the influential determinants for participating in global Volunteer Grids. Besides, this research employs a multiple regression analysis of these determinants, using a total of 130 observations collected from international data repositories. Our results show that R&D and Internet connection type (broadband or dial-up) are significant determinates for participating in Volunteer Grids. This result explains why developed countries are active and enjoy the benefits from Volunteer Grids, while developing countries still lag behind. Therefore, an increased participation in Grids cannot be solely achieved by interconnecting with developing countries through high-speed Internet backbones.

Keywords: Determinants, Grid computing, volunteer computing, adoption, Grid economics, regression analysis, infrastructure funding, developing countries.

JEL Classification Numbers: C13, C51, L17, L86, L88, L96, L98, M15.

1. Introduction

Grids are virtual supercomputers created through aggregation of distributed computing resources, generating computational power to execute demanding scientific problems in a cost-effective way. With the maturating of the concept, the middleware, and its applications, many organizations launched Grid computing infrastructure projects based on volunteer contributions from individuals and organizations globally. These projects offer computational infrastructures for investigating complex research problems that range from exploring new HIV/AIDS treatments (fightAIDS@home), finding new prime numbers (primegrid), searching for gravitational waves (Einstein@Home), predicting protein structure (TANPAKU), to searching for extraterrestrial intelligence (SETI@home). However, because of the imbalance of computational power between countries (Figure 1), it is not surprising to see weak participation from developing countries in these global Volunteer Grids.

Yet, since the success of Volunteer Grids depends on attracting sufficient participation [1], the role of developing countries should not be ignored. Therefore, all factors have to be understood that impact the amount of contributions from countries. While much of the effort in exploring and explaining the determinants of participation in Volunteer Grids projects has been concentrated on social sharing theory, the infrastructure drivers and technological needs have been overlooked.

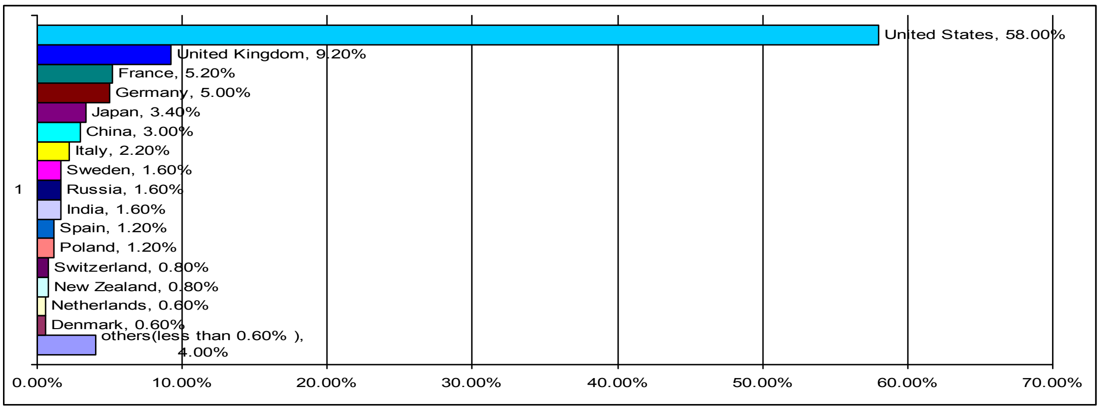

Figure 1. Processing power distribution between countries (based on data from Top500.com).

In this paper, we identify influential factors for a country's participation in Volunteer Grids and analyze 130 observations using a multiple regression analysis. Data for this analysis was collected from diverse international data repositories. This work applies the theory of ICT adoption and ICT diffusion to explain Volunteer Grid participation determinants. This study contributes to the literature of Volunteer Grids by highlighting prerequisites for participation, reveal limitations that developing countries face, and assist ICT policy makers in redefining their priorities, and create the proper environment for more active participation in global computing Grids.

The remainder of this paper is organized as follows: the next section presents the literature review on Grid computing. Section 3 provides our theoretical model. Section

4 discusses the methodology and the empirical analysis; whereas section 5 draws findings and policy recommendations. Section 6 concludes this work.

