DYNAMICS OF GLOBALIZATION
IN PHILIPPINE SCIENTIFIC COMMUNITIES

A Dissertation

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ABSTRACT

This research attempts to shed light on the simultaneous influence of scientifically strong countries on Internet use and knowledge production at the global periphery. Using survey data from interviews of 312 Filipino scientists, this study answers the following questions: (1) Does place of graduate education (i.e., Australia, Japan, the United States and the Philippines) configure scientists' Internet use? (2) Does Internet use shape scientists' professional network? (3) Does place of graduate education, Internet use and professional network influence collaboration and research productivity? and (4) How does collaboration relate to productivity when professional network is accounted for?

Results show that digital inequality occurs at advanced levels of hardware-software-user interaction skills, which appear to be emerging dimensions of a new form of digital inequality; these are mainly configured by level and place of graduate education. The effect of place of graduate education on networks is such that foreign training tends to increase the proportion of contacts at the scientific core. Much of the effect of the Internet lies on those components of professional network that has to do with network size, proportion of male alters, proportion of alters who are at the scientific core, location diversity, and multiplexity of communication means.

Results further suggest that most scientists are involved in domestic collaboration, and that network size is positively associated with the number of collaborative projects. Whether or not networks are comprised of foreign contacts, or whether they possess a more gender-balanced configuration does not influence collaborative patterns. As regards productivity, results indicate that after relevant scientist attributes are controlled for, collaboration does not influence scientific output. There are clear indications that having a doctoral degree, possessing advanced

hardware-software-user interaction skills, large networks, having more contacts at the scientific core, and proportion male alters strongly influence productivity. While professional networks influence collaboration, collaboration does not affect productivity. It could be that involvement in collaborations generates problems that undermine productivity so that scientists simply informally and causally activate their network without formally and officially engaging them in projects. It appears that this strategy is less problematic than engaging in formal collaborations.

CHAPTER 1: INTRODUCTION

Background

My work as senior research assistant at the International Rice Research Institute (IRRI) in Los Baños, Laguna, Philippines, from 1993 to 1997 had provided me with experience in disseminating statistical knowledge and software for rice research in the scientific research systems of Bangladesh, Cambodia, Myanmar,[1] the Philippines, and Thailand. The objective of my two-week trips to these peripheral scientific communities was to train senior rice scientists (holders of master's and doctoral degrees alike) on the modern methods and principles of experimental research designs, and the use of a statistical software called IRRISTAT. This software is continuously being developed at IRRI, and is widely disseminated to national rice research institutes for free, because typically these research organizations can barely afford to purchase and maintain updated licenses to popular statistical software such as GENSTAT®, SAS®, SPSS®, STATA®, and SYSTAT®. IRRISTAT is capable of performing sophisticated statistical analyses and executing advanced experimental procedures even with the most archaic computing machines typical of national agricultural research systems in Africa and in most of Asia.

In my "previous life," I introduced developing world agricultural scientists to new technological items and technical artifacts. The goal was to help them generate and produce scientific knowledge and to integrate them into the international rice science community. During my two-week training in 1996 at a South Asian rice research institute, one of my trainees, Dr. Biswa Bhattacharya[2], asked me if I could please visit the IRRI library when I returned to the Philippines and send him a photocopy of an article he had co-authored and published in a foreign

[1] Myanmar was formerly known as Burma.
[2] For purposes of protecting the identity and the privacy of people, I use fictitious instead of real names and places.

agricultural science journal. He told me that it was simply impossible to obtain this from their library owing to its lack of material resources and equipment. Naturally, I agreed to his request but this encounter left me with myriad questions about the meaning and practice of agricultural science in the developing world and about science as a "universal enterprise;" the constraints and coping mechanisms of scientists in the developing world as they go through their day-to-day activities; and the impact of Western technical know-how (i.e., education, training, and technologies) on peripheral science and individual knowledge workers; including their attitude towards global scientific practices and networking.

Objectives of the Study

This research delves into the impact of new information and communication technologies (ICTs) in general and the Internet in particular on the culture and practice of science in developing areas using concepts, methods, perspectives, and principles situated at the intersection of science and technology studies (STS), the sociology of international development, social network analysis (SNA), and Internet studies. I attempt to shed light on the under-researched aspects of science in the developing world, specifically the simultaneous influence of various scientifically strong countries[3] on the dynamics of Internet use, and on the generation and production of knowledge in scientific communities located at the global periphery.

This research seeks to examine and characterize the diffusion of the Internet and its impacts on the nature and dynamics of knowledge production in Philippine scientific communities. In this study, I emphasize those aspects of science (or knowledge production) that pertain to Filipino scientists' Internet use behavior, patterns of collaboration, professional network and research productivity. I focus particularly on Philippine scientific communities

[3] Borrowing concepts from science and technology studies and the sociology of development, I use the terms scientific center, scientific metropole, and scientific core to refer to scientifically strong communities located in Australia, Canada, Japan, the United Kingdom, the United States, and most of Western Europe.

because their nature and dynamics, as well as their manpower training and advanced education, are largely influenced by and/or take place in the doctoral degree granting institutions of three culturally, economically, scientifically and technologically strong countries: Australia, Japan, and the United States.

In this research, I have four research objectives: First, I want to know whether or not place of graduate education (i.e., whether having trained in Australia, Japan, the United States, or the Philippines) conditions Filipino scientists' Internet use behavior – their **current use**, **ready access**, **intensity** and **extent of experience**, and **diversity of use**. If so, I want to further explore whether or not place of graduate education translates into yet another important dimension of the digital divide (or digital inequality) among scientific knowledge producers in the developing world. In other words, does place of graduate education, after controlling for relevant socio-demographic factors, yield significant effects on aspects of Internet use. Second, I am also interested to know how place of graduate education and Internet use behavior jointly but independently affect the attributes of Filipino scientists' professional network structure in terms of its compositional quantity, compositional quality, heterogeneity, multiplexity, and homophily. Put another way, I want to know if there is substantial empirical evidence to support the assertion that ICTs, after controls have been accounted for, enhance the development of linkages and relationships among peripheral scientists and between peripheral scientists and core scientists. Third, I would like to know how place of graduate education, Internet use behavior, and professional network condition Filipino scientists' collaborative (e.g., national or international) behavior and scientific research productivity (e.g., in local or foreign scholarly journals). While collaboration and productivity appear to be both dependent dimensions and a function of professional network, I conceptualize collaboration to be causally prior to productivity. Finally, I would want to shed light on the relationship of three central concepts in the context of the Philippine scientific research system – professional network, scientific collaboration, and research productivity. Specifically, I would like to know if professional networks affect research productivity through scientific collaboration, or is it the case that scientific collaboration is influenced by professional networks but does not yield any significant effect on scientific productivity in the developing world? In a way, I attempt to explain the relevance or irrelevance of scientific collaboration in the peripheral knowledge production process.

These research questions are based, in part, on a recently completed analysis of scientists in Ghana, Kenya, and Kerala, India. However, these three study locations are all relatively homogeneous in their relationship to a single "scientific metropole." The Philippines, owing to a history of diverse colonial engagements, exhibits relationships to several "scientific metropoles;" this makes it a strategic research location for the study of postcolonial scientific influence. To answer these four major research questions, I embarked on a quantitative survey of a sample of 312 Filipino scientists in state research universities and government research institutes. The quantitative survey was reinforced with and substantiated by a preliminary face-to-face qualitative survey of 32 Filipino scientists, which I conducted in June to early July 2004 in Los Baños, Laguna, Philippines.

Significance of the Study

This dissertation has the to potential to contribute to the elaboration of concepts and relationships in the areas of science and technology studies (STS), the sociology of development, social network analysis (SNA), and Internet studies. In STS, it addresses the understanding of scientific culture and practice in peripheral areas experiencing the concurrent and/or simultaneous influence of economically, culturally, and technologically strong "scientific-metropoles." The study focuses on the interaction between the role of new information and communication technologies (or the Internet), and the influence of the knowledge production sites at the scientific core on developing world scientists' networking, collaboration, and productivity. I attempted to do this by exploring the impact of place of graduate education (or graduate training) on the nature and dynamics of Philippine science. In terms of the sociology of development, my dissertation potentially contributes to the theoretical elaboration of how position in the scientific global (or world) system configures emergent patterns of globalization. In particular, the potential contribution is on the elucidation of how scientifically strong communities (or dominant scientific cultures) influence the nature and dynamics of knowledge production in scientific communities of the developing world. My potential contribution to SNA centers on the elaboration of the concepts of compositional quantity, compositional quality, heterogeneity, multiplexity, and homophily from an egocentric perspective; and how these concepts and their respective measures are applied to the analysis of scientific research systems in the developing world. Specifically, this research examines how the structural aspects of scientists' personal network are (1) affected by place of graduate education and Internet use behavior, (2) and how these configure science culture and practice at the periphery.

Broader Impacts of the Study

The broader impacts of this study relate to digital divide (or digital inequality) issues, which are of critical importance to the globalization of science. In an era where "connectivity initiatives" to encourage Internet use and transnational collaboration are commonplace, there is yet a paucity of studies focusing on the potential and actual impacts of the Internet on personal networks that could be used as bases for policy formulation. My study of the concurrent impact of multiple scientifically strong communities on a scientifically peripheral country will address these issues in a strategic site. The empirical focus is a geographical and cultural area underrepresented in science and technology studies, as well as a population of underrepresented knowledge workers. My study will provide a detailed guide to current networks and partnerships both within these underrepresented scientific communities and between the Philippine and international communities. This study's results will be disseminated broadly to enhance understanding and serve as a basis for policies to integrate developing areas into the global scientific community. Findings can be used to inform policies by science agencies (e.g., the Philippines' Department of Science and Technology, the U.S. National Science Foundation, UNESCO, and the World Bank) on policy formulation involving global science and diffusion of innovations. As DiMaggio et al. (2001) have posited: the ultimate social implication of the Internet rests on the economic, legal, and policy decisions that are shaping the Internet as it becomes institutionalized.

CHAPTER 2: LITERATURE REVIEW

Introduction

This chapter consists of four sections. Section 1 is a discussion on the relationship between the Internet and science in the context of the developing world. Focus is on two diametrically opposed views: the **utopian** (or "elixir" argument) and the **negative utopian** (or "affliction" argument) perspective. I conclude this section by taking the stance that ICTs in general, and the Internet in particular, is neither an "elixir" nor an "affliction" but rather an essential technology (or technical artifact) in the knowledge production process, which initially may have some "teething" problems. In Section 2, four competing models of science**--objective and rational**, **competition**, **socio-cultural practice**, and the **extended translation view--** representing major approaches in STS are discussed (Callon 1995). The discussion focuses on the nature of science, the attributes of actors involved in scientific knowledge production and generation, and the overall orientation and dynamics of science. Toward the end of this section, I argue in favor of a view of science that takes into account contemporary and emerging changes in the temporal and spatial dimensions of social interaction brought about by the rapid diffusion and use of new ICTs, or the Internet.

In Section 3, I discuss why developing nations are so enmeshed in the pursuit of science. Five theoretical perspectives are presented in this regard: **modernization**, **dependency/world systems**, **institutional**, **urban bias**, and **global systems theory**. In the discussion, I attempt to show how each perspective is linked to the views of science presented in Section 2. I then argue that in our contemporary network society[4], characterized by transnational processes, forces, and institutions, and the pre-eminence of networks, there is a need for a perspective that takes into

[4] Contemporary network society is also referred to as contemporary society, knowledge society (Stehr 2000), global society (Sassen 2000), information society, or network society (Castells 2000).

account the changing spatial and temporal dimensions of social interaction as a result of "time-space compression" brought about by advances in ICTs. And finally, in Section 4, links between science and social networks are made. Specifically, I discuss the concept, definition, assumptions, and aspects of social networks that are relevant to the study of the impact of new ICTs on the nature, orientation, and dynamics of peripheral science.

Section 1: Internet and Science at the Periphery

The Internet--with its capacity to facilitate multi-way global communication, information interchange and retrieval through high-speed search engines--holds great potential in altering the temporal and spatial dimensions of social interaction (Castells 2000; Hamelink 1999; Rogers 1995; Stehr 2000). In the network society, the spatial dimension of social interaction is "warped" such that there is no mutual exclusiveness among domains; the temporal dimension is "compressed" such that interaction among actors, no matter where they are geographically located on the globe, takes place almost simultaneously (Castells 2000; Sassen 2000). Hence, social interaction does not only take place in real time and in real space, but also in cyber-time and in cyber-space (Castells 2000). In the Internet age, interaction among actors is becoming more and more dispersed and heterogeneous, and less and less proximate, contiguous, and homogeneous. In other words, the local contains much that is global, while the global is increasingly penetrated and reshaped by myriad locals.

Because it is a medium uniquely capable of combining and integrating modes of information and communication[5], the Internet constitutes an important research site for examining theories of social interaction, social change, and principles of social networks. More specific examples of these are the systematic examination of theories of technology adoption

[5] The Internet is a facility for information search and retrieval (World Wide Web) and electronic communication (email, instant messaging and telephony). Indeed, it has the potential to alter the spatial and temporal aspects of social interaction, and economic transactions.

(DiMaggio et al. 2001)[6], knowledge production, and the network analysis of research systems. Indeed, the Internet's potential to alter the temporal and the spatial dimensions of social interaction and aspects of social network structure encourages and puts forward a set of hypotheses and a strand of research which aim at testing the adequacy of traditional sociological perspectives in explaining social phenomena in the Internet era (Castells 2000; DiMaggio et al. 2001).

Recent works in sociological theory show that a number of contemporary theorists, like Castells, DiMaggio, Sassen, Sklair, and Stehr, to mention a few, are skeptical about the adequacy of concepts, perspectives, and principles which predate ICTs and the Internet. For instance, Castells (2000), Sassen (2000) and Stehr (2000) view contemporary society as increasingly becoming knowledge-based and therefore presenting new realities that entail new perspectives. DiMaggio et al. (2001) push for an "aggressive" sociology that will take on the challenge of studying the emergence of a potentially "transformative" technology--the Internet--and its implications on five sociological domains: (1) social inequality or 'digital divide,' (2) community and social capital, (3) political participation, (4) organizations and institutions, and (5) cultural participation and cultural diversity.

The Internet's rapid diffusion, its ability to facilitate high-speed information interchange and retrieval, and its capacity for global communication are bound to generate considerable social change (Castells 2000; DiMaggio et al. 2001; Rogers 1995; Stehr 2000). And because of the limited data, analyses, and studies focusing on the interplay of the Internet and society, the social consequences of the Internet have been topics of ongoing debate (Barjak 2004; Davidson et al. 2002; Edwards 1995). In STS, the exact nature of the Internet's impact on knowledge

[6] My definition of the Internet is consistent with that of DiMaggio et al. (2001:307) where it refers to the electronic network that links people and information through computers and other digital devices, allowing person-to-person communication and information retrieval.

generation and production in general, and particularly on the nature, orientation, and dynamics of science in peripheral areas, remain in dispute.

The “elixir” (or utopian) argument holds that this technological artifact **does not** represent a potential problem, but only an opportunity (Davidson et al. 2002; DiMaggio et al. 2001; Castells 2000; Escobar 1994; Uimonen 2001). For instance, social scientists of this camp contend that the Internet will revolutionize scientific communication by improving and increasing the frequency of informal communication among non-collocated scientists, narrow the “communication gap,” and help integrate disadvantaged scientists (Barjak 2004:2). In contrast, the “affliction” (or negative utopian) argument holds that the Internet forms a new basis for social differentiation and social evaluation that can exacerbate existing divides and create new forms of social inequities on a global scale (Davidson et al. 2002; DiMaggio et al. 2001; Hamelink 1999).

This research **does not** view the Internet as either an “elixir” or an “affliction,” but an essential technology in generating, producing, and disseminating scientific knowledge (Bijker 1995; Duque et al. 2005; Rogers 1995; Ynalvez et al. 2005). One possible consequence of widespread Internet diffusion is enhanced research communication and collaboration among scientists in developing areas, although there are concerns that collaboration at a distance may be difficult to sustain in the long run (Olson and Olson 2000) especially so when there are yet studies to be made regarding actors’ commitment to collaborative tasks when they are separated by great distances, broad spaces, and differing time zones. As an essential tool in the generation, production, and dissemination of scientific knowledge, the Internet is a multi-way flow that aids scientists by providing (1) access to colleagues, information, and databases essential for research; (2) opportunities for sharing results with other members of the national, international, or transnational scientific community; and (3) opportunities for building personal and organizational networks and linkages which are essential to having access to material and non-material resources (Crane 1972; Ehikhamenor 2003; Schott 1993).

The nexus between the Internet and science is anchored on the notion that the scientific knowledge production process is itself a form of social interaction. On the one hand, the Internet is basically a facility for social interaction among non-collocated actors. In the information age, it is increasingly becoming a required technology for doing science. On the other hand, the norms of science allude to a knowledge production process that involves both intensive and extensive forms of social interaction--formal and informal communication, local and foreign collaboration, national and international conferences, collocated and non-collocated consultations (Barjak 2004; Ehikhamenor 2003; Mulkay 1980). The connection between the Internet and science is also alluded to in Castells (2000) and in Sassen (2000) where both these social thinkers speculate about the Internet's role in the global integration of science. In terms of communication among scientists, Schott (1993) states that this form of social interaction operates at three fundamental levels: (1) the collegial circle of an individual scientist, (2) the national scientific community, and (3) the global scientific community. Schott found that interpersonal ties were more common at the local or national levels but rare at the global level. Most probably these findings were true for scientists in the developed world during the early 1990s. However, it is possible that this situation concerning scientists' communication networks may have changed with the advent of the Internet.

At present, it may no longer make sense to view the Internet as simply an "optional technology" but as a "required technology." As the Internet increasingly becomes a prerequisite for scientific research and transnational scientific collaboration, it is important to understand its impact on scientific communities in developing areas (Davidson 2002; Duque et al. 2005; Ynalvez et al. 2005). Although studies of Internet diffusion in the developing world have gained momentum and elicited interest, its diffusion together with its actual and potential impacts on the culture and practice of science at the periphery remains to be studied systematically and rigorously.

Section Synthesis

For these reasons, attention to the aspects of Internet use and their effects on developing world scientists' professional network, collaboration, and research productivity not only fills an empirical gap, but also provides new insights about the diffusion of ICTs in peripheral areas. As regards the impact of the Internet on science, the following research questions need immediate answers: First, are there differences in Internet use behavior among developing-world scientists? Second, what are the bases for digital inequality among scientists? Third, because a substantial proportion of scientists in peripheral areas typically receive graduate training in universities at the "scientific core," it would be insightful for policy and planning purposes to answer the question: does **place of graduate education** configure Filipino scientists' access and utilization of the Internet as an essential tool for knowledge production? Fourth, to what extent do aspects of Internet use condition the structure of the professional network, the pattern of scientific collaborative, and the research productivity of Filipino knowledge workers?

Section 2: Toward a Contemporary View of Knowledge Production

To fully comprehend the actual and potential impact of the Internet on science in developing areas, a clear understanding of the nature, orientation, and dynamics of science is imperative. In this section, four perspectives of science are discussed. The discussion focuses on each view's account about the nature of science, the attributes and orientation of actors involved in scientific knowledge production, the role of tacit skills in the knowledge production process, and the overall dynamics of science. Toward the end of this section, I identify a perspective of science that takes into account the emerging pre-eminence of social networks and the changes in social interaction brought about by ICTs in general and the Internet in particular.

Objective and Rational View of Science

One view about the nature, orientation, and dynamics of science - and perhaps the traditional way of viewing science - sees knowledge production as objective, rational, and unambiguous. Callon (1995) calls this the **limited translation model of science**. Based on this perspective, the objective of science is to highlight what distinguishes it from other human endeavors (Shapin 1995). It is seen as a special way of knowing in that neither human nor social dimensions enter into or influence the knowledge production process. In this view, knowledge production consists of statements that can either be theoretical, intermediate, or observational. The characterization of the relationship among these statements is a focal concern. This perspective treats science as a very special kind of social phenomenon wherein scientific knowledge is founded upon impartial observation of the real, objective world. Moreover, science is regarded as knowledge validated by the application of universal, unchanging, and impersonal criteria, which are entirely independent of the social position or personal commitment of science actors (Mulkay 1980).

Within this framework, actors are essentially the scientists, but reduced to the role of simply giving “objective” and “unbiased” statements (Callon 1995; Shapin 1995). Scientists’ position in the social structure does not influence the content and form of their statements. Assistants and laboratory technicians, together with their skills, manufacturers of instruments, and pieces of scientific equipment, are given less emphasis. Indeed, the social and cultural systems surrounding the knowledge production process are reduced to their "simplest terms" and are rendered as having marginal effects. In addition, the competencies attributed to scientists are solely based on their cognitive and sensory skills; that is, scientists must be capable of articulating knowledge claims that integrate their observations (Callon 1995). They should be capable of imagining statements that are not directly linked to observation and of introducing translations between them.

To these competencies is added what is called the rational dimension. The notion of rational activity rests on the actors' capacity to make justifiable and unbiased decisions. The rules for such justifiable decisions may have to do with the promise of a given theory, its generality, its robustness, the extent to which it fits experimental data, and its ability to resist rigorous testing (Callon 1995). Overall, this perspective frames the nature, orientation, and dynamics of science in the generation and production of statements resulting from the interaction between man and nature. Science aims at understanding, studying, and transcribing nature into statements, concepts, and rules (Mulkay 1980). In other words, scientific knowledge production means reducing the complexity of the universe into statements, concepts, and rules. According to this view, science develops in two interdependent ways: (1) interaction between scientists and nature, and (2) interaction among scientists.

Given this characterization of science, there are a number of disturbing and problematic implications. First, this universal model of science asserts that it is applicable to all places and contexts (e.g., developed and developing areas) at all times (e.g., industrial and informational era). Second, this perspective with its emphasis on man (or the scientist) and nature (or objective reality) is deficient in its capacity to shed light on the influence of other social factors and social institutions on scientific activity, growth, and development. Third, the framing of this perspective around man and nature makes it inadequate to address issues concerning the role of entities which are neither man nor nature, examples of which are technological artifacts like ICTs and the Internet.

Competition and Economic View of Science

Another perspective views science as producing and generating theoretical statement whose validity depend on the implementation of appropriate methods. The production and evaluation of scientific knowledge is the result of a process of competition emanating from the intersection of the Darwinian notion of struggle and survival--survival of the fittest and elimination of the unfit--and dynamics of Spencerian sociobiology. This view of science is silent about the content of scientific work and simply assumes that scientists develop knowledge that is submitted to the judgment other scientists (Callon 1995). As far as this perspective is concerned, knowledge is fundamentally transmitted in the form of publications that are disseminated without any restriction. In other words, this perspective assumes that scientific knowledge is transmitted "unproblematically" through codification, which implies the existence and role of tacit skills in knowledge production (Collins 1983) are marginalized and rendered less important, if not unimportant.

In this view of science, actors involved in knowledge production are the scientists themselves, and a distinction is made between scientists (or experts) and laypersons (or non-experts). In a way, there is this boundary that marks the difference between insiders and outsiders to the scientific community (Epstein 1996) and some distinction among knowledge workers in terms of skills, education, and experience. Assistants and laboratory technicians are not ignored but reduced to instrumental roles on the same level as scientific apparatus and equipment. Although scientists are viewed as social actors, their individual competencies are not defined, studied, or analyzed. Their involvement and membership in a discipline determine their objectives and ambitions, together with their theoretical and experimental choices. Hence, the rationality of scientific activity results from the interaction among scientists, particularly in their competition, and not from any inherent predisposition that distinguishes them from other human beings (Callon 1995).

Basically, the competition view of science is dependent on the process of growth (or development) which is central to the Darwinian, the Spencerian, and the neoclassical economic framework. The growth and advancement of science is explained by the fact that scientists work in research areas where there are still unexplored areas and where the anticipated symbolic returns are most likely because the problems being addressed are considered important. In a way, science is viewed as a means for man to control and predict nature, thus ensuring man's survival and dominance over nature. The very notion of competition implies a unitary objective of science that scientists in different places and contexts aim at.

Socio-Cultural Practice View of Science

The socio-cultural practice view argues that science and its actors are no different from any other social activities and other actors, and as such are subject to shifting priorities and values. Science is characterized as flexible and endemically uncertain, always problematic, contentious, and never resting. In other words, this perspective challenges "the atmosphere of revealed and unambiguous truth" that surrounds science and, consequently, scientific knowledge (Edge 1995). Science is a local and mundane affair that can be sufficiently accounted for by ordinary human learning capacities and ordinary forms of social interaction (Shapin 1995). An even stronger view argues that sociologists should analyze scientific knowledge symmetrically and impartially regardless of its perceived truth or rationality (Collins 1983). While the objective and rational view of science focuses on statements and the meanings inherent in the system of statements, concepts, and rules; the socio-cultural practice view posits that statements, concepts, and rules are meaningless without context. In other words, this perspective takes context into account and focuses on the importance and role of tacit skills in the scientific knowledge production process (Bowden 1995; Collins 1983; Knorr-Cetina 1995; Shapin 1995). It is further argued that certain forms of knowledge cannot be expressed in the form of explicit statements or codified knowledge (e.g., published research methods and results) implying that science is an activity that depends on local know-how, specific "tricks of the trade," and rules that cannot be easily be transmitted (Collins 1983; Shapin 1995).

In contrast to the objective and rational view of science (or the limited translation model of science) and the competition and economic view of science, knowledge producers are not limited to scientists themselves. Aside from assistants and laboratory technicians, the list of other actors and identities depends on the specific context and situation under study: manufacturers and distributors, media personnel, government agencies, funding agencies, and external pressure groups (Bijker 1995, 1999; Collins and Pinch 1998). What the socio-cultural practice view of science implies is that the boundaries of science vary and are continually negotiated (Gieryn 1995), while actors involved in production of knowledge can be individuals and/or organizations not necessarily from within the scientific community (Callon 1995; Epstein 1996; Mulkay 1980). Knowledge production is an open system that obtains inputs and material resources from the greater socio-economic context that it is embedded in. Within this framework, what is analytically important is to explore the mechanisms by which constraints, demands, and interests outside the scientific community that influence the generation and production of scientific knowledge. As Knorr-Cetina (1995:143) has aptly stated "the study of laboratories showed that scientific objects are not only 'technically' manufactured in laboratories but also inextricably symbolically and politically construed."

Researchers' (i.e., scientists', technicians', and assistants') competencies are diversified and include the capacity not only to formulate and interpret codified statements and algorithms but also to elaborate and control tacit skills. In the socio-cultural practice view of science, actors are also assumed to be capable of learning and innovating. This capacity to learn and innovate endows them with both historical depth and a faculty for invention, which enables one to understand why science is not limited to repetition (Callon 1995). The stress on tacit skills, tacit knowledge, and learning/innovating mechanisms leads one to view science actors as constituting a social group (Collins 1983; Shapin 1995). Interaction can only foster and develop within a framework of a shared culture, and scientific activities are no exceptions. This seemingly "radical" thinking has its origin on the notion of a paradigm proposed by Thomas Kuhn, who refers, on the one hand, to the group and, on the other hand, to the scientific competence and production of each of its members (Callon 1995). For Collins (1983), the core set is the fundamental group of actors responsible for the generation, production, and dissemination of scientific knowledge. For Crane (1972), scientific groups are structured like social networks. The dynamics of these networks depend on the "strategies of relationship building" followed by their members, and each transformation of the social network implies a cultural transformation.

Extended Translation View of Science

The fourth perspective of science is a hybrid of the objective and rational view and the socio-cultural practice view. Like the former, this eclectic view assumes that the main goal of scientific activity is to produce statements and establish relationships among statements. But like the latter, this hybrid view stresses the process of knowledge production, and the role tacit skills emanating from personal interaction between knowledge producers. In contrast to the objective and rational view, which focuses on statements, concepts, and rules, and their interrelationships, this hybrid view is aptly described as an extension (of the objective and rational view) because it includes all operations that link statements, technical devices, and human actors. The idea of translation within the framework of this eclectic view leads to the notion of translation networks, which refers to an aggregation of reality in which statements, technical devices, and human actors are brought together and interact with each other (Callon 1995). Clearly, translation networks are akin to Bijker's (1995 and 1999) concept of socio-technical ensembles, which are heterogeneous networks of human and non-human actors. Callon (1995) argues that scientific activity establishes translation network mainly through its ability to create and alter entities in the natural and social world.

In this view, the notion of an actor is subsidiary to (or a subset of) the more generic concept of an actant, which refers to an entity endowed with the ability to act (Callon 1995; Latour 2002). The ability and capacity to act may reside in a statement, a technical artifact, or a human actor who creates statements and constructs artifacts (Callon 1995). Within the bounds of the extended translation view, and by use of the term **human actor**, it is logical to think of actants as either human or non-human actors. Indeed, the notion of an actant is important in the study of scientific activity because scientific activities permanently modify the list and definition of entities (or actants) that make up the natural and the social world.

From scientific research laboratories and spaces come quarks, atoms, molecules, enzymes, proteins, plant and animal clones, high-yielding rice and maize varieties, light bulbs, the telegraph, telephones, mobile and cellular phones, computers, vaccines, and of late, the Internet. All these entities are new actants that neither exist nor have been known to exist before being brought into play by statements, technical artifacts, and human actors with embodied skills. At the rate at which scientific development in the fields of computer technologies, biotechnology, and physics is going, it is not surprising that robots, cyborgs, and cloned human beings will someday soon be included in the list of new actants. And as far as the emerging global system outside science is concerned, still other forms of actants are added to the list: transnational corporations, transnational networks, the transnational capitalist class, and many more.

Callon (1995) claims that the idea of translation networks renders both the man-nature distinction and the macro-micro conceptual bifurcation archaic and old fashioned. On the one hand, translation networks establish a continuum between passive, objective nature and expressive, subjective man. Callon (1995) calls this continuum "socio-nature." It is a middle ground, a socio-technical ensemble (Bijker 1995 and 1999), inhabited by actants--human and non-human--whose competencies and identities vary along with the translations transforming them. Indeed, "socio-nature" is embedded within translation networks. On the other hand, three properties of translation networks--irreversibility, lengthening, and diversity--obscure the macro-micro distinction. Irreversibility refers to the extent to which translations are consolidated, making further translations predictable and unavoidable. Under such conditions, actants become highly connected and complementary such that the boundary between the macro and the micro becomes blurry. Lengthening of networks pertains to the increasing number of diverse actants, which eventually leads to "black-boxing," in which entire chains of translation are folded up and embodied, in technical devices, substances, or skills (Callon 1995). Diversity of a translation network pertains to the interconnectedness of the system wherein many diverse and disconnected networks imply many translations. Conversely, when networks are strongly interconnected, then variety is low. These network properties open an avenue for the study and characterization of socio-technical ensembles pertaining to Internet diffusion and globalization of science by paving the way for new research questions to be asked. For example, does diffusion of the Internet lead to interdependence and complementarity in science style and orientation between core and peripheral scientific research systems? With the diffusion of the Internet, what new actants come into play in the generation and production of scientific knowledge in peripheral areas? What forces, processes, and institutions determine the diversity of actants in peripheral scientific research systems?

Section Synthesis

On the basis of this section's discussion, I argue that the extended translation view provides the most appropriate framework for studying the actual and potential impact of the Internet on scientific knowledge production in developing areas. This hybrid view takes into account the following salient aspects of contemporary scientific research systems: (1) the importance of both codified knowledge and tacit skills and tacit knowledge in the scientific knowledge production process, (2) the socio-cultural "situatedness" of scientific knowledge generation and production[7], (3) the evolving transnational forces, processes, and institutions resulting from ICT's capacity to alter the spatial and temporal dimensions of social interaction through high-speed and multi-way communication and information interchange, (4) the increasing dominance of networks in scientific research systems which make them heavily dependent on social interactions such as communication (i.e., formal and informal)[8] and

[7] The approach that I take recognizes that are many ways of doing science or "ethno-sciences" (embedded in indigenous contexts), or several ways of practicing scientific research rather than a single monolithic model, and different modes of their development, which are socially and historically conditioned (Gaillard et al. 1997:12).

[8] Barjak (2004) distinguishes between two types of scientific communication: formal and informal. Formal communication is impersonal and embedded in scientific journals, books, and to some extent at conferences and meetings. Informal communication is personal and social and is usually carried out through face-to-face discussions, email exchanges, instant messaging, and other similar forms of social interactions.

collaboration (Barjak 2004:1), and (5) the role trans-epistemic actors - of human and non-human actors inside and outside the boundaries of science - in the scientific knowledge production process.

The extended translation view permits relevant, contemporary, and substantive research inquiries to be investigated. Examples of such inquiries are the following: (1) Does diffusion of the Internet in peripheral scientific research systems enable codified knowledge and tacit skills and tacit knowledge to be transmitted and disseminated to developing world scientists? (2) What socio-technical (or **human and non-human actors**) entities inside and outside developing world science influence scientific practice, research productivity, communication behavior, collaboration patterns, professional networks, and Internet use behavior? (3) In contrast to scientific research systems in developed areas, how can we describe the "socio-nature" of scientific research systems in developing areas?

Section 3: Science and Development in Peripheral Areas

Macro-level orientation to social studies of science has implicitly focused on the nexus between science and development because national economic growth and scientific effort (i.e. in terms of knowledge generation and technological capability) are empirically correlated (Castells 2000; Gaillard et al. 1997; Grammig 2002; Schofer et al. 2000; Shrum and Shenhav 1995). For instance, scientific knowledge and technological production are almost always monopolized by economically dominant (Castells 2000; Gereffi and Fonda 1992) and strong states (Bradshaw et al. 1993; Migdal 1988) like Australia, Britain, Canada, France, Germany, Italy, Japan, Russia, the Scandinavian countries, and the United States. Countries in Asia (except Japan, Singapore, South Korea, and Taiwan), Africa, and Latin America (except Argentina, Brazil, and Mexico) are always consumers of technologies but never producers, beneficiaries of technology transfer programs but never benefactors. These technologies, more often than not, have proven largely ineffective and "alien" to local needs, and have resulted to the dependent and uneven development of peripheral nations (Bradshaw 1988; Grammig 2002).

Internationally comparable statistics show that countries with high human development have about 2,335 scientists and engineers per million, countries with medium human development have about 588 scientists and engineers per million, while estimates are not available for countries with low human development (UNDP 2003). From these existing statistics, it is implicit that science and technology are indispensable tools for competition and hegemony among firms, organizations, corporations, and nations. Indeed, the geography of scientific and technological capacity has a major impact on the sites and networks of global society (Castells 2000).

Having argued for a contemporary view of science that takes into account the changes brought about by ICTs, this section sheds light as to why peripheral areas (i.e., the Third World, least developed countries, underdeveloped countries, and satellite countries) are so enmeshed in pursuing a "Western-way of knowing" called science. Five theoretical perspectives are presented in this regard: **modernization**, **dependency/world systems**, **institutional**, **urban bias**, and **global system theory**. In discussing each of these perspectives, I attempt to show how each view the nature and dynamics of science. Toward the end of this section, a perspective that takes into account the altered dimensions of social interaction resulting from "time-space compression" brought about by recent advances in ICTs is proposed (Castells 2000, 2001).

Modernization Theory

Modernization theory views development as a uniform evolutionary path starting from traditional, rural, agricultural forms to modern, urban, post-industrial societies (Bradshaw 1987;

Escobar 1995; Chirot and Hall 1982; Shrum 2000). In other words, all societies, once engaged in the process of modernization, follow a prescribed sequence of developmental stages: traditional economies, transition to take-off, take-off itself, drive to maturity, age of high consumption, and the postindustrial society (Chirot and Hall 1982:82). Modernization theory emphasizes internal sources of socioeconomic development such as formal education, market-based economy, and democratic political structure; it de-emphasizes external influences (Jenkins and Scanlan 2001; Shrum 2000).

Among external influences, however, science is exceptional because it is considered beneficial to developing nations by way of "knowledge and technology transfer" from the West (Shrum 2000). That is, societies can be modernized by "transplanting" Western capital, forms of social organization, science and technologies to developing nations (Herkenrath and Bornschier 2003; Shrum 2000). Rostow posits that adoption of scientific methods is critical at the "transition to take-off" stage of development (Chirot and Hall 1982). In a way, modernization theorists view science and technology as catalysts for development that provide an enabling environment for economic growth in developing nations through their efficient use of resources (Shrum and Shenhav 1995).

As far as this perspective is concerned, development is simply a matter of knowledge and technology transfer, unproblematic and straightforward, context free, and not disruptive of existing social and cultural arrangements in developing nations (Herkenrath and Bornschier 2003). In a way, this scheme implies a monolithic, one-way, and top-down development scheme that holds true for all time, for all places, and for all contexts. The same holds true in the case of knowledge generation, production, dissemination, and representation. In this top-down development scheme, the sources of knowledge are completely alien to the place and identities to which knowledge is applied or introduced. As a model for social change, modernization theory fails to consider the possibility of having an interactive and multi-way knowledge generation and exchange process, which is made possible by recent advances in ICTs.

In this account, science is viewed as exceptional and far different from other social activities, presumed to be independent of people and culture (i.e., context-free), and viewed as seeking truths about and laws of the universe by generating and producing objective and rational knowledge claims. This conceptualization of science is familiar; it is very much akin to the limited translation model, or the objective and rational view of science. In other words, modernization theory emphasizes the beneficial role of objective, rational science in socioeconomic development and de-emphasizes this science's possible interaction with the social and cultural context.

Dependency/World Systems Theory

Modernization theory emphasizes internal, local, and native factors as catalysts for socioeconomic development while making science--an external, foreign, and alien factor--an exception (Bradshaw 1993a; Chase-Dunn 1998; Shrum and Shenhav 1995). Dependency theory (with its three main variants, namely **classical dependency**, **dependent development**, and **mature dependency**) and the more encompassing **world systems perspective** emphasize the role of external, foreign, and alien factors in the development of underdevelopment (Bradshaw 1987 and 1988; Jenkins and Scanlan 2001). In general, these perspectives as a whole argue that linkages and relations with developed nations, particularly through multinational corporations, are a means of domination and control that stifle and stunt economic growth and social development in peripheral nations (Bradshaw 1988; Chirot and Hall 1982; Herkenrath and Bornschier 2003).

Unlike the world systems approach, theories of dependency focus on individual nations, their role as suppliers of raw materials and cheap labor, and their functions as markets for high value-added products of developed nations (Chase-Dunn 1998; Shrum 2000). These asymmetrical exchange relations between core and peripheral countries result in the stunted socioeconomic development of the latter due mainly to the unequal balance of payments and trade. Classical dependency holds that underdeveloped nations remain dependent because foreign investment on raw material extraction results in highly specialized, low value-added, export-oriented activities such that the internal structural differentiation required for sustainable development is impeded (Bradshaw 1988; Firebaugh 1992).

A variant perspective, dependent development characterized by the triple alliance of foreign capital, local capital, and the domestic state (Bradshaw 1988; Bradshaw et al. 1993a; Jenkins and Scanlan 2001) qualifies the classical dependency argument. It holds that structural dependency--on foreign investment and external markets in developed countries--constrains and distorts, but is not necessarily incompatible with, development. This breed of dependency combines rapid economic development in local cores with increasing inequality in the local peripheries. Another variant, mature dependency is exhibited by developed nations that are dependent on foreign investment (Bradshaw 1988; Bradshaw et al. 1993a). The nature of this dependency is highlighted by the negative association between foreign direct investment and long-term economic development. Over and above these three variants of dependency theory, Castells (2000) and Escobar (1994) argue that the arrival of high technology results in a new form of dependency of technologically lagging nations on leading nations in ICTs so that there is a need to restructure the macroeconomic and political relations between developed and developing areas in the wake of cyber culture and society.