2. Literature Review: Volunteer Grids

In last few years, different types of Grids were developed: Enterprise Grids, Research Grids, Desktop Grids, and National Grids. The increase in computing power of PCs and Internet penetration along with the advancement of Gird technologies encouraged numerous communities to develop Volunteer Grids over the Internet. These Infrastructures provided a simple but efficient technique for accumulating huge computational power to carry out diverse data processing projects. However, the factors that define the success of these projects have not been completely analyzed.

These factors are often more than just the individual's interest. They rather rely on many other factors that characterize technology usage and adoption [2]. They are of technical, social, and legal origin [3], characterized by the environment and the organization [4].

However, previous empirical studies on the determinants for adopting and participating in global Volunteer Grids are very limited. The lack of empirical data and the relatively new research field contributed to this shortage in the literature. Most of the existing studies used surveys as their main instrument and concentrated mainly on exploring user-side determinants.

Taylor examined determinants affecting participation in Grid computing for supporting health science activities (e.g. drug evaluation) [1]. Using confirmatory factor analysis (CFA) in a laboratory experiment on 249 individuals, Taylor theorizes a multiple perspectives approach, in which he accounted for individual differences in technology adoption and voluntary participation in Volunteer Grids. Wijngaert and Harry studied circumstances, under which people are willing to share the resources in wireless Grids [5]. They explored factors that explain the use of this technology. Their findings showed that trust in communication partners can explain the willingness to use wireless Grids.

It was the original work of Engelbrecht [6,7], which pioneered the research in explaining cross-country determinants for participating in global Volunteer Grids. Engelbrecht studied social sharing determinants of participation in SETI@HOME using the United Nations HDI (Human Development Index), and a group country variable (indicating developed country or developing country) as his independent variables, and "SETI participants per capita" and "SETI results per capita" as dependent variables. Employing multiple regression analysis on 172 observations for both developed and developing countries, Engelbrecht found that participation and its intensity can be explained largely by the degree of Information Communication Technology (ICT) access and Gross Domestic Product (GDP) per capita.

Although nobody can neglect the contribution of Engelbrecht's work in setting the foundation for this research field, his work has endured some drawbacks. Seeking to accommodate more countries, Engelbrecht used composite indexes, which he criticized as controversial himself. In fact, the use of indexes creates difficulties in capturing the exact underlying weights of each of the factors that compose the index. Some of the direct consequences of this approach are the difficulties in defining the significance differences between sub-variables, the over-inclusion of many sub-variables, and the difficulties in deriving definitive policy implications. For instance, Digital Access Index (DAI) includes sub-variables as mobile subscribers per 100 inhabitants, fixed telephone subscribers per 100 inhabitants, and adult literacy. This indicator can easily be attacked. Fixed or mobile phone subscribers can rarely (if not at all) contribute to Volunteer Grids due to poor bandwidth capacity. It can also be noticed that literacy is a precondition for participation but not a sufficient condition. Finally, although Engelbrecht found that SETI@home participation and its intensity are not 'idiosyncratic' but rather largely explained by DAI and GDP, he stressed the importance of a "detailed analysis of the socio-institutional conditions affecting the further development of the underlying network infrastructures and incentives for participants". The framework for such research was defined by Barjak et al. [8]. The framework centers on four groups of essential factors that describe participation in Volunteer Grids: 1) technological frames and user requirements; 2) scientific shaping of technology; 3) economic factors; and 4) political influences. Based on this literature and to fill some of the research gaps in this field, this paper defines more precise and detailed determinants of participation in Volunteer Grids.

3. Theoretical Framework: Volunteer Grids Determinants

The theoretical foundation for identifying the Volunteer Grid determinants comes from two main branches of literature: literature on Volunteer Grids and literature on technology adoption [6], [7], [2] and [8]. The literature defines four categories, namely ICT infrastructure access (through high quality network connection), science and education intensity (through expenditure on R&D), economic capabilities, globalization, and country groups as core determinants for participating in and building Volunteer Grids. Based on this background, we refined the indicators. Figure 2 illustrates these indicators within our theoretical research model on Volunteer Grid determinants.