World systems theory focuses on the larger network among the industrialized core, the impoverished periphery, and a group of semi-peripheral nations where mobility within the system is conditioned by the resources and constraints affecting distinct sets of nations (Chase-Dunn 1998; Gereffi and Fonda 1992; Wallerstein 1974). In a way, this can be construed as a world stratification system with the economies of semi-peripheral and peripheral nations controlled by those of the core. With their emphasis on the production of primary, low value-added products, the unchecked economic influence of multinational corporations, and the political power wielded by local agents of capital; peripheral economies continue to be at high levels of socioeconomic inequality, low levels of democracy and economic growth (Shrum 2000). This perspective posits that a nation's location and incorporation into the capitalist world-economy are the key determinants of national development outcomes (Gereffi and Fonda 1992).

According to Shrum (2000), an interesting point in the dependency/world systems account is that science is neither benign nor neutral. Instead, it is more of malignant. Science is one of a group of institutional processes that contribute to the development of underdevelopment at the periphery (Bradshaw 1988; Shrum 2000). Put another way, science is seen as a "social cancer," which is especially debilitating if generated and produced in core countries and then applied and introduced to the periphery. To illustrate, scientific research activities are disproportionately concentrated in core countries, most are conducted for their benefit, with research emphases and applications directed at advancing these countries' geo-political hegemony and economic interest. The invention and production of new technologies by core countries for profit are associated with the introduction and diffusion of manufactured products that are often unsuited to the needs and conditions at the periphery, serving to draw scarce resources away from more important developmental activities (Bradshaw 1988; Shrum 2000). Indeed, as far as dependency/world systems account is concerned, science is a mechanism for world economic domination and the maintenance of geo-political hegemony.

From the standpoint of dependency/world systems theory, the orientation and dynamics of and motivation for science are derived from neo-classical and Marxist capitalist economics. The former holds that scientists are analogous to entrepreneurs who are calculating and are supposed to maximize personal returns. The latter posits that scientists are not so much interested in recognition per se as in the possibility of obtaining ever more of it (Callon 1995). Restated, scientists are not only interested to generate knowledge for its own sake, but to generate knowledge in areas where perceived profits and returns are high. Granted, it is then logical to argue that scientists play an important background role in maintaining world dependency. They comprise the necessary set of actors who translate basic knowledge into applied knowledge that then serves as the critical phase in the creation and production of new technologies. Eventually, these technologies constitute major components of foreign direct investment at the periphery. Pressing on, it seems reasonable to argue that the dependency/world systems account of science intersects largely with the competition view wherein science actors are presumed to be rational, calculating, and driven by interests.

Institutional Theory

Institutional theory explains why developing nations are so much involved in the advancement and wholesale promotion of science despite its generally unpredictable consequences (Drori et al. 2003; Escobar 1995; Schofer et al. 2000; Shrum 1995, 2000). Much of this involvement rests on the belief about the universality of science as means to national socioeconomic development. This belief, which inspired the institutionalization of science, has been elaborated by Western development experts, propagated through technical assistance programs and lending policies of international financial organizations, affirmed in development plans and discourse, supported by policy makers, and transmitted through the Western educational system (Escobar 1995; Schofer et al. 2000). In other words, two closely related processes that give real force to the belief in science as a means to national development are those of professionalization and of institutionalization. The former refers to the process that brings the Third World into the politics of expert knowledge and Western science; the later refers to the creation of institutions from which discourses about development are generated, produced, and disseminated (Escobar 1995).

Essentially, institutional theory is an account of the emergence, growth, and morphology of academic and state research sectors as successful organizations in developed countries (Shrum 2000). These organizations serve as models for developing nations to emulate in order for them to achieve the high levels of development that are characteristic of Western societies. Institutional theory's construction of the nature, orientation, and dynamics of science is an admixture of the objective and rational view and the competition perspective of science. It takes from the limited translation view the argument that scientists and scientific communities are principal exponents of universalism, promoting the idea of a worldwide, universal, and context-free science system (Shrum 2000). On the other hand, although institutional theory stresses neither competition and conflict, nor power and interest of actors, the processes it describes are often fueled by mechanisms of power and domination that are best explained by the competition view of science.

As an account of why nations are so enmeshed in scientific pursuits, institutional theory is enlightening but at the same time disturbing. For instance, its assumption about science and social reality seems devoid of any sense of realism. For example, institutional theory assumes that cultural, political, economic, and social contexts are non-reactive such that the introduction of foreign organizational structures and ways of knowing will produce uniform desirable positive effects in developing as well as developed nations. Many past and recent studies in social studies of science have proven this empirically nonsensical and too one-dimensional (Duque et al. 2005; Shrum 2000; Ynalvez et al. 2005). In the context of contemporary society, its assertion of a monolithic Western model of science simply no longer holds because science is rapidly informed from many locals with their own admixture of tacit skills and globally codified knowledge.

Urban Bias Theory

Urban bias theory holds that underdeveloped nations implement investment, tax pricing, and other policies that disproportionately favor urban over rural areas (Bradshaw 1987; Bradshaw et al. 1993a). It further argues that urban-based groups (e.g., industrialists, small-scale capitalists, and urban workers) use and pressure the state to re-direct capital, technology, resources, and investments to the local metropoles and exploit the peasantry (Bradshaw 1987; Jenkins and Scanlan 2001). The bias in favor of local metropoles, or local centers, results in disparities between urban and rural areas in terms of consumption, wages, quality of life, and investment levels.

Jenkins and Scanlan (2001) point out that the most salient of these disparities is the urban-rural gap in investment level, which translates to lower productivity and widening income inequality in rural areas. In addition, overvalued currency, protective import tariffs, lofty agricultural taxes, and export duties work toward decreased investments in the agricultural sector. As a result, urban bias perpetuates economic inefficiencies and inhibits economic development in rural areas. Instead of being an indicator of development, over-urbanization is an indicator of economic illness (Bradshaw 1987).

Unlike the modernization and dependency/world systems theory, urban bias implicitly assumes that science is a given. It is assumed to be part and parcel of investment and there is less concern about whether it is being externally imposed or internally composed. Its orientation and distribution, but not its production and generation, are controlled by urban-based interest groups through their influence on the state. Consistent with the competition view of science, there is a relationship between science and its socioeconomic milieu achieved by establishing a clear boundary between what is inside and outside the domain of science. The autonomy of science does not exclude exchange with and influence from the outside world (Shrum 1995 and 2000). For example, Bourdieu conceptualizes two markets: a restricted market, limited to specialists, where scientific theories are debated, and a general market that transmits the products to the external actors interested in them--firms, state, and other interest groups (Shrum 1995:41).

In this account, what is emphasized as stifling development is less of whether science and investment are foreign or domestic, but more of whether science and investment are oriented and distributed proportionately and equitably between urban and rural areas of peripheral economies. As mention earlier, relevant actors to the orientation and distribution of scientific knowledge are not only limited to scientists themselves, but also include the state and urban-based interest groups. However, knowledge generation and production are still the exclusive responsibility of scientists and the scientific community. This is definitely not the case within the socio-cultural practice view of science, wherein generation and production of knowledge is not exclusive to scientists and may involve other actors outside the scientific community. Within the purview of urban bias theory, orientation and distribution of scientific knowledge are politically and socially configured, but its generation and production are generally within the boundaries of science and are pursued by scientists themselves. For urban bias theory, much that is problematic about knowledge production does not reside in the production process itself, but in its distribution within national socioeconomic sectors.

Global Systems Theory

Modernization and urban bias theory emphasize intra-national (internal and native) forces, processes, and institutions as factors affecting socioeconomic development, while dependency/world systems and institutional theory emphasize inter-national (external and foreign) forces, processes, and institutions. Despite these differences, all four perspectives explain development through a state-centered approach by focusing on the authority and power of the nation state in effecting social change, and by employing nation states as units of analysis. These perspectives also assume the dominance of "linear time" over "space of place" which, contemporary social theorists claim, is typical of sociological theory before the advent of ICTs (Castells 2000; Sklair 2001).

In contrast, global systems theory emphasizes transnational forces, processes, linkages, and institutions--that cross national borders but do not derive power and authority from the nation state--as factors configuring socioeconomic development (Bradshaw et al. 1993a; Sklair 2001).[9] Social theorists like, Castells (2000), Sassen (2000), and Sklair (2001) describe contemporary global society as transnational in nature whose spatial logic is that of "space of flows" instead of "space of place," and whose temporal logic is that of "random time" instead of "linear time." According to these theorists, these transmutations in the fundamental logic of social interaction are consequences of ICTs' capacity for high-speed communication and high-

[9] Linkages refer to transnational economic linkages (TNELS), examples of which are foreign aid, foreign trade, foreign direct investment, and foreign loans (Bradshaw et al. 1993a).

quality information exchange among globally dispersed actors, where actors can be individuals, groups, organizations, or nations.

Global systems theory posits that contemporary socioeconomic disparities are shifting away from the traditional divide among nations--core, semi-periphery, and periphery--and between sectors--urban and rural (Bergesen and Bata 2002; Sassen 2000; Sklair 2001). Instead, disparities are moving toward the divide between members and non-members of the transnational capitalist class (TCC), or the "globally coordinated elite." This class is situated in and identified with no particular nation or country, derives and exercises power and authority through transnational corporations (TNC), pursues labor and resources all over the world in its insatiable desire for profit and capital accumulation in a global scale (Evans 2005; Sklair 2001).[10] This means that an actor stands in an increasingly objective global position with respect to other global classes as opposed to the social classes within nation-states (Bergesen and Bata 2002).

Restated, socioeconomic development largely depends on whether an actor (in this case, an individual or an organization) is connected to the network structure of the TCC. This network structure consists of actors possessing capital (i.e., organizational, political, technical and scientific, and cultural capital) relevant to the furtherance of the interests of the TCC. It is important to note that the possession of the types of capital mentioned above is a necessary condition for an actor to be included in the network structure. The network structure also consists of connections serving as global channels for the movement of data, information knowledge, and resources necessary for the further accumulation of economic capital by the

[10] As an emerging class, TCC is composed of corporate executives, globalizing bureaucrats and politicians, globalizing professionals, and consumerist elites (Castells 2000; Sklair 2001). In the global economy, TNCs increasingly take away the power of the state.

TCC. Hence, actors outside this network structure constitute the emerging domain called the global periphery, while actors connected to this network structure comprise the global core.

This account views science as a global network that relies on communication among scientists around the world, wherein ICT expansion contributes to the formation of a global scientific community (Castells 2000). However, despite the globality of science, its orientation and practice are geared toward the concerns and interests of the TCC (Castells 2000; Sklair 2001). In other words, global systems theory frames the dynamics of science as globally networked and coordinated, generated and produced by actors within science (from different localities and from different levels), influenced and configured by actors outside science, and generally oriented toward and distributed according to the interests and goals of the TCC. This view of science is at the intersection of the competition and the extended translation perspective. In essence, global system theory assumes the nature and dynamics of science to be uniform across network sites (i.e., localities and levels) and resistant to social and cultural influences of localities.

As to ICTs' role in the formation of a global scientific community, this account assumes a uniformly enhancing effect of ICTs on the content and intensity of communication, collaboration, productivity, and visibility of scientists in different network sites. However, recent studies on scientific research systems at the global periphery criticize these characterizations of contemporary science as too one-dimensional, shallow, and devoid of empirical realism. This criticism deserves serious attention in light of recent findings that transnational scientific collaboration and productivity do not immediately follow or result from ICT expansion and adoption at the global periphery. Despite the rapid diffusion of ICTs in peripheral areas, scientist communication behavior, collaboration patterns, and research productivity are largely configured by cultural, organizational, and social contexts (Duque et al. 2005; Ynalvez et al. 2005).

Section Synthesis

On the basis of the foregoing discussion, I propose an approach to science and technology studies that takes a more "situated" study of the nexus between science and socioeconomic development. The approach that I propose is essentially a global systems approach with the some revisions and qualifications. Although this approach focuses on concrete transnational movements of capital, culture, knowledge, and technological innovations, it expresses caution in assuming global uniformity in the nature, orientation, style, practice, and dynamics of science. It also exercises caution in assuming uniform enhancing consequences of information and communication technologies (ICTs) on scientific communication, collaboration, and productivity across localities with varied and distinct cultural, economic, historical, political, and social configurations.

In contrast to modernization, dependency/world systems, institutional, and urban bias theory, I propose and adopt an approach that questions the following assumptions about socioeconomic development, knowledge production, social networks, and ICT expansion at the periphery: (1) that science refers to a clear and specific variety of Western knowledge with uniformly positive effects on different production sites and contexts, (2) that development is a unidirectional process of social change faithfully traversing Western trajectories, (3) that science is a positive definite contributor in the development process, and (4) that ICT expansion enhances networking and collaboration between core and peripheral knowledge workers (Escobar 1995; Shrum 2000). Empirical support for these concerns comes from my most recent analyses of scientific productivity in India and Africa wherein I found that the impact of the

Internet on foreign journal productivity is largely configured by the level of development and organizational setting. Implicit to this finding is that there is no single overarching model for the nature, orientation, and dynamics of science mainly because actors outside the network space of the TCC are far from being a homogeneous lot.

Section 4: Techno-Scientific Social Networks

Because science itself is a social activity, the set of behavior and activities of actors involved in scientific knowledge production is mainly configured by social interactions and social institutions (Callon 1995; Shrum and Bankston 1993/1994; Shrum 1997). One way to conceptualize these social patterns is to view action in terms of relationships among actors. This approach, typically described as social network analysis, has become prominent in science and technology studies, especially so with the Internet's potential to enhance and to facilitate social interaction across the barriers of time, space, and distance (Castells 2000 and 2001; Shrum and Bankston 1993/1994; Shrum 1997). However, social network analysis is still underutilized as a means for studying and as a method of analyzing scientific research systems in peripheral areas. But with the advent of ever faster computers with extremely large storage capacity plus the advances in statistical science and graph theory, there seems to be a renewed interest in network theory and analysis. In this section, I discuss the concept, definition, assumptions, and aspects of social networks that apply to the study of the impact of ICTs on the nature and dynamics of knowledge production at the periphery.

The Concept of Social Networks

Science is organized by fields of specialization and areas of concentration and structured around networks of scientists who interact through conferences, publications, and seminars (Castells 2000; Ehikhamenor 2003). Scientists also engage in other types of relationships or forms of interaction: informal discussions, collaborations, and graduate student-professor mentoring, to mention a few (Barjak 2004; Crane 1972; Ehikhamenor 2003). While contemporary knowledge production is hitherto characterized by such forms of social interactions, it is also different in that these interactions increasingly take place on-line, making communication across time zones and geographical boundaries fast and efficient. These interactions and relationships, whether on-line or off-line, are indicators of some sort of social structure in scientific research systems. Hence, such systems can be better framed theoretically and characterized empirically as social networks (Wasserman and Faust 1994; Schott 1993; Shrum and Bankston 1993/1994; Shrum and Beggs 1997). The focus of the social network perspective on relationships yields insightful sociological explanations compared to those that focus on the attributes of social actors, which can only infer the presence of social structure when aggregates behaving in similar ways are discovered (Wasserman and Faust 1994; Wellman and Berkowitz 1991). My proposed research views social network analysis not as a formal theory in sociology, but as a methodology for investigating social structure within knowledge production systems (Shrum and Beggs 1997; Otte and Rousseau 2002).

In the Information Age, social networks constitute the new social morphology, and the diffusion of the logic of networks significantly modifies the operations and outcomes in the processes of production, experience, power, influence, knowledge, and culture (Castells 2000; Sassen 2000). This view of social networks is relevant to contemporary science and technology studies as it effectively links the new information technology paradigm to social structure. As Castells argues, the new information technology paradigm provides the material basis for social networks' pervasive expansion through the entire social system. This social system is characterized by the preeminence of social relationships and/or social interaction over social action. In other words, social networks do matter (Castells 2000; Hurlbert et al. 2000 and 2001). The structure and content of social relationships and/or social interaction precede social action mainly because information, which inheres in social relationships, is important in providing a basis for social action in the Information Age and in contemporary knowledge society (Castells 2000; Coleman 1988; Stehr 2000).

Defining Social Networks

Several theorists have provided definitions of social networks. Granovetter (1973 and 1974), Wellman and Berkowitz (1991), and Otte and Rousseau (2002) view social networks as a way of representing social structures in terms of sets of system members and sets of ties depicting relationships. This view implies that a social network is neither a method nor a metaphor, but an essential tool for studying social structure (Marsden 1990 and 2003). In addition, it describes a social structure in terms of networks and interprets the behavior of actors in light of their differing positions and locations within a social structure (Marsden 1990; Wellman and Berkowitz 1991). Mathematically inspired approaches consider a social network as an area of graph theory; and define a network as a finite set of actors and the relations and functions defined by these actors (Scott 2000; Wasserman and Faust 1994). Networks are depicted graphically in n-dimensional space as sets of points representing actors and lines representing relations or channels (Scott 2000; Wasserman and Faust 1994). Applying these ideas to scientific research systems, points may represent scientists, researchers, and technicians, while lines may denote communication channels, collaborations, joint-authorships, or laboratory linkages.

Another group of theorists view social networks as interrelated systems of ties among actors, but specify explicitly that actors can be individuals, organizations, sectors, communities, or even states and nations (Marsden 1990; Shrum 1997; Shrum and Bankston 1993/1994; Shrum and Beggs 1997). Obviously, this broadens the set of actors, which includes the micro-, meso-, and macro-level units of analysis (Neuman 2006; Smelser 1997). This manner of conceptualizing and defining actors not only permits analysis at different levels (i.e., micro, meso, and macro), but also allows the study of relationships across levels (i.e., micro-meso, micro-macro, and meso-macro) (Marsden 1987 and 1990). An even more generic description of a social network that is potentially suited and readily appropriate to the social realities ushered in by the Information Age is provided by Castells (2000 and 2001). He argues that networks assume a central role in the Information Age so that instead of defining networks in terms of actors, he prefers to define them as sets of interconnected nodes, where nodes are points where the curve intersects itself. The nature of these nodes depends on the type of the concrete network under investigation. Clearly, this definition makes network analysis also applicable to other fields of science like biology, computer science, economics, information science, physics, and psychology (Castells 2000; Podolny and Paige 1998).

For Castells (2000 and 2001), a network-based social structure is a highly dynamic open system that is susceptible to innovations without threatening its equilibrium. Although he does not explain why, it could be hypothesized that susceptibility to innovations largely stems from the preponderance of weak ties that is characteristic of network society. It will be recalled from the works of Granovetter (1973 and 1974) that weak ties are sources of non-redundant or innovative information. The stability of a network-based social structure most probably derives from its sheer network size and density, which are made possible by new information and communication technologies.

In contemporary global society, social interaction increasingly involves actors who are dispersed globally and located in different time zones (Castells 2000; Sklair 2001). Non-human entities, like ICTs, are needed to make these interactions and exchanges possible and sustainable. Indeed, non-human entities play an increasingly central role in initiating, facilitating, and maintaining contacts and ties among globally dispersed human entities. As such, it appears logical to include both human and non-human entities in the conceptualization of networks in contemporary society. In science research systems, for example, such a network may be aptly described as a **translation network** (Callon 1995; Latour 2002) or a **socio-technical ensemble** (Bijker 1995 and 1999) or a **socio-technical network**. Within this translation network resides the social network of scientists, scientific communities, and state agencies, as well as the technical network of computers, telephone hubs, and communication satellites. The notion of a node (Castells 2000) or the idea of an actant (Callon 1995; Latour 2002) from the extended translation view of science discussed in Section 2, and the transnational forces, linkages, processes, and institutions, discussed in Section 3, constitute a "fertile breeding ground" in developing the nexus among translation networks, social networks, and technical networks.

The conceptual bifurcation and resultant interaction between technical and social networks within translation networks (or **socio-technical ensembles**) may lead to greater understanding of the actual and potential impact of ICTs on the globalization of science. Regardless of conceptual definition, social networks have been shown to affect powerfully the distribution of resources available to actors, including assistance, aid, and information (Granovetter 1974; McPherson and Smith-Lovin 1987; Beggs et al. 1996a and 1996b; Beggs and Hurlbert 1997; Hurlbert et al. 2000).

<u>Assumptions of the Social Network Approach</u>

Essentially, the core feature of the social network approach is its rejection of the notion that norms and dyadic interactions are the building blocks of social systems. Instead, it advances the idea that systems of ties are the bases of social structure. In other words, a better way to understanding social phenomena is to take relationships as the fundamental building blocks of social structure and grouping of similarly situated actors as the result (Wellman and Berkowitz 1991). Another core feature of the social network approach is its premise that contextual factors are crucial in explaining actor behavior (Shrum and Beggs 1997). It is not simply the attributes of actors themselves that are central and critical, but rather their relationships with other actors that are equally relevant. These constitute context.

Five assumptions drawn from social network analysis applied to the study of knowledge production in developing areas (Shrum and Bankston 1993/1994; Shrum 1997) are noteworthy. However, before any of these can be applied to the study of ICT diffusion in scientific research systems at the periphery, there is a need to re-think them. It is not that these assumptions are flawed. But because the fundamental aspects of social interaction tend to be altered by advances in telecommunications technologies they are inevitably presenting new realities that may require new perspectives or reassessment of basic social network assumptions (Castells 2000; DiMaggio et al. 2001; Stehr 2000).

Assumption 1 states that: "**At any point in time, actors with varying resources are embedded in a multidimensional framework of relationships**" (Shrum and Bankston 1993/1994). In other words, ties are usually non-symmetrical, differing in content and intensity, while actors are also usually asymmetrical with respect to material and non-material resources (Wellman and Berkowitz 1991). Although this holds true for networks that predate the Internet, contemporary scientific networks could be different in that ICTs may have significantly modified the shape and distribution of the multidimensional framework of relationships, such that knowledge about the theoretical distributions of relationships may be necessary to facilitate analyses and modeling. Assumption 2 states: "**Relationships encourage certain behaviors and increase the likelihood of certain outcomes, while at the same time foreclose opportunities and make other choices less likely**" (Shrum and Bankston 1993/1994). With the advent of ICTs, this assumption is open to certain clarifications such as whether or not on-line and off-line relationships solicit the same behavioral patterns and generate the same set of outcomes. Also it may be asked whether or not on-line, global relationships generate the same trust and commitment needed in productive collaborative activities. Assumption 3 states: "**Relationships consist of interactions of varying durations that take place at specific times and places**" (Shrum and Bankston 1993/1994). Within this context, relationships are interdependent, such that changes in one will have consequences for others. However, it is not clear whether this assumption holds true when applied to the analyses of interactions and relationships occurring in cyber-time and cyber-space. Definitely, empirical studies are needed to evaluate the tenability of this assumption.

Assumption 4 states: "**The motivations and behavioral repertoires of actors are the outcome of socialization processes that leave them with a particular history of relationships; some that are defunct, and some that are active**" (Shrum and Bankston 1993/1994). Again there is a need for empirical studies that would delve into the question of whether sources of motivations and patterns of behavioral repertoires in real-space mirror those in cyber-space. In other words, are the nature and dynamics of social interaction in real-space the same as those occurring in cyber-space? And finally, assumption 5 states: "**Socially constructed information about resources, relationships, and behavior circulates within the network, continually creating and recreating a distribution of statuses and a pattern of cultural elements**" (Shrum and Bankston 1993/1994). Probably, the most important comment about this assumption concerns the quality, quantity, and rate of diffusion of information within the network. With ICTs' capacity to transmit both codified knowledge and tacit skills (e.g., through on-line digital video players with extremely high quality and resolution), it seems that these parameters about information within the network need qualification.

Properties of Social Networks

In applying social network analysis to the study of scientific research systems in developing areas, Shrum and Bankston (1993/1994) emphasize two important points. First, actors can be understood in terms of only two levels of abstraction: individuals (i.e., scientists, researchers), and organizations (i.e., departments, colleges, universities and states, but not countries). Second, the social network approach should not be limited to the analysis of actors and relationships. Instead, analysis should also extend to the patterns and outcomes from the configuration of relationships within a network, the resources and incentives associated with actors, and the histories of individual and organizational actors (Beggs et al. 1997; Shrum and Bankston 1993/1994; Shrum and Beggs 1997). There are several properties of social networks that can vary from one focal actor to another (Borgatti et al. 1998; Marsden 1987 and 2003; Otto and Rousseau 2002; Shrum and Beggs 1997). Of this array of properties, the following are deemed relevant to the study of scientific research systems in developing areas: range of compositional quantity, range of compositional quality, heterogeneity, multiplexity, and homophily (Schott 1993; Shrum and Beggs 1997).

Broadly speaking, range indicates aspects of diversity in networks in which focal actors are embedded. It provides information about the concentration or dispersion of relational types without reference to any particular relational type (Shrum and Beggs 1997). Measures of range are important because networks with greater range tend to reach more deeply and extensively into the social structure (Borgatti et al. 1998; Shrum and Beggs 1997). In contemporary science, such networks may be effective in tapping information and other kinds of resources necessary to produce quality science and should also impact on the relevance of the science that is pursued (Schott 1993). Range can be either narrow or broad in compositional quantity by reaching few or many other actors (or alters) and in compositional quality by reaching only proximate or distant alters (Borgatti et al. 1998; Schott 1993).

A measure of compositional quantity is network size. Network size is the number of other non-redundant actors (or alters) that a focal actor is directly linked or connected to, possibly weighted by the strength of the tie (Borgatti et al. 1998; Otte and Rousseau 2002). In the case of core professional networks of science actors, for instance, network size may be the simple count of the number of other scientists with whom a focal scientist has direct contact. Larger networks represent greater diversity, offer access to a greater variety of capital, resources, and opportunities, and increase access to non-redundant, and at times innovative, information (Beggs et al. 1996; Rogers 1995; Shrum and Beggs 1997). For example, the greater the number of other scientists a focal scientist has, the greater the likelihood that one of these other scientists has the resource needed, such as funding opportunities, collaborative projects, and academic job openings or secondments. As a technology that facilitates interaction among spatially dispersed actors in seemingly real time, the Internet has the potential to increase the number of alters that a focal actor has.

Spatial range (or spatial dispersion) is an example of a measure of compositional quality. The spatial range of alters for developing world scientists may be mainly local, regional, national, or transnational. Developing world science actors may have collaborators who are from the same scientific community, a science community in another part of the country, scientific communities in another developing (e.g., Asia, Africa, or South America) or developed areas (e.g., Australia, Canada, Japan, New Zealand, Western Europe, or the United States). Spatial range is an especially salient indicator of participation in global science (Castells 2000; Schott 1993).

Density refers to the sparseness of connections among colleagues or the proportion of pairs of alters that are connected (Borgatti et al. 1998; Schott 1993; Scott 2000). It is related to the availability of social support and also measures the potential strength of normative pressures toward conformity by indicating the capacity of alters to collectively influence a focal actor (Marsden 1987). Dense or close network environments, wherein all pairs of alters are especially close, typically contain less diverse alters, which results in greater chances of redundant information. Such networks also tend to stifle diffusion of innovations and pioneering activities (Borgatti et al. 1998; Granovetter 1973; Rogers 1995). Granovetter (1976) has shown that **average acquaintance volume** provides a rough estimate of density given that its sampling distribution is known.

Heterogeneity is the variety of alters with respect to relevant social categories such as gender, age, race, education, technical skills, or occupation talents). It measures the diversity of alters focal actors can contact within their network environment. High diversity implies integration into several spheres of society, which is deemed advantageous for instrumental actions like gathering information and diffusion of innovations (Granovetter 1973 and 1974; Marsden 1987; Rogers 1995). Applied to Internet diffusion among science actors in developing areas, this implies that actors with highly heterogeneous alters have greater chances of learning about and adopting the Internet. Multiplexity refers to the diffuseness or specificity of the relationship of each actor with each of the other actors. A network has low multiplexity if the relationship with each alter is extremely specific, or it is multiplex to the extent that each relationship comprises multiple contents (Schott 1993). Multiplex relationships allow the resources of one relationship to be appropriate in other relationships, as such relationships between actors tend to be strong and durable when relationships are multiplex (Coleman 1988). For instance, a student and a professor who are also co-authors of scientific papers or are project collaborators will have stronger and more durable relationship compared to another student who is simply attending a course of that professor.

McPherson and Smith-Lovin (1987) have shown the mechanism by which network composition configures homophily (having similar characteristics between a focal actor and alters). Homophily is the principle that a contact between similar actors occurs at a higher rate than among dissimilar actors. It implies that distance in terms of social characteristics translate into network distance, or the number of relationships through which a piece of information must travel to connect two actors (Beggs et al. 1997; McPherson et al. 2001). Strong and homophilous ties are most likely to reside in a focal actor's core network (Hurlbert et al. 2000). Homophily limits actors' social worlds in a way that has significant implications for the information they receive, the attitudes they form, and the interactions they experience (McPherson et al. 2001; Rogers 1995). However, homophily may also improve communication by reducing ambiguity and 'noise' in the exchange of messages and information (Borgatti et al. 1998).

In global science, homophily in terms of gender, sector, organization, or location from which scientists are educated and trained may determine scientific interaction, communication, and collaboration among these scientists. For instance, in studying peripheral scientific communities, it would be relevant to know whether, say Philippine scientists, educated and trained in Japan, tend to interact, communicate, collaborate, and publish less with other Philippine scientists trained in Australia and the United States and more with other Philippine scientists who are also trained and educated in Japan. As a limiting factor to actors' social worlds, it is possible that homophily in education and training may also lead to the formation of a stratification system within peripheral scientific communities wherein scientists trained, say, in the United States are accorded higher prestige, more rewards, and more perks than those trained in, say, Japan who may be accorded lower prestige, and fewer rewards and perks.

Section Synthesis

In general, the concept of a network is a prominent feature of this research. In Section 1, the Internet is viewed an essential tool in scientific knowledge production, mainly because it has the potential to facilitate social interaction and networking among non-collocated knowledge actors. In Section 2, the extended translation view of science frames the nature, orientation, and dynamics of science in contemporary society as a translation network consisting of human and non-human actors, or actants. In Section 3, the global system perspective with a more "situated" emphasis talks about transnational networks of science actors. Indeed, the contemporary study of the actual and potential impacts of ICTs on the nature, orientation, and dynamics of science at the global periphery is essentially the study of the social networks of science actors.

The various aspects of social networks discussed in this section, when applied to the study of diffusion of innovations, scientific communication, patterns of scientific collaboration, and research productivity point to several research questions as the following: Does homophily with respect to gender, sector, or location shape the patterns of technological diffusion and configure scientific communication, collaboration, and productivity? Do higher levels of compositional quantity, compositional quality, homophily (in terms of gender, sector, or location), multiplexity, and homogeneity results in increased communication, more collaborations, and higher productivity among scientists? Does homophily in gender, sector, or location fossilize into stratification systems (or inequalities) such that those who are associated with some groups are less productive, visible, rewarded, and remunerated compared to some other groups?

CHAPTER 3: CONTEXT OF THE STUDY*

Philippine Country Profile

Over the last three centuries, the Philippines had colonial engagements with Spain, the United States, and Japan before it gained independence in 1946. Because of the mass educational system introduced by the United States, the Philippines' political organization, economic structure, and socio-cultural configuration resembles that of the United States. At present, Philippine scientific research systems (state universities and government research institutes) exhibit a strong American influence through financial aid, infrastructural development, material resources, and human resource development. The last two decades, however, witnessed the emerging influence of Japan in the Philippine economic, educational, socio-cultural, and techno-scientific spheres. Japanese financial aid, technical assistance, scientific infrastructure and development, and human resource training have been pouring in and becoming increasingly visible. In more recent years, scientific manpower development programs from Australia have also increased in visibility.

The Philippines is in the Southeast Asian region. It has a total land area of 300,000 sq km.; and, at present, its population is about 81million, with 61% living in urban areas, with an annual urban population growth rate of 3.9% for the period 1990 to 2003. In 2003, the unemployment rate was 11.4%, while 27.4% of Filipino families were below the national poverty line (Crouch and Liu 2004; United Nations Development Program 2004; World Bank 2004). Gross domestic product consists of agriculture (14.5%), industry (32.3%), and services (53.2%). Major trading partners are the United States, Japan, Singapore, and China. Its major exports are electrical equipment, garments, and coconut oil. In 2002, per capita gross national income was at $1,030, while aid per capita was at $7 (World Bank 2004). Life expectancy at

*Reprinted by permission of *Perspectives on Global Development and Technology*, Vol. 5 No. 4 (2006), pp. 277-302. Copyright 2006 by Koninklijke Brill NV, Leiden, Boston birth is 69.8 years, and the under-five mortality rate is 38 per 1000. The adult literacy rate is 92.6 and the overall human development index is 0.753. In terms of ICT penetration, 41 per 1000 have main telephone lines for 2003, 270 per 1000 are cellular phone subscribers for 2003, while data is not available for per 1000 Internet users (United Nations Development Program 2005).

Through the Philippine Network Foundation (PHNET), the country obtained its first public Internet connection in 1994 by way of a 65 kbit/s link to Sprint in the United States. PHNET is a consortium of private and government agencies affiliated with the Department of Science and Technology, and various universities. Today, there are 50 Internet Service Providers (ISPs) and about 3.5 million Internet users who are concentrated in Metro Manila and provincial urban areas. Governmental agencies, public and private educational institutions, and the business sector are rapidly adopting the Internet. However, sophistication of use is still considered low, with much of the activity concentrated on emailing, chatting, browsing, and playing games. More sophisticated Internet use, in the form of e-commerce; e-banking, and other similar activities have yet to be realized.[11]

Philippine Agricultural Scientific Communities

In terms of scientific development, the Philippines is at the periphery of the global scientific system. Its scientific manpower and infrastructure are far behind other Asian countries like China, Japan, Malaysia, Singapore, South Korea, and Taiwan. Much of the contribution of Philippine knowledge producers to global science is from its agricultural sciences. This is the only field that has an internationally recognized research outlet: *The Philippine Agricultural Scientist*. Philippine knowledge production is concentrated in five major scientific communities

[11] I borrow the concept of sophistication of use as one of the aspects of Internet use (Ynalvez et al. 2005).

located in (1) Bicutan, Taguig; (2) Diliman, Quezon City; (3) Los Baños, Laguna; (4) Muñoz, Nueva Ecija; and (5) Batac, Ilocos Norte. Los Baños and Muñoz are considered centers of excellence for agricultural research and education and are thus the natural choice for my study sites.

Los Baños Science Complex

Los Baños nestles in the foothills of the legendary Mt. Maria Makiling. It is 65 km south of the national capital region, Metro Manila. Los Baños is known to the Western world for two reasons: it was a Japanese concentration camp during the Second World War, where thousands of soldiers from the “Free World” were imprisoned. It is also home to the “green revolution” for rice, and where Philippine national science and International science system come face-to-face. Los Baños is home to the University of the Philippines College of Agriculture, the Institute of Plant Breeding, the National Crop Protection Center, the International Rice Research Institute, and the Southeast Asian Ministers of Education Organization Regional Center for Graduate Study and Research in Agriculture (SEARCA).

A majority of the prominent agricultural scientists in the nation and in the Asian region are based in Los Baños. This has made it one of the important sites for agricultural knowledge production in the nation, the region, and the world. Many of the scientists in Los Baños were trained in Australia, Japan, the United States, and in Los Baños itself. Although the degree of Internet expansion in Los Baños has been generally uneven, with government research institutes having more access than colleges and departments, the growth in the number of Internet shops has been unprecedented. Yet, not many scientists utilize the Internet for reasons that are financial, technical, and personal. Some report being financially constrained to use the Internet in shops, others report technical difficulty such as slow connection time, and still others report being shy to be seen in places frequented by kids! Those who do use the Internet extensively are the young, typically high school students engaged in on-line games.

Science City of Muñoz

The Internet as an important tool in knowledge production appears to be at a rudimentary stage. The Science City of Muñoz is 147 km north of Manila. It is not as prominent as Los Baños, but is the second largest agricultural science community in the Philippines. It is home to the Central Luzon State University, Philippine-Sino Agricultural Technology Center, National Center for Rural Development, Philippine Rice Research Institute, Philippine Carabao Center, and the Bureau of Post-harvest and Research Extension. The Internet expansion pattern is similar to Los Baños in that research institutes have far better connectivity than academic units. During my visit to the Philippine Rice Research Institute, I was surprised to see that scientists were using the latest laptops and desktops. Printers, telephones, and fax machines were enviously commonplace. In contrast, connectivity and information technology infrastructure in the colleges and departments of the Central Luzon State University were older and fewer. Connectivity in the academic units is simply pathetic by developed world standards.

What makes Muñoz very much like Los Baños and ideal for studying the effect of place of graduate training on scientific practice and Internet expansion is the presence of a large number of scientists trained in Australian, Japanese, and U.S. universities. Other agricultural universities and research institutes in the Philippines also have foreign-trained scientists and researchers, but their concentration and number are nowhere near those of these two premier agricultural scientific communities. With the number and diversity of scientists trained at the scientific core, Muñoz and Los Baños provide a rare opportunity to study postcolonial scientific relations and influence.

CHAPTER 4: RESEARCH DESIGN

Qualitative Interviews

My research employs a research design that is a triangulation of qualitative interviews and a quantitative face-to-face survey method. The qualitative interview of n = 32 agricultural scientists from the Los Baños science community from June to July 2004 aimed at (1) seeking formal and informal contacts--who can help plan and conduct the quantitative face-to-face survey in January 2005--from among researchers at the University of the Philippines Los Baños Department of Social Sciences; (2) obtaining formal written consent from heads of departments to conduct interviews with their constituent scientists; (3) getting pieces of information (e.g., organizational brochures, sampling frames, estimates of expenses) relevant to the planning of the quantitative survey; and (4) gaining an in-depth understanding of the research culture, training, work experience, and Internet use behavior of Filipino agricultural scientists. All these allow the formulation of meaningful and relevant sets of hypotheses, the refinement of research questions, and the further development of the survey questionnaire.

To capture the details and richness of the pieces of information from my qualitative interviews, I digitally recorded conversations and interviews, which took place at respondents' respective offices, workstations, laboratories, or residences. Interviews which initially started formally and ended in a more relaxed tone lasted for about 45 to 90 minutes. With their permission, I also digitally photographed my respondents in their offices, workstations, laboratories, or residence, obtained brochures and/or organizational reports when available, and asked for their business cards or contact details in the absence of such cards. The interviews included narratives about respondents' academic background, professional career, involvement in research projects, professional contacts, and Internet access and use. I also asked them to briefly describe their experiences when they were doing their graduate studies, their interaction with professors, the organization of staff in their laboratory, and the culture of doing research in the Philippines as compared to their place of graduate education. The contents and information from these interviews were used to explain and substantiate the results of the face-to-face quantitative survey. For reference, a copy of the qualitative questionnaire used is provided in Appendix A.

Quantitative Survey

The quantitative survey questionnaire used in the Philippine sites was based on a template that has been used in Kerala, India; Kenya, and Ghana in 2000-2002. This survey instrument was exempted from a full review by the Louisiana State University's Institutional Review Board. To provide substantive understanding of the dynamics of the knowledge production process in these locations, I also collected and analyzed supplementary data from organizational memoranda, policy papers, and annual reports. From January to March 2005, I organized, conducted, and managed the face-to-face interviews of a representative sample of n = 312 Filipino scientists in two locations: Los Baños, Laguna (n=180), and Muñoz, Nueva Ecija (n=132).