3.1 Independent Variables on ICT Infrastructure

Traditionally, ICT infrastructure (especially, PC and Internet penetration) has always been used as one of key determinants in technology adoption literature and technology diffusion literature [9] [10]. Grids scholars have emphasized the importance of underlying ICT infrastructure as a core prerequisite for a successful participation in Grids. For instance, Engelbrecht found empirically that ICT access is a significant determinant of participation in global Volunteer Grids [6] [7]. However, not defining the type of ICT and the ICT quality, which is required and sufficient for participation, was a notable weakness of this study. Seeking to shed light on this aspect, this study uses more specific ICT infrastructure indicators to explore their effect on participation in Volunteer Grids. In detail, the following indicators are used: ratio of computers per inhabitants (PC), ratio of broadband subscribers per inhabitants (BS), ratio of dial-up connection per inhabitants (DC), the level of competition in the ISP sector (CI), and the Internet Bandwidth Interconnection capacity (IB).

Based on this, we will investigate the hypothesis H1: *ICT infrastructure indicators are positively correlated and significant determinants of participation in Volunteer Grids.*

3.2 Independent Variables on Economic Capabilities

A considerable amount of literature also emphasizes economic capabilities as key determinants of technology adoption and usage [11] [12]. Gross domestic product (GDP - the value of all final goods and services of a nation in a given year) per capita or the GDP divided by the size of the population has always been a key indicator of economic capability in ICT adoption and diffusion studies. However, GDP per capita is a general indicator that provides only a broad signal of people's economic capabilities. Therefore, GDP per capita cannot exclusively reflect the intensity of investments in research and education, which are essential for the e-infrastructure development. Hence, in our study, the expenditure on education (EE) and the expenditure on R&D (ER) are used to reflect a country's economic support for science and technology.

We will analyze the hypothesis H2: *Economic capability factors are positively correlated and significant determinants of participation in Volunteer Grids.*

3.3 Independent Variables on Science and Education Intensity

Throughout the literature, science and education is a significant indicator for measuring ICT adoption and usage [13]. While most studies emphasize illiteracy as the main determinant of ICT use and ICT diffusion [14] [15], in the context of Grid computing, not only an adequate level of education is needed but also advanced knowledge capacity. Consequently, we argue that the number of researchers (NR), availability of scientists and engineers (AS), and the quality of science and education (QR), are far more realistic indicators to reflect the differences between countries in participating in Volunteer Grids.

During our study, we will examine hypothesis H3: *Science and education intensity factors are in general positively correlated and significant determinants of participation in Volunteer Grids.*

3.4 Independent Variables on Globalization and Country Group

Given that globalization is an important aspect of e-infrastructures [16] [12], we argue that globalization (GL) is one determinant of participation in volunteer Grids. It indicates that citizens of countries with high internationalization are more interested in participating in global Grid e-infrastructures than countries with low internationalization. For our study, the KOF Index of Globalization was used to capture the internationalization and the openness of the country. The KOF index was selected due to its flexibility. It allows eliminating factors that may create multi-collinearity and, therefore, guarantees the integrity of the data.

As can be seen in Figure 1, a gap exists between developing and advanced countries in term of processing power. Consequently, in a first step, we used a binary variable to account for the country's status in the same way as in [6]. Yet, our initial analysis results showed that the variable could not capture the huge gap between advanced and developing countries. The data showed high skewness (long tail). Therefore, we grouped the data into three categories: 1) highly developed; 2) averagely developed and highly developing (DV); and (3) averagely developing and least developing (LD). Two binary variables were used to capture the later two categories, whereas the first category was used as the reference category.

In detail, we will analyze hypothesis H4: *Globalization and country group indicators are in general positively correlated and significant determinants of participation in Volunteer Grids.*

3.5 Dependent Variable: Grid Participation Capacity

To create a data set that is as comprehensive and representative as possible, this study employs data collected by the Berkeley Open Infrastructure for Network Computing (BOINC) project [17]. BONIC implements a public, volunteer desktop computing Grid. It incorporates and supports more than 40 global Volunteer Grids from diverse fields (e.g. mathematics, strategy games, biology, and medicine). Participants can register their computing resources with one or multiple projects, and can control the amount of resources contributed to the different projects (e.g., 60% to studying global warming, and 40% to SETI) [18]. BONIC collects this data and builds statistics about usage per user, team, project, and country. For constructing the dependent variable, we used the BONIC data collected for all projects on a per-country basis, averaged over a period of three months (from October 2008 to December 2008).