For each location, respondents represented a variety of research fields in two organizational settings: government research institutes ("applied" or "research" sector) and state universities ("basic" or "academic" sector). For each organizational setting, I randomly and proportionately selected scientists by place of graduate education: **Australia**, **Japan**, **United States**, and the **Philippines**. My sampling method is a **stratified random sampling design** with locations purposely selected. Organizational setting and place of graduate education served as stratification variables within locations, with simple random sampling within strata.

The Philippine quantitative survey questionnaire was drafted in English and consisted of about 200 questions pertaining to social and demographic information, professional activities, personal networks, collaborative behavior, access to various types of communication technologies, and Internet access and use behavior. For reference, a sample of the questionnaire used is provided in Appendix B. Development of the questionnaire involved a number of important phases. The questionnaire was drafted and pre-finalized at the Louisiana State University Department of Sociology in December 2004. Information obtained from the qualitative interviews served as guidelines in developing the first draft. During the interviewers' training in mid-January 2005 at UPLB, I solicited more comments from trainees and made further revisions based on these comments and problems that cropped-up during the practice interviews. By the last week of January, the final version was available, which included a cover page that listed the names of those who comprise the Philippine survey team. The actual survey started and gained momentum in late January and was finished by the first week of March. Two interviewers and I checked the survey returns and responses in the evenings and requested revisits and call-back when necessary.[12] Prior to shipment to LSU, the filled-out questionnaires were photocopied and stored in Los Baños. These photocopies served as a back-up in case the originals were either destroyed or lost during my trip back to the U.S. Data entry and preliminary data validation were done in Los Baños, while the second and final data validations were done at the LSU Department of Sociology. The originals are now stored in an archival room at the third floor of LSU's Stubbs Hall.

Research time and material resources were proportionately allocated between Los Baños and Muñoz. The survey itself was facilitated through close consultations with my former professors and my personal contacts at the University of the Philippines Los Baños (UPLB)

[12] My mother and my brother helped me in checking survey returns every evening.

Department of Social Sciences. Prior to the actual interviews in January, a team of six enumerators with extensive social research experience in the Philippines (who were already recruited by the time I arrived in Manila on January 1, 2005) attended a two-day training session. The training was aimed at aiding interviewers understand the study objectives, details of the questionnaire, data validation procedures, and the terms of reference.

Access and Permission

Access to the state universities and government research institutes was not particularly difficult owing to my educational, personal, and professional ties with people in my study locations. For the organizations in the Los Baños science community (i.e., College of Agriculture, College of Forestry, College of Veterinary Medicine, School of Environmental Sciences and Management, Institute of Plant Breeding, National Crop Protection Center, the National Institute of Biotechnology and Applied Microbiology), I have both formal and informal contacts there because I earned my bachelor's and master's degrees from this place and worked at UPLB for about eight years. The Dean of the School of Environmental Studies and Management was my father's close friend and my godfather. The Dean of the College of Arts and Sciences was my former professor and a member of my graduate committee.

Access to the organizations and researchers in the science community of Muñoz was made possible through indirect and informal contacts. For example, my former UPLB graduate adviser is a personal friend of the president of the Central Luzon State University, while the incumbent executive director of the Bureau of Post-Harvest and Extension was a former high school student of my mother. One of the staff at the Human Resource Department in the same research institute is a close friend of my neighbor at LSU's Nicholson Apartments in Baton Rouge. At the Philippine Rice Research Institute, one mid-level staff who has access to the most updated list of scientists and researchers is my cousin, who with the necessary and proper permissions from management made things not only easier but a lot faster. My work experience at the International Rice Research Institute also came in very handy because of the personal network that I had established while conducting training and doing extension work. These ties made it easier for me to contact and gain the confidence of scientists at the Philippine Rice Research Institute headquarters in Muñoz, Nueva Ecija, and at the University of the Philippines College of Agriculture.

During my visit to Los Baños and Muñoz in June to July 2004, I obtained formal written permission to interview scientists at the UPLB College of Agriculture, the Institute of Plant Breeding, the National Crop Protection Center, the CLSU College of Agriculture, the Philippine Rice Research Institute, and the Bureau of Post-harvest Research and Extension (Appendix C). For the rest of the organizations surveyed, my mother, with the help of my younger brother, was the one who personally obtained permissions to conduct surveys at the UPLB College of Forestry and Natural Resources, the UPLB College of Veterinary Medicine, the UPLB School of Environmental Sciences and Management, and the Bureau of Post Harvest Research and Extension.

Despite all the painstaking efforts to gain formal and informal access and permission to organizations and scientists, it was not necessarily the case that everything went smoothly. For example, one senior faculty at UPLB's College of Veterinary Los Baños Medicine was adamant when one of my interviewers requested an interview. Although we had secured the necessary upper- and middle-level management approval and had the necessary informed consent form, this faculty member was very irate about what we were doing and studying. He said something to the effect that we were treating them as guinea pigs! I could not believe this was happening.

Although we tried to explain to him the nature of the study, he was simply adamant, which left us no other option but to leave him alone, with the College Dean being very apologetic when he realized what had happened. I do not hold any grudges nor hard feelings about this encounter. However, this episode made me realize that there is still this prevailing and strong perception that science is not amenable to social analysis; that science actors are a special breed of individuals who are immune to being studied and analyzed. But again, such thinking resides within the expectations of the limited translation view of science. In contrast, the theoretical framework of my research is consistent with the socio-cultural practice and extended translation view of science that argues that science is a social institution made up of social actors and as such is amenable to social analysis and examination.

Conceptual Framework

The conceptual framework of the study is presented in Figure 4.1. It contains the major concepts I employed and graphically summarizes the research hypotheses I addressed. **The framework builds on concepts, findings, and principles located at the intersection of the extended translation view of science, global systems theory, the "essential tool" perspective of the Internet, and egocentric social networks**. In studying the dynamics of globalization in Philippine scientific communities, I mainly focus on scientists' collaborative behavior and research productivity, and how both are configured by their professional network, Internet utilization, place of graduate education, and other relevant personal and contextual factors.
An equally important issue in science and technology studies, which this work addresses, is the elaboration of the relationship among professional network, scientific collaboration, and research productivity. The causally prior positioning of scientific collaboration with respect to research productivity (Fig.4.1) has given conflicting results (Lee and Bozeman 2005; Duque et al. 2005).

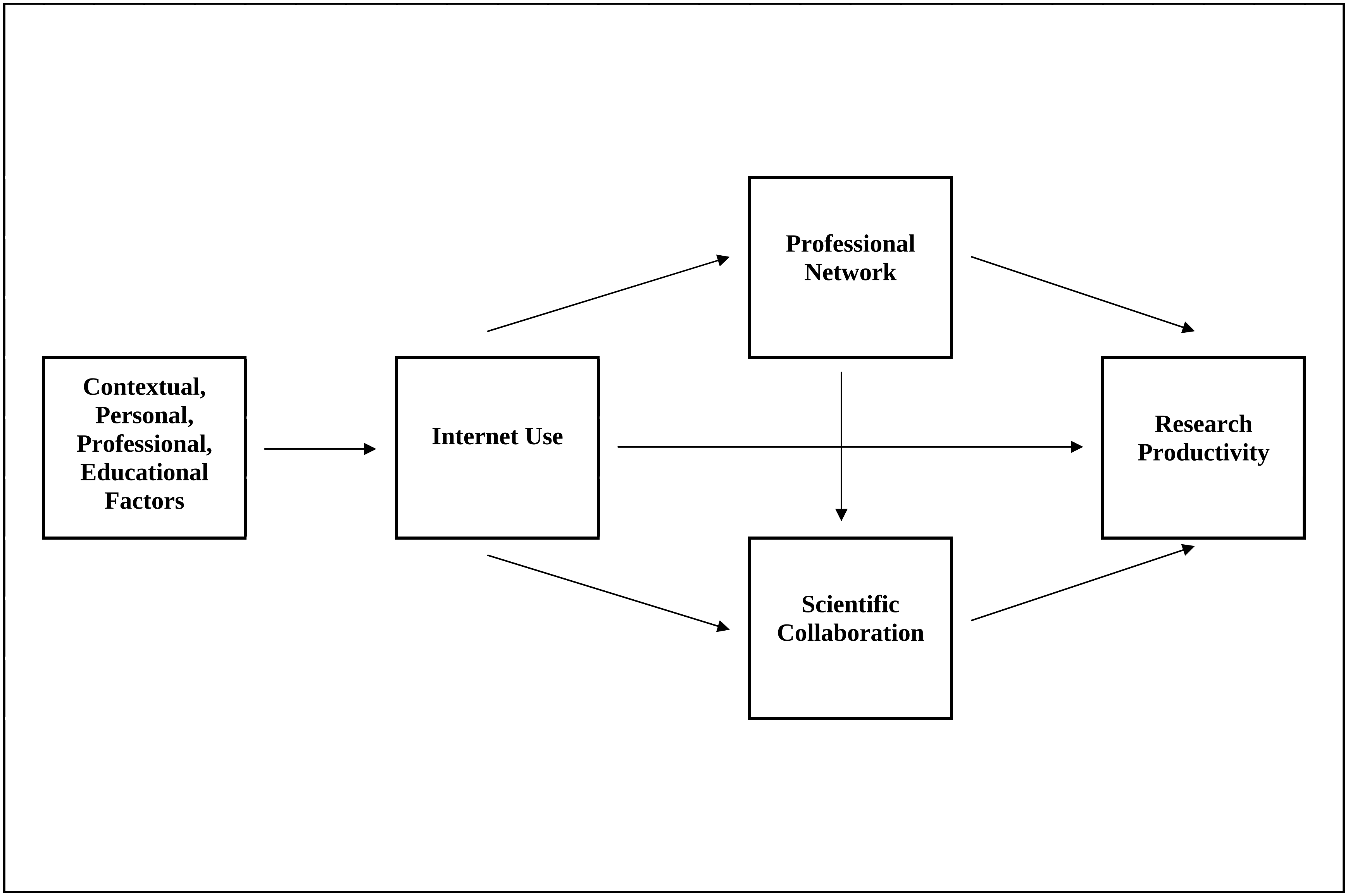

Figure 4.1: Conceptual Framework Showing the Hypothesized Relationship among Internet Use, Professional Network, Scientific Collaboration, and Research Productivity

The assumption that collaboration leads to enhanced productivity, and the findings derived from recent literature are far from consistent. In the developed world, for example, recent results from Lee and Bozeman (2005) have shown that collaboration is positively related to productivity. In the developing world, however, collaboration and productivity have been shown not to be associated at all. This finding has led to the collaboration paradox (Duque et al. 2005). With these inconsistent results, this study explores whether professional network plays an important mediating role in configuring the relationship or non-relationship between scientific collaboration and research productivity.

Measurement

Dependent and Intervening Variables

In my conceptual framework (Fig. 4.1), the ultimate dependent dimension is **scientific** or **research productivity**. **Scientific collaboration** and **professional network** are both central intervening dimensions. It is hypothesized that professional networks affect research productivity directly and indirectly through scientific collaboration. Research productivity is measured using 10 indicators. These are number of publications in domestic and foreign journals in the last five years (Ynalvez et al. 2005), number of papers presented in national workshops and international conferences, number of bulletins for extension, research reports, book chapters written, and papers written in the last 12 months. Two additional measures are total number of publications in scholarly journals, and papers in conferences. All indicators are measured at the interval-ratio level, which possesses positively skewed distributions.

The intervening dimension, **scientific collaboration**, is measured using eight indicators. These are number of collaborative projects (ranging from 0 to 3), does respondent collaborate (1=yes, 0=no), respondent has collaborators in the immediate survey site (1=yes, 0=no), respondent has collaborators in other Philippine sites (1=yes, 0=no), respondent has collaborators in Australia (1=yes, 0=no), respondent has collaborators in Japan (1=yes, 0=no), respondent has collaborators in the U.S. (1=yes, 0=no), and respondent has collaborators in other foreign sites (1=yes, 0=no). Except for number of collaborative projects, which is measured at the interval-ratio level but with a narrow range of values, all other indicators are measured at the binary ordinal level. Although I recognize that reliability tends to increase by using interval-ratio indicators for collaborators in different locations, the structure of the questions in the survey questionnaire did not make it possible for these types of information and data to be gathered.

Another important set-up not considered in past and recent literature is the mediating effect of a scientist's professional network on scientific collaboration and research productivity, which according to Sangowusi (2003), Shrum and Bankston (1993/1994), and Shrum and Beggs (1997) is important for the efficiency and effectiveness of the scientific enterprise. A scientist's professional network is not only confined to relationships with other scientists, but may also extend to linkages with policymakers, extension service personnel, executives and technicians from financial and development agencies, and other relevant identities and groups (Callon 1995; Epstein 1996; Shrum and Beggs 1997). I employed an ego-centric network design (Marsden 2003) wherein respondent scientists serve as focal actors (or egos). I used a name generator to solicit for up to a maximum of 12 contacts (or alters).[13]

Although there were as many as 23 indicators from which basic descriptive statistics were obtained, I used only seven important and promising indicators for further analysis. In other words, professional network was operationalized using: network size (ranging from 0 to 12), or the number of self-reported alters deemed important to respondent's professional career

[13] In this research, a name generator refers to a set of questions, which elicits from respondents names of people whom they consider important in their research work and professional career (see Appendix B, p. 230).

and work; proportion of alters who are males (ranging from 0 to 1), which relates to an ascribed attribute that may have implications for having access to resources and ties regarded as valuable in the Philippine scientific system; proportion of alter at the core (ranging from 0 to 1) which may translate as an advantage and a resource in individual research productivity. Gender diversity (ranging from 0 to 1) and locational diversity (ranging from 0 to 1) were both defined and calculated as the index of qualitative variation for gender and locations, respectively. Gender heterophily (ranging from 0 to 1) was calculated as the mean of the absolute difference between ego's gender (1=male, 0=female) and each alter's gender (1=male, 0=female). A measure of the multiplexity of communication means was defined as the mean number of ways ego communicated with all alters reported.

Independent Variables

My main independent dimensions are **Internet use** and **place of graduate education**. I adopt and revise the manner in which Ynalvez et al. (2005) operationalized Internet use, by adding yet another dimension (i.e., **intensity of use**) to their four-dimensional measurement specification (i.e., current use, ready access, extent of use, and diversity of use). I argue that Internet use experience, or hardware-software-user interaction, further bifurcates into short-term and long-term temporal dimensions. **Intensity of use** is that dimension which facilitates the development of intense and intimate interaction skills between hardware, software, and user and which makes for a technology's inclusion in one's daily and routine activity.

On the other hand, **extent of use** is that dimension, which is prerequisite to developing and stabilizing proficiency skills and strengthening confidence of use of the Internet. Confidence and proficiency with hardware and software occurs over the long term and may be best captured by experience in number of years. Reviewing the measurement approach in Ynalvez et al.

(2005) and incorporating yet another dimension, the first aspect in the sequence, **current use**, refers to the degree to which scientists define themselves as users of information and communication technology (Ynalvez et al. 2005). The second aspect, **ready access**, is largely contextual and pertains to the degree to which a particular technology is present, available, and accessible for use within the immediate environment (Ynalvez et al. 2005). The third aspect, **intensity of use**, pertains to the temporal intensity and frequency of hardware-software-user interaction within a typical day. The fourth aspect, **extent of use**, pertains to the temporal extent of hardware-software-user interaction over extended periods of time, which constitutes prolonged routine exposure. Clearly, there is a difference between a first time user and one who has interacted with a technology for years, who through repeated and continuous exposure has incorporated a technological practice into a pattern of daily life (Ynalvez et al. 2005).

The fifth aspect relates to socio-cultural practices that constitute Internet use; the convergence of diverse behavior associated with the use of the Internet (Ynalvez et al. 2005). This aspect also refers to the skills level and competency one has developed with respect to the different facilities associated with the Internet. An individual may have diverse use of a technology, but may not be highly skilled or may not have developed sophisticated use of the technology. For example, individuals would typically report using the Internet for information search and communication, but may not be using the advanced functions of the Internet's search and communication facility.

Previous studies have shown that scientists' academic training is an important factor in knowledge production, and is traditionally measured by level or years of education. Although this is definitely an important dimension in scientific work, there is yet another factor which I term **place of graduate education** that may also play an important--although often neglected--

role in understanding knowledge production because it is so closely related to the concept and acquisition of **tacit knowledge** (Collins 1983 and 2001; Down 2000; Olesko 1993). In contrast to explicit knowledge ("cookbook" or codified knowledge), which is information or instruction that can be expressed in diagrams, equations, symbols, or words and can be stored, copied, and transferred by impersonal means, such as written documents or electronic files. Tacit knowledge has not been or cannot be expressed explicitly, but can only be transmitted by way of face-to-face interaction, fellowship and mentoring, or by on-site laboratory training (Collins 2001; MacKenzie and Spinardi 1995:45). In general, places of education (i.e., colleges and universities) are institutional sources of both explicit and tacit knowledge (Olesko 1993). But, with the usually high degree of personal contact and interaction between pupil and master, graduate student and advisor in master's and doctoral training, it is logical to argue that places of graduate education tend to be important sources of tacit knowledge, especially so when graduate training is for extended periods of time.

My hypothesis is that the place where a scientist receives advanced training in the knowledge production process, which normally takes from four to seven years, configures a scientist's Internet use behavior, structure of professional network, and patterns of scientific communication, collaboration, and productivity. Typically, advance scientific training requires relocating to a university setting within the Philippines or abroad. It involves learning new explicit and tacit knowledge (Collins 1983 and 2001; MacKenzie and Spinardi 1995), behavior, and ways of knowing and doing. For example, my qualitative interviews with Filipino scientists trained in Japanese universities, through scholarships (*Monbusho*) sponsored by Japan's Ministry of Education and Culture, revealed that the typical relationship between a professor (*sensei*) and a graduate student (*insei*) was characterized as closely knit, intense, and with a high frequency of interaction, both at the formal and the informal level. *Sensei* will normally go out of his way to get to know an *insei* at a more personal level. Such interaction (though asymmetrical and hierarchical), especially during mid-afternoon tea breaks and laboratory meetings, tend to establish strong and durable professional and non-professional relationships, which continues long after an *insei* has received his doctoral degree and has returned to the Philippines.

In terms of work ethic (which, I argue, has a direct bearing on scientific productivity), a typical workweek for a graduate student in Japan will be from Monday to Saturday. On average the day starts at about 9:00 AM and ends at about 11:00 PM. Indeed, exposure and immersion of graduate students in foreign scientific and research culture may result in a change in attitude and behavior, which may be reflected in students' use of and interaction with telecommunication technologies and in the ways they conduct scientific research. Although I do not have any solid predictions about the effect of place of graduate education on Internet use behavior, professional network, collaboration, and scientific productivity, I hypothesize that Filipino scientists trained in Australia, Japan, the United States, and the Philippines will exhibit differential behavioral patterns and cultural practices with respect to telecommunications technologies and scientific practice.

Control Variables

Factors that mainly serve as controls in my regression analyses (i.e., for both the normal error and the binary logistic regression models) include contextual, personal, and professional factors. Contextual factors consist of location (1=Los Baños, 0=Muñoz), and organizational setting (1=government research institutes, 0=state universities). Personal factors include gender (1=male, 0= female), age (in completed years), marital status (1=married, 0=not married), and number of children. Professional factors consist of presence of a computer in respondent's personal office (1=yes, 0=no), number of people sharing a computer, and membership in professional organizations (1=yes, 0=no).

Analytical Methods

Basically, I employed a statistical method that is akin to a **path analysis**, which is consistent with the conceptual framework shown in Figure 4.1. Regression models were specified in a manner that Internet use, network, collaboration, and productivity indicators were ordered and sequentially treated as dependent variables, while previous dependents variables at each sequence were made independent variables. The ultimate dependent variables were the set of research productivity indicators, meaning that these variables never served as independent variables in all the regression models specified. Traditional path analysis uses standardized normal error regression analysis for its component models. My approach, however, used both the **logistic** and the **normal error regression** approaches because my dependent variables were either binary-ordinal or interval-ratio in scale.

In cases wherein the interval-ratio dependent variables were highly positively skewed (e.g., number of publications in a foreign scholarly journal in the last five years), the natural logarithm of these variables was calculated prior to doing normal error regression analyses. On instances when the dependent variables had zero values, a small positive number $k = 0.5$ was added before the natural logarithms were calculated. Throughout the entire path analysis, the following type I error rates (α) were used: 5% denoted by an asterisk (*), 1% denoted by a double asterisk (**), and 0.1% denoted by a triple asterisk (***).

CHAPTER 5: INFORMATION AND COMMUNICATION TECHNOLOGIES*

Introduction

In this chapter, I describe how Philippine scientists have adopted new information and communication technologies (ICTs). Their access to and utilization of personal computers, email, and the World Wide Web are explored and examined. Toward this end, I present relevant descriptive statistics together with the results from frequency tables generated from the face-to-face survey data collected from n = 312 scientists and researchers in Los Baños and in Muñoz. I then delve into the concept of Internet use, deconstruct it into five aspects pertaining to access and use (**current use**, **ready access**, **intensity of use**, **extent of use**, and **diversity of use**) and derive empirical measures for each of these concepts. I also examine how these aspects are configured by scientists' contextual, personal, professional, and educational attributes. In the analysis that follows, one particular dimension of scientists' education--**place of graduate education**--is the focal independent dimension, **aspects of Internet use** are the dependent dimensions, and other contextual, personal, professional, and education variables serve as controls in the logistic and the normal error regression analyses.

Demographic Characteristics of Respondents

Table 5.1 shows the demographic profile of the n = 312 randomly sampled Philippine scientists working at state universities and government research institutes in Los Baños, Laguna, and in Muñoz, Nueva Ecija. These two locations are the country's premier research training centers and scientific production sites for the agricultural sciences. Of the total sample size, 37 (or 12%) scientists were trained in Australia, 47 (or 15%) in Japan, 60 (or 19%) in the U.S., and the remaining 168 (or 54%) in local universities. Although the majority (54%) of Philippine

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Table 5.1: Mean Comparison of Philippine Scientists' Contextual, Personal, and Educational Information

Respondent's (R's) Characteristics	Place of Graduate Education				All Scientist	LSD Pairwise Comparison[1]					
	Australia (n=37) [1]	Japan (n=47) [2]	U.S. (n=60) [3]	Philippines (n=168) [4]	(n=312)	1-4	2-4	3-4	1-3	2-3	1-2
Community (1=Los Banos, 0=Munoz)	0.65	0.64	0.78	0.47	0.57	*	*	*			
Sector (1=research institute, 0=state univ)	0.27	0.43	0.18	0.37	0.33			*		*	
Age (in years)	46.27	44.60	53.33	47.24	47.89		*	*	*	*	
Gender (1=male, 0=female)	0.56	0.70	0.68	0.38	0.51		*	*			
Marital Status (1=married, 0=not married)	0.76	0.83	0.90	0.82	0.83						
Number of children	1.78	2.19	2.42	2.14	2.15				*		
Number of children below 21	1.24	1.87	1.23	1.46	1.44					*	*
Degree (1=Ph.D, 0=MS)	0.54	0.96	0.88	0.46	0.63		*	*	*		*
No. of years spent abroad	4.32	4.87	4.90	0.79	2.62		*	*	*		
Year highest degree was obtained	1995.7	1997.1	1985.4	1994.6	1993.3		*	*	*	*	

* means are significantly different at the 5% level

[1] LSD means least significant difference test

scientists are locally trained, those who received advance graduate training at the scientific core typically obtained their degrees from the U.S. and will have spent between four to five years there. The distribution of scientists trained in these three scientifically strong countries closely mirrors the strength of the Philippines' cultural, economic, and political ties with each of these core countries. For example, the Philippines has the closest relations and strongest ties with the U.S. as a result of the former's colonial engagement with the latter, which dates back to the end of the Spanish-American war in 1898. The close relations and strong ties run along cultural, economic, political, educational, technological, and scientific lines render the relationship between the two as highly multiplexed.

Ties between Japan and the Philippines are definitely much less intense and multiplexed when compared with those between the U.S. and the Philippines, but these are stronger and more multiplexed than those between Australia and the Philippines. Philippine-Japan bilateral relations run along economic, scientific, and technological lines. Although these ties are relatively weaker compared to those between the Philippines and U.S., there are clear indications in recent years that these ties are becoming stronger and more diversified. As mentioned earlier, the Philippine-Australian bilateral relationship is weakest among the three set of relationships. An obvious reason is that Australia and the Philippines had never had any significant historical or colonial engagement. Although the British invaded the Philippine Islands during the Spanish colonial regime, the natives of the Philippines supported Spain in its war against Great Britain so that there was not any opportunity for Great Britain and the Philippine Islands to develop and foster bilateral relations that would have paved the way for closer ties. In contrast to Philippine-Japanese and Philippine-American relations, Philippine-Australian relations are mainly along economic and scientific lines, which have yet to gain momentum and strength. Lately, however, Australia has initiated a number of economic projects and scientific manpower development programs.

Among foreign-trained Philippine scientists, earlier Ph.D.'s typically obtained their degrees from the U.S., while later Ph.D.'s typically obtained their degrees from Japan. There is, however, an increase in the number of Philippine scholars going to Australia and to Japan as a result of increased assistantships and scholarships over the last three decades. However, these scholarships and assistantships are usually government-to-government arrangements and not choices made by individual scientists. If Philippine scientists were given the choice of the country from which to receive advanced scientific training or if they had the full locus of control over the decision of where to pursue their master's and doctoral degrees, U.S. universities would definitely be the number one choice.[14]

In terms of location, most (58%) scientists are based in Los Baños, while the majority (67%) is in state universities. These estimates are consistent with the expectation that the University of the Philippines at Los Baños is the country's premier and largest scientific community. It is internationally acknowledged as a center for excellence in agricultural research and advanced education. From Table 5.1, scientists' mean age is about 48 years, a little over half (51%) are male, and a vast majority (83%) are married, typically with two children. Furthermore, most scientists (63%) have doctoral degrees and had spent an average of about 2-3 years training abroad. While there seems to be an almost equal proportion of males and of females in the sample and in the general population, cross-tabulating gender with place of

[14] Most Filipinos are inclined to think of anything that has to do with America as good and worthy of emulation, whereas anything non-American is viewed with misgiving and seen as inferior. Philippine scholars have termed this "colonial mentality" as mainly an outcome of the positive impression of America as colonizer and the benevolent assimilator: America is a great liberator, the patron of democracy and of liberal thinking, the proponent of mass education; the "big white brother" who came to help the "little brown brother." In contrast, other colonizers, like Spain and Japan, were viewed as oppressors who socially excluded and mistreated the natives.

graduate education yields an interesting pattern. From Table 5.1, it is obvious that the majority of scientists who trained in each of the foreign locations are males, while most females tend to receive scientific training from local training institutions. There appears to be a clear indication that although there seems to be an equal proportion of men and of women scientists in Philippine scientific research systems, males have more opportunities to receive advanced training abroad than females. Further, cross-tabulating gender against level of graduate education reveals a significant χ^2 test (results not shown), meaning that gender and level of graduate education are very likely not independent of each other. This means the opportunities for education among Filipino knowledge producers closely traverse gender lines.

Among female scientists, the proportion of those who do have and those who do not have doctoral degrees are almost the same, but among male scientists, the proportion of those who do have doctoral degrees far exceeds those who do not have. Again, despite the seemingly equal number of men and women in the Philippine scientific research system, male scientists are more likely to have a Ph.D. and receive their degrees it abroad, or at the scientific core. An educated guess about this phenomenon could imply the workings of the traditional notion of women as housekeepers and child caregivers and men as breadwinners. Somehow, this traditional thinking and expectation seems to diffuse into the culture and practice of scientific human resource development and training. These results yield partial support to the assertion of the socio-cultural practice view of science that scientific institutions are essentially social institutions, which are configured and influenced by the larger cultural system and/or social system in which it is embedded. This same observation--if it does not fully put into question the assertion of increasing institutional isomorphism globally--at least indicates that the supposed homogenization of social structural forms may still be far from realization in the developing world in general and in the scientific knowledge sites of peripheral countries at the present time. If ever there is this on-going process of isomorphism of scientific institutions, it may be the case that rates by which this process takes place vary across cultural systems and/or social systems. The shift toward isomorphic scientific forms and system may be taking place, but it may be that scientific systems all over the world may be shifting at far different rates.

Computers: Utilization for the Full Sample

As far as agricultural scientific knowledge production is concerned, the first IBM compatibles and Apple II computers were already available at the Agricultural Resource Center (ARC) in the early 1980's, but these same computers were not readily available in the immediate workstations or in the personal offices of scientists. Data processing and computing services for agricultural research were centrally channeled to and done at ARC, which was jointly funded by the International Rice Research Institute, the Southeast Asian Ministers of Education Organization Regional Center for Graduate Study and Research in Agriculture, and the University of the Philippines at Los Baños. Now, 25 years later, I examine the expansion and diffusion of personal computers (or PCs), which have virtually rendered ARC's IBM mainframe computers used for large-scale agricultural data processing in the Philippines' premier agricultural research system obsolete and relegated to oblivion.

From the descriptive statistics presented in Table 5.2, almost all respondents reported having a PC at work and having ready access to it. Most had acquired these machines for the first time in mid-1993. Although about three-quarters of these computers are reportedly connected to the Internet, connections are far from fully operational and reliable in most cases. Insider information from my qualitative survey in June-July 2004 describes the connectivity problem as riddled with frequent breakdowns of the network server, irritatingly slow connection

Table 5.2: Mean Comparison of Philippine Scientists' Computer Utilization

Respondent's (R's) Computer Utilization	Place of Graduate Education: Australia (n=37) [1]	Japan (n=47) [2]	U.S. (n=60) [3]	Philippines (n=168) [4]	All Scientists (n=312)	LSD Pairwise Comparison[4]: 1-4	2-4	3-4	1-3	2-3	1-2
R has a personal computer at work	0.97	1.00	0.98	0.99	0.99						
Year R's computer was it first available	1995.25	1993.32	1991.83	1994.05	1993.60			*	*		
R has computer in personal office (1=yes, 0=no)	0.53	0.53	0.58	0.41	0.47						
Number of people who use computer including R	2.58	2.99	3.24	4.19	3.64	*					
R has ready access to a computer (1=yes, 0=no)	0.97	1.00	1.00	1.00	1.00						
R has ready access to a printer (1=yes, 0=no)	0.97	1.00	1.00	1.00	1.00						
Is R's work PC connected to internet? (1=yes, 0=no)	0.72	0.77	0.80	0.69	0.73						
R has a personal computer at home (1=yes, 0=no)	0.89	0.98	0.95	0.86	0.90						
Year R first acquired home personal computer	1997.03	1997.20	1994.61	1996.93	1996.50			*	*	*	
Number of people using home computer including R	2.97	3.48	3.54	3.69	3.53						
Is R's home personal computer connected to internet? (1=yes, 0=no)	0.67	0.63	0.84	0.60	0.67			*		*	
No. of hours computer is used each week by R	12.58	11.80	10.62	10.79	11.10						
How often does R use a computer for fun?[1]	2.97	3.17	3.08	3.22	3.16						
How comfortable is R in using computers?[2]	1.00	1.13	1.31	1.23	1.21		*				
How sophisticated is R in using computers?[3]	2.84	2.53	2.77	2.85	2.79						

* means are significantly different at the 5% level

[1] categories are 1=frequently, 2=occasionally, 3=seldom, 4=never, 9=DK/NR

[2] categories are 1=very comfortable, 2=somewhat comfortable, 3=slightly comfortablefrequently,4=not at all comfortable, 9=DK/NR

[3] categories are 1=sophisticated, 2=somewhat sophisticated, 3=more than basic, but not sophisticated, 4=basic, 9=DK/NR

[4] LSD means least significant difference test

time, and frequent power outages. In some instances, though, the reason for no connectivity at all can surprisingly be very non-technically related, as in the case of external cables and wires being stolen. This is what happened at the Bureau of Post-harvest Research and Extension in Muñoz, which was explained to me by the bureau's executive director.

For the full sample, as majority (53%) of the PCs at work are either located in a shared office or are in a communal work area. Only 47% of PCs are located in personal offices, a situation which is in stark contrast to the situation in the research offices of the developed world. The user-hardware ratio is at 3.64:1 meaning that about three to four scientists share an older PC model, which typically is equipped with a slow microprocessor. This ratio is a far cry from that observed in U.S. universities where scientists are each assigned a desktop computer and in some instances each is also assigned a laptop. From these results, it is obvious that access to and use of PCs in Philippine scientific communities is a far cry from the usual notions that scientists in developed areas (Australia, Japan, North America, and Western Europe) have, where scientists are typically assigned a desktop in their personal offices. In most cases, scientists in developed areas have laptops (or notebooks) which make user-hardware ratio values of either 1:1 or 1:2 commonplace and taken for granted.

Indeed for scientists in developed areas, access to and utilization of PCs, more or less fit the definition of a "personal computer"--maybe even to the point of being a "very personal computer"--in that each is assigned to a single user and is located in personal offices. Indeed, for most scientists in the developed world, there is much "digital" and "architectural privacy" at the same time and most of the time. In contrast, the results in Table 5.2 suggest that PCs, as construed in the Philippine research context, are rarely personal technical artifacts located in places devoid of architectural privacy. These pieces of equipment can be more accurately described as “public computers,” which are shared and typically stationed in communal work areas--libraries, laboratories. This arrangement in PC access and use is understandable given the limited material resources in peripheral research systems, and it also has a very high tendency to preclude researchers from having the necessary privacy--**personal, digital, and architectural**--that is important for productive research.

In their homes, 90% of scientists report having a PC with most having acquired it for the first time in mid-1996. While it is interesting to have an idea about the quality of computer infrastructure in the home vis-à-vis that in the workplace, information on the make and year of the hardware and the versions of installed software are not available from the survey. Basically, home PCs can also be aptly described as “share-wares.” Similar to the situation in the workplace, about three to four persons share a home computer, which includes the scientists themselves. With 83% of scientists married and with two children on average, it is logical to presume that their spouses and children share these home computers with respondents. In contrast to the workplace context, only 67% of those who have home PCs report having connectivity or Internet connection. Respondents from the 2004 qualitative survey report purchasing pre-paid dial-up Internet cards, which are normally available from the Philippine Long Distance Telephone Company or other telecommunications stores.

In a typical week, scientists use computers between eleven to twelve hours on average (whether at home or at work). This translates to using the computer roughly two hours per day, which is a very short time by developed world standards and which could all the more be shortened by the slow connection time. Whether at home or at work, majority (96.8%) of respondents report using the computer for some other things **except** for fun or play, like computer games. This, however, does not imply that they are not comfortable using PCs. In fact, 82.7% report being very comfortable using computers, although their level of sophistication will be at a more than basic level, like typing documents and entering data; it will not be at the advanced levels like hardware and software programming. The level of sophistication in using a PC is relatively low considering that scientists and researchers possess higher levels of education and training when compared to the general population. Only 6.7% report using computers at a very sophisticated level like writing programs and configuring hardware. Most probably the limited personal and architectural privacy prevents scientists from developing advanced computer-interaction skills. It could also be the case that scientists do not have access to in-house computer literacy training.

Computers: Utilization by Place of Graduate Education

Place of graduate education is a central factor in this study. My interest in it rests mainly on its potential to be a basis for inequality among peripheral scientists, especially when there are differences in perceptions of deference and prestige among international training institutions. As some respondents have alluded to, graduates from the U.S. tend to be perceived as having more prestige if not better training than those who have graduated from Australia, Japan, and the Philippines. Consistent with this concern and without controlling for other factors, do differences in place of graduate education somehow relate to inequalities in PC utilization?

Grouping graduates from Australia, Japan, and the U.S. together as foreign trained and graduates from all over the Philippines as domestic trained yields interesting findings. Significant inequalities between foreign and domestic-trained scientists are detected for (1) number of scientists sharing an office PC, (2) having a home PC, and (3) having Internet connection at home. In contrast to locally trained scientists, those who trained abroad share their office PCs with fewer other scientists, are more likely to have computers at home, and have home PCs connected to the Internet. Differences with respect to where the office PC is located is marginally significant at the 5% level, with foreign trained more likely to have PCs located in their personal office than their locally trained counterparts. There are no detectable differences between foreign and locally trained scientists with respect to the proportion of (1) having office PCs, (2) when offices PCs were first available, (3) where office PCs are located, (4) having office PCs connected to the Internet, (5) when home PCs were first obtained, (6) number of people sharing home PC, (7) number of hours using PC in a week, (8) frequency of using PC for fun or play, (9) levels of comfort, and (10) of sophistication using PC.

Based on these results, foreign trained scientists have lower hardware-user ratio, but this does not mean they have significantly more time spent using computers. What foreign-trained scientists gain from the lower hardware-user ratio may not be more time to use this equipment, but more convenience and flexibility on when to use it. Locally trained scientists, on the other hand, use computers as much as those who were trained abroad in terms of number of hours, but are able to utilize these machines with lesser flexibility and convenience; probably they have to wait for their turn to use these machines. Furthermore, foreign-trained scientists and locally trained scientists are at parity in the workplace with respect to access to PCs and the Internet. However, foreign graduates are more likely to enjoy having PCs and Internet connectivity at home. The lingering question at this point is: Why is it that foreign graduates who have fewer other scientists to share their office PCs with, who are more likely to have computers and Internet connections at home have very similar computer time use patterns as local graduates?

In Table 5.2, I partition receipt of foreign graduate training into distinct and non-overlapping categories pertaining to Australian, Japanese, and U.S. training structures. I then compare these four training structures with respect to various dimensions of PC utilization.

Results obtained from a one-way analysis of variance indicate significant differences among the four places of graduate education at the 5% level with respect to: (1) year work computer was first available; (2) number of people sharing a computer at work, (3) year home computer was first available, (4) whether or not home computer is connected to the Internet, and (5) how comfortable respondent is using computers.

Detailed examination reveals that U.S.-trained scientists are among the earliest to have ever used computers, while those trained in Australia are among the most recent ones to have ever used computers. This is indicative of the fact that in earlier years, Philippine scientists were trained in the U.S. while in recent years scientists were sent for training in Australia. While in general, there is this norm of digital resource sharing in Philippine scientific research system; Australian trained scientists are observed to have the lowest hardware-user ratio, while Philippine-trained scientists have the highest. There is also this general pattern that foreign-trained scientists have a lower hardware-user ratio compared to locally trained scientists. In terms of Internet connectivity, U.S. graduates have the highest rate with Australian, Japanese, and Philippine-trained scientists significantly lower, but exhibiting no differences among themselves. If there is indeed a U.S. training advantage in terms of PC and Internet use, it is not so obvious in the workplace but appears to be discernible in the context of home computing connectivity.