The large diversity of projects, that users are offered to contribute their resources, represents a neutralization of personnel preferences, motives, and interests. Results per capita are used as dependent variable following the argument of Engelbrecht [6] [7].

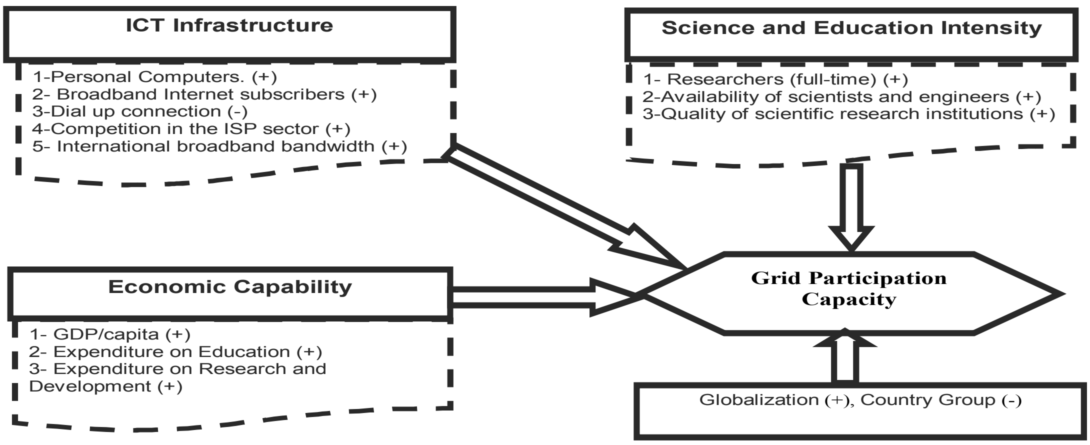

Figure 2. Theoretical research model on Volunteer Grid determinants

4. Data and Methodology

4.1 Data

Data was collected from diverse international data repositories. ICT indicators were collected mainly from the World Telecommunication Indicators Database of the International Telecommunication Union (ITU). Economic indicators were obtained from International Monetary Fund (IMF) and the United Nation Human Development Index (HDI), whereas the science and education intensity indicators were provided by the HDI and the World Economic Forum (WEF) competitiveness report. The data represents the most recent data available, year 2006 and 2007. We assume that the time lag of not more than one year between some of the variables cannot create a bias since significant changes in these variables cannot be realized within one year by a country. Yet, from 248 countries, only 130 countries were analyzed due to data availability.

4.2 Methodology

Based on the prior established theoretical research models explaining the determinants of participation in Volunteer Grids, the following multiple regression model (unrestricted model) has been formulated:

$$y_i = b_0 + b_1(PC) + b_2(BS) + b_3(DC) + b_4(CI) + b_5(IB) + b_6(GDP) + b_7(EE) + b_8(ER) + b_9(NR) + b_{10}(AS) + b_{11}(QR) + b_{12}(GL) + b_{13}(DV) + b_{14}(LD) + \varepsilon_i \quad (1)$$

For the purpose of analysis and to find the most fitted model, several models (level-level model, level-log model, log-level model, and double-log model) were estimated. All regression parameters were estimated using Ordinary Least Squares. Data management was performed using SPSS software 16.0.1(2007).

5. Empirical Results and Analysis

5.1 Estimation

Before estimating the model, the correlation matrix was calculated using the Pearson bivariate correlation coefficient, in order to understand and identify cross-influences between variables. The values of correlation matrix suggest the existence of multi-collinearities. To resolve this multi-collinearities problem, we eliminated variables that cause this problem and produced a reduced model (Table 2). However, since the theory does not suggest such elimination, we performed a one-to-one estimation of all independent variables against the dependent variable. The results of this analysis showed that all selected explanatory variables are statistically significance and each one of them has large explanation power against the dependent variable.