Email: Access and Use

In Table 5.3, I present survey results pertaining to Philippine scientists' access and use of email. It is clear from the results that although 93% of scientists report ready email access, whether at home or at work, 97% report ever using email and 97% report being current users. This observed disparity between ready access and current use is expected in developing areas but

Table 5.3: Mean Comparison of Philippine Scientists' Email Utilization

Respondents (R's) Email Utilization	Place of Graduate Education				All Scientists	LSD Pairwise Comparison[5]					
	Australia (n=37) [1]	Japan (n=47) [2]	U.S. (n=60) [3]	Philippines (n=168) [4]	(n=312)	1-4	2-4	3-4	1-3	2-3	1-2
R has ready access to (1=yes, 0=no)	0.97	1.00	0.97	0.88	0.93	*	*	*			
R ever used email (1=yes, 0=no)	1.00	1.00	1.00	0.95	0.97			*			
R currently using email (1=yes, 0=no)	1.00	1.00	0.98	0.95	0.97						
Last time R sent an email[1]	1.30	1.36	1.47	1.74	1.58	*	*	*			
First year R used email	1994.5	1995.7	1995.8	1998.3	1996.9	*	*	*			
R unable to access email (1=yes, 0=no)	0.73	0.62	0.62	0.66	0.65						
R's reason for inability to access email[2]	1.61	1.24	1.54	1.51	1.50						
How many email messages R sends?[3]	2.54	2.64	2.51	2.30	2.43						
How many emails of R related to research?[3]	2.41	2.22	2.17	1.96	2.11	*					
How many emails R receives?[3]	3.03	2.83	2.81	2.72	2.79						
How many hours weekly R on email?	4.16	4.10	3.13	2.92	3.36	*	*				
R ever been a member of S&T discussion group[4]	0.65	0.51	0.42	0.38	0.44	*			*		
R ever sent a message to S&T discussion group[4]	0.59	0.49	0.48	0.48	0.49						
R ever discussed with colleague in the Philippines[4]	0.73	0.83	0.77	0.78	0.78						
R ever discussed with a colleague in Asia[4]	0.59	0.87	0.65	0.57	0.64		*			*	*
R ever discussed with someone in a developed country[4]	0.73	0.60	0.60	0.41	0.52	*	*	*			
R ever started professional relationship by email[4]	0.32	0.36	0.32	0.31	0.33						
R ever continued professional relationship through email[4]	0.89	0.91	0.72	0.77	0.80		*		*	*	
R ever discussed proposals[4]	0.68	0.66	0.68	0.48	0.57	*	*	*			
R ever submitted or reviewed manuscripts[4]	0.62	0.74	0.58	0.45	0.54		*				
Email use diversity index (0=min, 6=max)	3.59	3.36	3.08	2.50	2.88	*	*	*			

* means are significantly different at the 5% level

[1] categories are 1=yesterday or today, 2=within the past week, 3=within the past month, 4=within the past 6 month, 5=longer than 6 months, 9=DK/NR

[2] categories are 1=technical, 2=financial, 3=others, 9=DK/NR

[3] categories are 1=less than one each week, 2=between one and six in a week, 3=usually one or two daily, 4=more than two daily, 9=DK/NR

[4] categories are 1=yes, 0=no

[5] LSD means least significant difference test

this is substantially small compared to those observed by Ynalvez et al. (2005) among Ghanaian, Kenyan, and Malayali scientists. The majority of scientists (77.3%) use Internet connection at home, at work, or both to access email. About 60.5% report using email within the last 24 hours, while 29.3% report using it within the past seven days. The earliest reported use of email was in 1984, the latest in 2004, with the typical scientist having used email for the first time in 1997. Scientists who reported not being able to access an email account for at least one week in the past year mentioned technical problems (73.5%), financial reasons (3.5%), and the remaining for some other reasons (23.0%) like having busy schedules or out of town domestic trips.

In a typical week, scientists send between one and six messages, of which between one and six messages are related to their research, and they receive between one and six messages. Although these are comparatively low receiving and sending rates when compared to the developed world, it is obvious that email is mainly for research-related communication and exchange. As to the number of hours using email in a typical week, 49.7% report using email between one and five hours per week, while 33.7% report using email for less than an hour per week. Using the midpoints of each of the categories as point estimates, the number of hours of email use in a typical week is roughly three and a half hours, or about 40 minutes per week day. However, this is not yet what is called productive time use, as much of these 40 minutes includes waiting time to establish connectivity, response time delays in browsing from one webpage to another, and the accrual of reconnection time when connectivity is unexpectedly cut due to unstable Internet connections typical of dial-up connections.

As to what scientists have ever done using email, 44% report having been a member of a discussion group concerned with science and technology, 49% have sent a message to a discussion group concerned with science and technology issues, 78% discussed research with a colleague in the Philippines, 64% discussed research with a colleague in Asia but outside the Philippines, 52% discussed research with someone in the U.S., Europe, or other developed countries, 33% started a professional relationship with someone met on the Internet, 80% continued email correspondence with someone met personally, 57% discussed proposals with funding agencies, and 54% submitted and/or reviewed manuscripts for journals. Based on these statistics, a large proportion of scientists in the Philippine research system have yet to be initiated to the possibilities and activities that can be done through email. It may also be the case that other scientists are simply unable to do the above activities due to inferior Internet infrastructure or high user-hardware ratio.

In Table 5.3, I further explore scientists' access to and use of e-mail by comparing places of graduate education--Australia, Japan, U.S., and the Philippines. From these results, it is obvious that nearly all Philippine scientists have ever used email and consider themselves as current users. For the variable having ever used email, U.S. trained scientists (100%) have a significantly higher rate than those trained in Philippine graduate institutions (95%). However, no significant differences are detected between Australian- (100%) and Japanese-trained (100%) and Philippine-trained scientists (95%). As to ready access to email, rates are similarly high among Australian- (97%), Japanese- (100%), and U.S.- (97%) trained Filipino scientists. Compared to those trained abroad, locally trained scientists have a lower rate (88%).

These results suggest that the dichotomous distinction between having and not having email access, using and not using email seem to be blurring. In other words, the digital divide with respect to binary access and binary use are steadily diminishing bases for inequality in Philippine research system. As with other forms of inequality, it may be the case that there is an on-going transmutation to another level and form of inequality with respect to digital inequality.

It could be that new forms of inequality transcend these binary access and binary use distinction, and have may be shifting to more advanced levels or sophisticated forms. This could suggest that the digital divide may be in the process of shifting from basic to advanced forms of inequality.

The majority of each of these places of graduate education reported having sent an email during the last 24 hours. However, the rate for locally trained scientists (51.6%) is significantly lower compared to 73.0%, 70.2%, and 68.3% for Australian-, Japanese-, and U.S.-trained scientists, respectively. In terms of exposure to email, it is clear that foreign-trained scientists had been introduced to email much earlier than their Philippine counterparts. Australian-trained scientists were, on average, introduced to email in mid-1994, Japanese-trained in mid-1995, and U.S.-trained in late 1995. In contrast, Philippine-trained scientists report having used email for the first time in early 1998, which is about two years later compared to those trained abroad. While these groups of scientists may differ in time they first used email, all groups report not being able to access email for one week in the year prior to this study's survey, and the reasons given were consistent across groups, i.e., it was largely due to technical problems and marginally attributable to either financial problems or other constraints. This seems to suggest that the problem was more structural or organizational, and less of having to do with differences in training structure or differences in financial capacities.

To access email, the work place is the modal response category, while accessing email home comes second. This pattern of accessing email primarily at work and secondarily at home is consistent across all scientists regardless of their place of graduate education. It is interesting to note, however, that despite the absence of statistically significant differences in the access patterns, the majority of Philippine- trained scientists access email from work. This behavior may be attributed to the lower proportion of Philippine-trained scientists having computers at home, and with many of them having higher user-hardware ratio at home. In terms of receiving and sending email messages, again all four groups yield similar patterns such that most scientists receive between one to six messages and send between one and six messages in a typical week. Japanese-trained scientists, however, are slightly more likely to send email than Australian-, U.S.-, and Philippine-trained scientists. Of the four places of graduate education, Australian scientists have significantly higher rates of sending research-related email compared to other scientist groups. This could be due to the fact that Australian-trained scientists are heavy email users immediately after returning from Australia, as this is the means by which they continue communicating with their adviser as they work on finishing their dissertation.

Earlier I discussed extensive exposure to email which focused on the number of years using email, which was measured as first time to use email. Now, I focus on intensity of exposure to email. As to the number of hours using email in a typical week, Australian- (4.61) and Japanese-trained (4.10) scientists exhibit significantly more number of hours than those trained in the U.S (3.13) and the Philippines (2.92). In a way, Australian- and Japanese-trained scientists have more intensive use of email than their U.S.- and Philippine-trained colleagues. This observation could be due to the fact that Australian-trained scientists heavily maintain email contact with their graduate adviser immediately upon coming home to the Philippines, while Japanese-trained scientists may have imbibed the practice of frequent and affective interaction which is typical of the Japanese sense of community. The extent of email experience as measured by number of years using email is an indicator of a scientist's familiarity with the technology. Compared to Philippine-trained scientists, results show that foreign training in general translates to significantly more extensive use of email.

What activities have Philippine scientists done on email? Again, I answer this question by comparing scientists by place of graduate education. Australian-trained scientists are more likely to be members of science and technology discussion groups, while those trained in the U.S. and in the Philippines are the least likely to join these on-line discussion groups. However, there are no significant differences among these groups' rates in sending messages to on-line science and technology discussion groups.

The next three activities refer to email communication of respondents with scientists in locations outside the Los Baños and the Muñoz scientific communities. When I say outside, I mean the following: scientists in Philippine locations other than Los Baños and Muñoz, scientists in Asia excluding Philippine locations, scientists in developed countries like Australia, North America, and Western Europe. From Table 5.3, results indicate that a majority of scientists (73% for Australian-trained, 83% for Japanese-trained, 77% for U.S.-trained, and 78% for Philippine-trained) report having communicated with scientists in other Philippine locations through email. There are no indications of any drastic departure from the general pattern that the majority of respondents communicate with scientists in other Philippine locations.

On the matter of communicating with scientists in Asia excluding the Philippines, results show that majority of scientists in each group report communicating with scientists in Asia. The rate is particularly high for Japanese-trained scientists which is significantly different from rates for Australian-, U.S.-, and Philippine-trained scientists. A possible explanation for this behavior can be derived from my ethnographic interviews carried out in June-July 2004, wherein Japanese-trained scientists claim that Japanese professors (*sensei*) maintain strong ties with them even after graduation, a practice which is consistent with the tight knit and affective-oriented relationship which is consistent with the Japanese notion of community.

Communication between my respondents and other scientists in developed countries yields a pattern wherein Australian- (73.0%), Japanese- (60.0%), and U.S.- trained (60.0%) scientists communicate more in it than their locally trained colleagues (41%). These percentages further suggest that a majority of scientists in each of the foreign places of graduate education communicate with scientists in developed areas. Not only does foreign training translate to higher rates of communication with scientists in developed areas, but also the majority of scientists in each of the foreign-trained groups do so. Put another way, foreign training seem to predispose scientists to maintain communication with scientists in scientifically strong communities.

Starting a professional relationship with someone met on the Internet is a minority behavior, both within and across places of graduate education (Australian- [32%], Japanese- [36%], U.S.- [32.%], and Philippine-trained [31%]), and there are no significant differences in the behavioral patterns among the four places. In contrast, continuing and maintaining email communication with someone met personally is obviously a majority behavior, again both within places and across places (Australian- [89%], Japanese- [91%], U.S.- [72%], and Philippine-trained [77%]). Analysis indicates that there are significant differences in the behavioral patterns among the four places of graduate education. Australian- and Japanese- trained individuals have significantly higher rates than scientists trained in either the U.S. or the Philippines. This result may be attributable to the tight knit and affective relationship between Japanese professors and their students, and Australian students' need to communicate with their professors upon returning home, especially when there are revisions to be made in their dissertation manuscripts after the international review process. Using email to discuss research matters with funding agencies is a majority response of scientists trained at the core. The same solicits a minority response among locally trained scientists. These are substantiated by the results presented in Table 5.3, which indicate that foreign-trained scientists have significantly higher rates of discussing research with funding agencies than scientists trained locally. Presumably, advanced education at the core equips students with the attitude, proficiency, and skills that enable them to interact with officers from funding agencies, both locally and internationally. As regards the use of email in reviewing manuscripts for scientific journals or submitting manuscripts, only foreign-trained scientists exhibit this as a majority behavior, while Philippine-trained scientists do this as a minority behavior. It could be that those who are selected to review manuscripts are ones who possess foreign training as a result of their connections or experiences with others who occupy important positions in professional organizations.

Based on the foregoing discussion, it is obvious that there are significant differences among the four places of graduate education vis-à-vis utilization of email. More often than not, foreign education translates to better access, more intensive and extensive experience, and diverse email use. Nonetheless, this does not necessarily imply that training at the core (i.e., Australia, Japan, and the U.S.) leads to isomorphic email practices in scientific work. Neither does this imply that scientific communities and practices at the core can be accurately described as homogeneous. Nor do these pieces of evidence support the idea of a monolithic and universal form of knowledge production. Instead, the results from this section adduce evidence that supports more the contention of the extended translation and the socio-cultural practice view of science than the limited translation model science (or the rational and objective view of science) and world institutional theory. In other words, this section has shown that the nature of scientific training varies from one social system to another, and this variation impacts the practice and utilization of on-line scientific communication.

Web: Access and Use

In this section, I discuss another component of the Internet--the World Wide Web. The Internet is mainly used for two purposes: First, for synchronous (e.g., chatting and instant messaging) and asynchronous communication (e.g., email). Second, it is also a means for data and information search. I now delve into the Internet's functionality as a means for data and information retrieval for knowledge producers. I examine the web access and use behavior of Philippine scientists, and see how these intersect with place of graduate education. I analyze the effect of place of graduate education on web utilization **without any controls** by way of one-way analysis of variance, which is followed by a least-significant-difference test (LSD).

From Table 5.4, it is evident that 95.5% of respondent scientists report having used some form of web browser as of the time of survey. Disaggregated by place of graduate education, results indicate small differences among the four places of graduate education: Australian- (100%), Japanese- (100%), U.S.- (95%), and Philippine-trained (93%). These differences are not statistically significant. As to the last time these scientists browsed the web, 45.2% report having done so in the last 24 hours and 38.5% in the past week. However, it is observed that those who report having used the web in the last 24 hours is foreign trained, while those who reports having last used the web last week are Philippine trained. The difference in time of last use between foreign and locally trained scientists is significant.

As regards the year scientists first used the web, the average scientist reports sometime mid-1998, or about four years after Netscape launched its first browser. Those trained in Australia and Japan had used the web much earlier than either U.S.- or Philippine-trained scientists. These results, however, may be highly confounded with the effect of year of graduation, as most of the recent scientists have been trained in Australia and Japan, but those

Table 5.4: Mean Comparison of Philippine Scientists' Web Utilization

Respondent's (R's) Web Utilization	Place of Graduate Education: Australia (n=37) [1]	Japan (n=47) [2]	United States (n=60) [3]	Philippines (n=168) [4]	All Scientists (n=312)	LSD Pairwise Comparison[5]: 1-4	2-4	3-4	1-3	2-3	1-2
R ever used a web browser (1=yes, 0=no)	1.00	1.00	0.95	0.93	0.96						
Last time R browsed the web (ordinal)[1]	1.62	1.53	1.67	1.99	1.81	*	*	*			
First year R searched the web	1996.7	1996.7	1998.1	1999.4	1998.40	*	*	*	*	*	
Hrs in week R use web (ordinal)[2]	2.35	2.30	2.14	1.95	2.09	*	*				
Hrs in week R use web for job (ordinal)[2]	2.27	2.17	2.09	1.86	2.00	*	*				
R comfortable using the web (ordinal)[3]	1.14	1.21	1.51	1.33	1.32			*	*	*	
R ordered product or service on web (1=yes, 0=no)	0.49	0.47	0.30	0.25	0.32	*	*				
R created web page (1=yes, 0=no)	0.19	0.23	0.14	0.19	0.19						
R conducted an info search (1=yes, 0=no)	0.95	0.98	0.96	0.99	0.97						
R used an electronic journal (1=yes, 0=no)	0.84	0.87	0.72	0.69	0.74		*				
R acquired or used data (1=yes, 0=no)	0.92	0.94	0.88	0.90	0.90						
R collaborated on sci'fic project (1=yes, 0=no)	0.51	0.64	0.60	0.44	0.52		*	*			
R found reference materials (1=yes, 0=no)	0.95	0.96	1.00	0.95	0.96						
R accessed research reports (1=yes, 0=no)	0.95	1.00	0.96	0.97	0.97						
R part of online chat group (1=yes, 0=no)	0.22	0.19	0.18	0.19	0.19						
R used online job listings (1=yes, 0=no)	0.59	0.40	0.40	0.41	0.43						
R used online maps (1=yes, 0=no)	0.59	0.47	0.49	0.47	0.49						
R downloaded software (1=yes, 0=no)	0.62	0.77	0.70	0.54	0.61		*	*			
R published a paper (1=yes, 0=no)	0.19	0.43	0.35	0.16	0.24		*	*			*
Web use diversity index (0=min, 5=max)	2.65	3.17	2.67	2.07	2.43		*	*	*		
R influence of internet so far (ordinal)[4]	1.11	1.26	1.26	1.27	1.24						
R influence of internet in future (ordinal)[4]	1.08	1.21	1.21	1.20	1.19						
R's hours using web (interval)	5.58	4.65	4.37	3.60	4.14	*					
How web is freq accessed from home (days)?	108.05	86.15	105.04	44.13	69.68	*	*	*			
How web is freq accessed from work (days)?	124.19	154.47	121.25	126.95	130.00						
How web is freq accessed from public terminal (days)?	5.03	3.38	3.09	2.38	2.98						
How web is freq accessed from Internet café (days)?	22.30	9.91	12.93	11.12	12.60						
How web is freq accessed from friend (days)?	2.70	3.11	1.07	2.04	2.11						
No. of hours using web for job (interval)?	5.19	4.06	4.20	3.18	3.75						

* significant at the 5% level

[1] categories are 1=yesterday or today, 2=within the past week, 3=within the past month, 4=within the past 6 month, 5=longer than 6 months, 9=DK/NR

[2] categories are 0=not at all, 1=less than one hr, 2=between one to less than five hrs, 3=between five to less than ten hrs, 4=between ten to less than twenty hrs, 5=over twenty hours, 9=DK/NR

[3] categories are 1=very comfortable, 2=somewhat comfortable, 3=slightly comfortable, 4=not at all comfortable

[4] categories are 1=improved matters greatly, 2=improved matters somewhat, 3=has had no effect, 4=impaired matters somewhat, 5=impaired matters greatly, 9=DK/NR

[5] LSD means least significant difference test

trained in the U.S. are more of the older and earlier batch of scientists. In other words, the digital divide with respect to last use of web may be superficially attributed to differences in places of graduate education, but could well disappear in the presence of controls.

The majority of respondents (59.1%) use the web between one and five hours in a typical week. Using the midpoints of response categories, the average web use time is estimated at four hours in a typical week, about 45 minutes per day. Significant differences in web use time are detected among the four places of graduate education with Australian-trained scientists having the most number of hours (5.58 hours) and Philippine-trained scientists having the least (3.60 hours). The most popular places for web access are primarily at the workplace and secondarily at home. Web access from friends' place, cybercafé and/or Internet shops, and public terminals simply do not appeal to respondents.

Reasons given by my respondents are as follows: friends' Internet connections are typically private artifacts, which are typically located in bedrooms so that web browsing in a friends' place translates to "too much invasion of privacy," which Filipinos are not really comfortable with. With regards to cyber cafés or Internet shops, these places are typically populated by elementary and high school kids who heavily engage in on-line games. Playing per se is not incompatible with adults wanting to do research work, but it is the noise and raucousness of the place, which discourages scientists from doing work in these places**.**

Another reason given by one scientist is more of an "image problem," especially so when people associate Internet cafes with computer games and high-school students' haven. The unease and tinge of embarrassment come from something like a professor being misconstrued as still playing games instead of doing research work. As one University of the Philippines scientist puts it "I do not go to Internet shops because those are only for young people…I do not want to be seen in such places lest other people think that I am still into video games at this age." Public computers in libraries can be popular. However, public computers in libraries are simply a rarity in my study location. As another University of the Philippines professor said, "There are no public terminals in the main library."

What research-related activities have Philippine scientists done on the web? To answer this question, a series of items were presented to respondents which they were to answer with either a "yes" or a "no." Questions covered items pertaining to having ever ordered a product and/or service for research, created a web page and/or homepage, conducted an information search, used an electronic journal, acquired and/or used scientific data, found and examined reference materials, accessed research reports and/or scientific papers, participated in on-line chat groups, used on-line job listing, used on-line maps, downloaded any software, or published any research papers.