Consequently, we choose to regress both models, the unrestricted model and the reduced model. Then, we use the R-square and F-statistics to choose the best fitted model. Table 1 and Table 2 show the regression estimate results for both models.

Table 1. Unrestricted Model Regression Results

	Level-Level	**Log-Level**	**Level-Log**	**Log-Log**
(Constant)	93.769 (8.308) [a]	-0.500 (-1.01)	119.621 (2.81) [a]	0.884 (0.84)
Personal computers (PC)	49.209 (3.04) [a]	0.584 (0.82)	4.563 (0.99)	0.354 (3.13) [a]
Dial-up Internet (DC)	5.5E-7 (2.02) [b]	-2.3E-9 (-0.19)	1.761 (1.08)	-0.006 (-0.15)
Broadband (BS)	-0.508 (-0.01)	1.867 (1.01)	-4.641 (-1.52)	0.329 (4.36) [a]
International Internet bandwidth (IB)	0.001 (2.48) [a]	-3.8E-5 (-2.24) [a]	2.222 (0.74)	-0.012 (-0.16)
Competition in	-1.909 (-0.95)	0.138 (1.58)	-4.877 (-0.23)	0.493 (0.97)

ISP (CI)				
GDP/capita	0.001 (-1.82) [c]	2.1E-5 (3.50) [a]	-1.290 (-0.19)	0.449 (2.74) [a]
Public expenditure on education (EE)	0.413 (0.57)	0.088 (2.83) [a]	3.667 (0.55)	0.285 (1.74) [c]
R&D expenditure	-4.618 (-1.43)	-0.126 (-0.89)	0.322 (0.11)	0.092 (1.357)
Researchers in R&D (ER)	4832.3 (2.88) [a]	-52.766 (-0.72)	5.288 (1.92) [c]	-0.046 (-0.67)
Scientists & engineers (NR)	-0.956 (-0.33)	-0.137 (-1.10)	-46.074 (-1.39)	-2.482 (-3.04) [a]
Quality of scientific research institutions (QR)	2.610 (0.90)	0.007 (0.05)	61.629 (2.16) [b]	0.528 (0.75)
Globalization (GL)	0.135 (1.43)	0.016 (3.95) [a]	3.842 (0.31)	0.176 (0.59)
Developing (DV)	-75.3 (-11.74)[a]	-0.258 (-0.92)	-78.7 (-10.59) [a]	-0.368 (-2.01) [a]
Least developed (LD)	-99.99 (-2.690) [a]	-1.2 (-3.77) [a]	-16.3 (-13.92) [a]	-1.2 (-6.09) [a]
R^2	0.887	0.811	0.832	0.911
Adjusted R^2	0.873	0.788	0.812	0.900
F-value	64.218	35.188	40.809	83.584

(..)[a] denotes statistical significance at the 1% level for the two-sided t-test.
(..)[b] denotes statistical significance at the 5% level for the two-sided t-test.
(..)[c] denotes statistical significance at the 10% level for the two-sided t-test.

Table 2. Reduced Model Regression Results

	Level-Level	**Log-Level**	**Level-Log**	**Log-Log**
(Constant)	91.110 (9.42) [a]	-0.567 (-1.33)	113.3 (2.73) [a]	0.175 (0.166)
Personal computers (PC)	51.284 (3.31) [a]	0.744 (1.09)	4.429 (0.96)	0.37 (3.17) [a]
Dial-up Internet (DC)	5.7E-7 (2.15) [b]	-1.3E-9 (-0.11)	2.696 (1.70) [c]	-0.014 (-0.34)
Broadband (BS)	-8.759 (-0.22)	2.496 (1.41)	-4.587 (-1.51)	0.309 (4.01) [a]
International Internet bandwidth (IB)	0.001 (2.55) [b]	-3.8E-5 (-2.24) [b]	2.295 (0.76)	0.001 (0.01)
GDP/capita	0.001 (-1.69) [c]	1.9E-5 (3.22) [a]	0.013 (0.01)	0.390 (2.33) [b]
Public expenditure on education (EE)	0.612 (0.89)	0.085 (2.80) [b]	7.042 (1.10)	0.356 (2.19) [b]
R&D expenditure	-4.545 (-1.47)	-0.148 (-1.09)	0.847 (0.31)	0.036 (0.52)
Researchers in R&D (ER)	4883.56 (2.94) [a]	-61.742 (-0.84)	5.482 (1.98) [b]	-0.046 (-0.66)
Globalization (GL)	0.124 1.45)	0.017 (4.42) [a]	3.801 (0.36)	0.109 (0.37)
Developing (DV)	-75.013 (-11.78) [a]	-0.281 (-1.01)	-79.38 (-10.62) [a]	-0.36 (-1.89) [c]
Least developed (LD)	-99.679 (-12.83) [a]	-1.260 (-3.69) [a]	-117.1 (-13.92) [a]	-1.23 (-5.75) [a]
R^2	0.885	0.806	0.825	0.901

Adjusted R^2	0.874	0.788	0.809	0.892
F-value	82.704	44.538	50.592	97.663

$(..)^a$ denotes statistical significance at the 1% level for the two-sided t-test.
$(..)^b$ denotes statistical significance at the 5% level for the two-sided t-test.
$(..)^c$ denotes statistical significance at the 10% level for the two-sided t-test.

To test for excluding variables while moving from the unrestricted to the reduced model, we use the F statistics:

$$F = \frac{(SSR_r - SSR_{un})/q}{SSR_{un}/(n-k-1)} = \frac{(R^2{}_{ur} - R^2{}_r)/q}{(1-R^2{}_{ur})/(n-k-1)} \quad (2)$$

where *SSRr* is the residual sum of squares for the reduced model. *SSRun* is the residual sum of squares for the unrestricted model. R^2ur is the R square for the unrestricted model, while R^2r is the R square for the reduced model. *q* is the numerator degree of freedom that is equal to the reduced model degree of freedom minus the unrestricted model degree of freedom. Finally, *(n-k-1)* represents the denominator degrees of freedom of the unrestricted model, where *n* is the sample size and *k* denotes the number of predictor variables.

Assuming that the Classical Linear Model (CLM) assumptions hold, then *F* is distributed as a random variable with *q* and *n-k-1* degrees of freedom. Looking at the *F-distribution* table, we get for the numerator degree of freedom *q = 3* and the denominator degree of freedom *(n-k-1)= 115* at the 5% critical value a value between 2.71 and 2.68. Table 3 shows the calculated F statistics (equation 2) and, based on those, the decision between the unrestricted and the reduced model.

Table 3. F statistics test

Model	F Statistics Result	Decision Between the Unrestricted and the Reduced Model at 5% Critical Value
Level-Level	0.6784	restricted model
Log-Level	1.0140	restricted model
Level-Log	1.5972	restricted model
Log-Log	*4.3071*	*unrestricted model*

As can be seen in Table 3, only the log-log model indicates that the unrestricted model has coefficients not equal to zero. The reduced model is better off in all other cases.

5.2 Results Discussion

Results of Table 1 and Table 2 show that computer and broadband penetration estimates are positive and statistically significant factors in the ICT infrastructure determinants category. In contrast, the factor "dial-up internet connection" in the same category does not provide consistency and statistically significant estimates. The same is true for the factor "competition in the ISP sector" of the same category. However, the factor "Internet Interconnection Capacity" was able to generate statically significant estimates in many of the estimates despite the changing sign between positive and negative values. Overall, the ICT infrastructure category reports mostly expected and interesting results in many of the estimates. Therefore, the hypothesis H1 can be accepted.

In the “Science and Education Intensity” category of determinants, the “researcher in R&D” factor indicates a strong and positive effect on a country’s participation in Volunteer Grids. Yet, even though availability of scientists and engineers as well as quality of scientific research institutions are believed to be two essential factors for participation, these two factors could not show statistically significant results. Their results vary from positive to negative and from significant to insignificant. This outcome could be a result of multi-collinearity or/and the way, in which data was collected. Yet, most of the estimates indicate that hypothesis H2 can also be accepted.

The results within the “Economic capabilities” category of determinants are expected and consistence. The factor “GDP per capita” always reported strong, positive, and statistically significant estimates. The factor “Expenditure on education and on R&D” shows mostly statistically significant and positive estimates. Only in some cases, the factor results in statistically insignificant and/or negative coefficient estimates. The same is true for the factor “researcher in R&D” (which, on the other hand, is not surprising, given the very high correlation between the two factors). In general, these results suggest the acceptance of hypothesis H3.

Finally, while the results in the category “globalization” showed in most cases positive coefficients but statistically significant estimates, the “country group” binary variables showed in most cases strong, negative and statistically significant estimates. Consequently, we can only accept hypothesis H4 as well.

6. Discussion and Policy Implications

Volunteer Grids are one of the most promising new computing paradigms. The vast potential it holds is changing the way of computational scientific research in all fields. While advanced countries are active and already enjoying the benefits of these supercomputers, OECD (Organization for Economic Co-operation and Development) acknowledged the potential benefits of global Volunteer Grids for developing countries as well. They state that: “The potential benefits to developing countries are considerable, since scientists would be able to join international global-scale collaborations with only a modest investment in a local infrastructure as minimal as an Internet-linked and a high-performance workstation” [21].

However, as our results suggest, participation in Volunteer Grids is hardly restricted by the availability of “Internet-linked and high-performance” workstations. Instead, other quantitative and qualitative determinants, which are more important, have to be fulfilled. For instance, the factor “dialup”, which represents a link to the Internet, could not produce any statistically significant coefficient in any of the models. In contrast, the “broadband penetration” indicator shows positive and statistically significant estimates in all models, identifying it as a key element for participating in Volunteer Grids.

Moreover, the results show that, although funding of high-speed interconnections to developed countries is crucial, it is not sufficient. It is obvious that, to bear participation in Grid infrastructures, developing countries have to stimulate many other determinants (e.g. “R&D” and “education”) first. In fact, without competence in R&D, participation in Grid e–infrastructures does not benefit developing countries. Consequently, policies for supporting science and technology in developing countries should be developed to attain adequate levels of gains from Grid participation. Increasing the number of R&D centers, facilitating personnel mobility, encouraging partnerships between universities and industry, continuous upgrading and training of personnel, increasing international cooperation and international joint research programs are just some of the polices that could help here.

Our results also suggest a strong linkage between “economic capability” estimates (“GDP per capita”, “expenditure on education”, and “expenditure on R&D”) and the level of participation in global Volunteer Grids. This represents one of the most challenging concerns of developing countries. Promoting public-private partnership in science and technology research, tax incentives for private sector spending in R&D, and facilitating human resource mobility between public and private R&D sectors, could help governments to tackle these set of determinants. In general, our results indicate not only a difference between developing and advanced countries but also a difference between advanced countries and countries in-between these two groups. A future study could investigate a finer grouping of countries than just the three groups that have been considered here.

Lastly, we have to mention that, although our model could identify a large number of factors that can explain participation in Volunteer Grids, there will always be an unexplained fraction that needs further analysis. In addition, any policies that try to bridge the identified gaps need to be not only undertaken nationally but internationally.

6. Conclusion

Based on literature analysis and a multiple regression analysis, this study proposes a model that identified and estimated the determinants of participation in global Volunteer Grids. Four key determinant categories were investigated: ICT infrastructure, science and education intensity, economic capabilities, and country group.

The analysis of the results showed that many factors impact the intensity of participation and utilization of Volunteer Grids. In particular, we can state that not only an Internet connection and a workstation are the stimulating factors for participating in Volunteer Grids but also many other factors. The results showed the significance of factors such as broadband Internet connections, the R&D capacity, and the differences between developed and developing countries.

Consequently, in addition to funding Internet interconnections to advanced countries, proper policies for increasing science and technology capacity and for growing international cooperation in R&D will support developing countries’ efforts to participate in global Volunteer Grids.

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