From Table 5.4, it is clear that ordering a product and/or service for research is a minority behavior (32.1%) among Philippine scientists. The minority behavior is similarly observed across places of graduate education, but Australian- (48.6%) and Japanese-trained (46.8%) scientists exhibit significantly higher rates compared to U.S.- (29.8%) and Philippine-trained (24.5%) scientists. Possible explanations for these results are as follows. For local orders, it is far more convenient and efficient to use landline phones. For international orders, it is very rare for scientists to personally initiate and transact orders with companies outside the country. Instead, scientists are more inclined to contact local distributors in the national capital region (Manila, Makati, Mandaluyong City, Parañaque City, Pasay City and Quezon City) or in other Philippine locations, which translates to cheaper merchandise, as purchase orders from various research entities are pooled to make bulk orders instead of an individual purchase order.

Having created a web page and/or a homepage is a minority behavior (18.7%), while having conducted an information search translates to a majority behavior (97.3%). For both of these on-line research-related activities, there are no significant differences among scientists trained in different places of graduate education. These results are more or less expected, given that these scientists typically have minimum training in programming in hyper-text markup language (HTML), which is an important skill in constructing web pages.

A majority (74.2%) of Philippine scientists reported having used an electronic journal. While a consistently majority behavior across places of graduate education (Australia, 83.8%; Japan, 87.2%; U.S., 71.2%; and Philippine, 69.0%) there are obvious differences in rates, with those trained in Japan having the significantly highest rate. As regards having ever acquired and/or used scientific data, a majority (90.3%) of Philippine scientists, regardless of place of graduate education, report having done so on-line. Again, these behaviors and estimated rates are consistent with my expectations. Philippine scientists report that it is much easier to acquire scientific data on-line than it is to access electronic journals on-line, which usually charge an access fee. Considering the exchange rate between the U.S. dollar and the Philippine peso (U.S.$ 1.00 = PHP 55.00), such access fees, considered minimal by developed world standards, are simply too expensive for the average scientist in the developing world, who earns the equivalent of roughly U.S. $455.00 per month in national currency unit for a typical family size of four.[15]

Much of the excitement about the diffusion of the Internet in the developing world is founded upon the expectation that it will revolutionize and globalize science by making peripheral scientists visible in the international scientific community through non-collocated interaction, on-line collaboration, and networking. From Table 5.4, it seems that there is reason

[15] Exchange rate from www.oanda.com

for excitement and optimism as a majority (51.5%) of respondent scientists report having collaborated on a scientific research project. Amidst these optimistic results, empirical evidence suggests that there is still much room for improvement. While a majority of Philippine scientists have collaborated on-line, collaboration rates significantly vary across place of graduate education with Japanese- (63.8%) and U.S.- (59.6%) trained having higher rates than Australian- (51.4%) and Philippine-trained (43.9%) scientists (Table 5.4). Philippine scientists more often than not collaborate with their professors in graduate school. The Japanese-training advantage mainly derives from the close and tight-knit bonds that develop between professors and their students during graduate training and long after students have graduated. From a cultural point of view, it is normal for Japanese professors to be mindful of their students both in the context of academic and personal life, so that in the long run academic relationships develop into strong ties and multiplexed with both affective and instrumental aspects. The affective aspects develop as a result of frequent and close interaction, while the instrumental aspects are founded upon a form of symbiotic relationship aimed at productivity in English-language scientific journals, wherein Japanese professors provide the symbolic and material resources for research production, while their Philippine students provide the non-material resources (time, labor, and English communication skills) needed for scientific knowledge production in the West.

The high rate of on-line collaboration between U.S. professors and Philippine scientists is also based on the strong ties and relationships the professors and students develop during graduate education. However, this is qualitatively different on average from the Japanese training scheme in that ties and relationships are basically instrumental in nature and less affective in nature. Despite the fundamentally instrumental relationship between U.S. and Philippine professors, what strengthens them may be largely due to the similarity in norms and culturally defined goals in American and Philippine culture, especially since Philippine economic, political, and social arrangements are patterned after America. The result that among the three foreign places of graduate education, those trained in Australia have the lowest rate of on-line collaboration with their professors is both expected and intuitive. In terms of cultural, social, economic and political arrangements, Australia will be the farthest among to three to Philippine configuration. This in itself can dampen to interaction among individuals as studies in social network theory have shown that homophily is an important consideration in durable and sustainable relationships. Put another way, the ties that develop between Australian professors and their Philippine students are at best described as instrumental and non-affective. Instrumental ties can be made durable and sustainable over time and over great distances if practices, expectations, and meaning systems are similar as in the case of U.S. professors and Philippine graduate students, but the same instrumental ties can be rendered tenuous and unsustainable in the long run and over great distances if practices, expectations, and meaning systems are very dissimilar, as in the case of Australian professors and Philippine graduate students.

Finding and examining reference materials and accessing research reports and/or scientific papers on-line are majority behavioral patterns, and this is true regardless of place of graduate education. In contrast, using an on-line job listing or an on-line map is a minority behavioral pattern. It is interesting to note that despite the many Filipino chat rooms in Yahoo®, participation in on-line chat groups are an extremely minority behavior among Philippine scientists. In the Philippines, the notion of a chat room conjures someone who is young and interested in meeting a special someone for more intimate and affectionate interaction. Filipino chat rooms, typically named with sexually oriented keywords, involve vulgar and sexually explicit language which is typically associated with the less educated and the masses of

Philippine society. In other words, claiming to be involved in chatting is seen as a negative label that hints at “being lonely,” “lonesome,” “having nothing to do,” “lazy,” and “desperate for love.”

Downloading software for research use is one of the excitements associated with the advent of the web in developing world science. Empirical evidence shows that this is a typically majority behavior for scientists trained abroad, but a minority behavior for scientists trained locally. On the other hand, publishing a paper on-line is quite a minority behavior as it entails many digital skills to publish on the web. Although a minority behavior, Japanese-trained scientists engage more on publishing on the web, while Philippine trained scientists are the least likely group of scientists to publish their work on the web.

Correlates of Email Access and Use

In this section, I explore the relationship between various aspects of scientists’ adoption of electronic communication and their contextual, personal, and professional characteristics. I focus mainly on the effect of **place of graduate education**. Because many of the activities on the Internet involve emailing rather than either searching or browsing (Castells 2000 and 2001), I delve into those aspects of Internet use pertaining to email access and use (i.e., current use, ready access, intensity, extent, and diversity of use). The results of my regression analysis are presented in Table 5.5. The analyses for **current use** and **ready access** employ binary logistic regression. Those for **intensity** (or number of hours in a typical week), **extent** (or years of use), and **diversity of use** employ an ordinary least squares regression.

Current Email Use

Of the variables in the model, it is clear the only level of education influences current email use. Most scientists who report current use have doctoral degrees. Contextual, personal,

Table 5.5: Correlates of Philippine Scientists' Email Utilization

Scientist Attributes	Email Utilization[1]				
	Current Use[2]	Ready Access[2]	Hours of Use[3]	Years of Use[3]	Diversity of Use[3]
Constant	41.50	2.24	3.65	9.58	2.15
Location (1=Los Baños, 0=Muñoz)	1.71	1.57 **	-0.60	2.15 ***	0.27
Sector (1=research institute, 0=state univ.)	1.60	2.31 **	-0.19	1.53 ***	0.43
Age (in years)	-0.13	-0.04	-0.02	-0.13 ***	-0.04 **
Gender (1=male, 0=female)	1.11	-0.50	0.65	0.06	0.39
Marital status (1=married, 0=not-married)	-17.97	-0.93	-0.67	-0.20	-0.05
Number of children	0.12	0.09	0.07	0.08	0.15
Computer in personal office (1=yes, 0=no)	1.48	0.76	0.72	0.61	0.28
No. of persons sharing computer	-0.05	0.00	-0.11	-0.04	-0.03
Member of professional organization (1=yes, 0=no)	-17.44	1.00	0.94	1.48	1.13 *
Have a Ph.D? (1=yes, 0=no)	2.36 *	1.12	0.23	0.55	1.33 ***
Australian trained (1=yes, 0=no)	17.48	19.14	1.28	3.23 ***	0.92 **
Japanese trained (1=yes, 0=no)	15.34	17.99	0.64	1.42 *	-0.25
United States trained (1=yes, 0=no)	17.06	1.81	0.01	2.61 ***	0.01
Coefficient of Determination (R-square)[4]	0.11	0.14	0.07	0.29	0.20

[1] Type I error rates are as follows: * for 5%, ** for 1%, and *** for 0.1% significance

[2] Binary logistic regression results

[3] Normal error (OLS) regression results

[4] R-square values for "ready access" and "current use" are calculated using Nagelkerke correction of the Cox and Snell technique.

and professional factors do not exhibit any significant effect on current email use. It seems that on issues regarding basic use or non-use, Philippine scientists have generally attained parity along important contextual, personal, and professional characteristics. The significant positive effect of level of education could be attributed to the more privileged status of doctorates as regards use of email compared to non-doctorates. It is interesting to note that the training background of scientists does not translate to any observed advantage or disadvantage. This could imply that as far as current use is concerned, scientists from different training structures do not exhibit any difference.

Ready Email Access

Ready access is mainly a contextual matter. Location and sector appear to be the only important correlates of ready access to email wherein those in Los Baños (b = 1.57) and those in research institutes (b = 2.31) have clear advantage. However, it should be noted that the effect of sector is stronger than the of location so that while scientists in Los Baños generally have the advantage in terms of ready access, this is additively enhanced among scientists who are in research institutes based in Los Baños. In other words, scientists working in research institutes located in Los Baños have the best opportunity to ready access, while those in state universities in Muñoz have the least opportunity.

As far as ready access is concerned, personal, professional, and educational factors do not exhibit any significant effects. The digital divide with respect to ready access appears not to be apparent along age, gender, and marital status, computer location, number of people sharing a computer, or level and place of graduate education. From these results, there appears to be an emerging pattern, i.e., the digital divide along access and use measured dichotomously seems to be disappearing and may be shifting to other aspects beyond simple access and use. Examples of these aspects are intensity, extent, and diversity, which are measured at a higher level of measurement and deal with more sophisticated aspects of use.

Intensity and Extent of Email Use

Intensity and extent of use provide an opportunity to explore the temporal dimension of email practice. Intuitively, intensive and extensive email use represents a behavioral pattern that is frequent, routine, and normalized. The regression analysis in Table 5.5 indicates that none of the independent variables affect intensity of email use, which is measured as the number of hours using email in a typical week. Frequency of use appears not to be associated with any of the contextual, personal, professional, and educational variables in the regression model. However, it is not clear whether this is a case of parity being achieved by scientists in the different categories, a case of unreliable measurement, or a case of inadequate variability in responses.

In contrast, extent of use is strongly configured by differences in location, sector, age, and place of graduate education. Scientists in Los Baños in research institutes, who are younger and who have foreign-trained, are associated with extensive use of email. Although foreign training generally exhibits more extensive email use than local graduates, the regression coefficients indicate the effects of each of these foreign training structures are far from uniform. Australian-trained scientists report the most extensive use, while Japanese-trained scientists report the least. This result corroborates the claim of Australian graduates that immediately after arriving from Australia, they see themselves immersed in a deluge of email exchanges with their advisers regarding the comments of international reviewers on their thesis or dissertation.

Diversity of Email Use

It is clear from Table 5.5 that diversity of email use is independent of contextual differences. This is evident from the non-significant coefficients for location and sector.

Although personal, professional, and educational factors clearly influence diversity of use, they occur along specific indicators. For personal factors, age is negatively associated with diversity. Younger people tend to use email in diverse ways. For professional factors, membership in professional organizations means using email in diverse ways. And for educational factors, having a Ph.D. and having trained in Australia both lead to diverse email practices; Japanese-, U.S.-, and Philippine-trained scientists report basically similar levels of diversity.

Evidently, much of the digital inequality in the utilization of email occurs at more advanced levels of use. Extent and diversity of use seem to be the emerging dimensions of the digital divide, and that much of the inequality appears to stem from differences in levels and places of graduate education. It appears certain that the digital divide is shifting from simple distinction of use and non-use, and access and non-access to advanced levels consisting of extent and diversity of use. In much of this new form and level of digital inequality, level and place of graduate education seem to be the emerging bases for inequality.

Correlates of Web Access and Use

While most of the activities on the Internet involve communication through chat-rooms, email, and instant messaging, the Internet is also important as an information resource and search facility. When I say "information," I mean scientific information in the form of on-line data, e-journals, and on-line scientific reports and papers. The availability of scientific information and data on the net can be construed as an emerging realization of the Mertonian notion of communalism, which is one of the norms of the scientific community. In a way, the invention of the World Wide Web may have the high potential to communalize, universalize and globalize science across among relevant scientific research communities in both developed and developing contexts.

In this section, I explore those contextual, personal, and professional factors that correlate with web access and use--in others words, web use behavior. The notion of web use is conceptualized as having aspects pertaining to access and use. The aspect of Web access generally describes users as having ever accessed the web regardless of temporal frequency and exposure, or contextual considerations. Web use, on the other hand, is further partitioned into intensity, extent, and diversity of use (Castells 2001; Ynalvez et al. 2005). Similar to the measurement strategy used for email access and use, the notions of intensity and extent of use are applied. The notion of diversity of use (Castells 2001) refers to the different activities and practices that go with web use as applied to scientific research. In the effort to link contextual, personal, professional, and educational factors with web use variables, I employ a set of logistic and normal error regression analyses.

<u>Web Access</u>

Table 5.6 presents regression results for web use and access on contextual, personal, professional, and educational characteristics of Philippine scientists. In terms of having ever used a web browser, contextual factors do not have any significant effect at the 5% level. In other words, contrary to expectation there is no marked distinction between scientists in the research and academic sector, and between scientists based in Los Baños and in Muñoz. With much of the material and financial resources, as well as human resource development programs, needed for research channeled primarily to research institutes, it seems counter intuitive that no difference in the general population of scientists is apparent along the lines of sector and location.

In terms of personal characteristics of scientists, age (b = -0.24) and gender (b = -2.08) have significant effects on ever having used a web browser. Younger and female scientists are

Table 5.6: Correlates of Philippine Scientists' Web Utilization

Scientist Attributes	Web Utilization[1]			
	Ever Used[2]	Hours of Use[3]	Years of Use[3]	Diversity of Use[3]
Constant	12.36 **	2.10	10.43 ***	2.75 ***
Location (1=Los Baños, 0=Muñoz)	1.53	-0.11	0.74	-0.21
Sector (1=research institute, 0=state univ.)	1.01	0.47	1.43 ***	0.27
Age (in years)	-0.24 **	-0.01	-0.13 ***	-0.05 ***
Gender (1=male, 0=female)	-2.08 *	0.79	0.50	0.11
Marital status (1=married, 0=not-married)	-2.16	-0.01	-0.25	-0.03
Number of children	0.34	0.17	0.15	0.09
Computer in personal office (1=yes, 0=no)	1.27	1.22 *	0.51	0.09
No. of persons sharing computer	0.03	0.00	-0.06	0.00
Member of professional organization (1=yes, 0=no)	2.96 *	1.29	-0.47	1.09 **
Have a Ph.D? (1=yes, 0=no)	1.56	-0.67	1.19 *	0.55 **
Australian trained (1=yes, 0=no)	18.52	1.96 *	2.35 ***	0.64 *
Japanese trained (1=yes, 0=no)	16.63	0.84	1.31 *	0.64 *
United States trained (1=yes, 0=no)	1.69	0.69	1.32 *	0.62 **
Coefficient of determination (R-square)[4]	0.47	0.07	0.23	0.19

[1] Type I error rates are as follows: * for 5%, ** for 1%, and *** for 0.1% significance

[2] Binary logistic regression results

[3] Normal error (OLS) regression results

[4] R-square value for "ever used" is calculated using Nagelkerke correction of the Cox and Snell technique.

more likely to have ever used the web compared to older and male scientists. In a way, it can be said that age and gender are significant dimensions of the digital divide as defined by having ever accessed a web browser. Personal characteristics, like being married and having children, do not translate to any obvious significant effect on web access. With regard to scientists' professional attributes, being a member of a professional organization is positively linked with the likelihood of having ever used a web browser. However, the number of persons sharing a work computer and the location of computers do not affect the likelihood of web access. Level and place of graduate education also do not affect web access. Age, gender, and membership matter when it comes to having ever used a web browser or not. Specifically, being young, female, and a member of professional organizations is more likely to have ever accessed a web browser. No significant effects are detected for level and place of graduate education.

Intensity of Web Use

Regression results for number of hours in a typical week spent using the webs are also presented in Table 5.6. Scientist contextual and personal attributes exhibit no significant effects. Digital inequality with respect to web use time seems insensitive to differences in location, sector, age, gender, marital status, and number of children. Among professional factors, only location of computer (b = 1.22) turns out to be significant: scientists with computers in their personal offices report more hours using the web in a typical week. Probably, the architectural privacy provided by the personal office may have something to do in the increase in time spent using the web, which makes sense and is intuitive. The number of people sharing a work computer and membership in professional organizations are not at all significant. These results may appear counter intuitive, but if time spent in a typical week is already too short to begin with, then there is not much variation to expect.

As regards to educational characteristics, level of education does not matter but place of education does. Specifically, Australian-trained scientists spend more time using the web than any other group of scientists. Japanese-, U.S.-, and Philippine-trained knowledge producers do not exhibit any significant differences in web time. The analysis' inability to detect differences between Japanese- and Philippine-trained, and U.S. and Philippine-trained scientists are surprising. However, this could also mean that foreign training, even among core countries[16], does not necessarily produce isomorphic techno-scientific social structures. The differences could well be attributable to the varying styles of training, or could also be due to the differences in each of these training systems' emphasis on using web-based resources.

Extent of Web Use

While intensity of use mainly refers to the degree to which the web is integrated into an individual's daily routine, extent of use primarily refers to the time period that an individual has interacted with the web, which would allow that individual to be comfortable and at ease with the various functionalities of the web. Intensity is more akin to frequency of use, while extent is nearer to the notion of prolonged interaction which translates into experience. In this study, I empirically defined extent of web use by the number years since a scientist first browsed the web.

From Table 5.6, it is clear that differences in sector matters, but not location. Scientists in government research institutes have about one and half years (b = 1.43) more experience in web browsing than their counterparts in state universities, which is expected given the priority of the national government on the applied research system's computerization and connectivity. On the other hand, there is no substantial difference in web use experience between scientists based in Los Baños and those in Muñoz.

[16] Refers to Australia, Japan, and the United States.

If computers were available to research sector scientists and academic sectors scientists at almost the same time, then one possible explanation for the observed difference in years of experience could be when these computers where actually connected to the Internet. An alternative explanation is reminiscent of urban bias theory, wherein research sector scientists have more opportunities to receive training on the latest innovations than their counterparts in academe owing to the research-sector bias in developing areas as a result of limited and scarce resources being allocated to real-world problems rather than to the advancement and development of theoretical knowledge. For example, my on-site visit to the Philippine Carabao Center, the Philippine Rice Research Institute, and the Bureau of Post Harvest Research and Extension in Muñoz revealed that scientists in government research institutes have far better computers (laptops, latest versions of Microsoft Windows, branded computers) and high band-width Internet connections. Computers in various colleges at the University of the Philippines at Los Baños and the Central Luzon State University in Muñoz were simply not comparable with those in government research institutes. Computers were old, slow, and were typically without connectivity.

Among the personal factors, age was a significant determinant of web use experience such that younger scientists had more extensive experience with the various facilities of the web. Gender, marital status, and number of children do not have any effect on the extent of web use. It is also obvious from the results from Table 5.6 that the number of persons sharing a work computer and whether scientists have computers in their private offices or membership in professional organizations do not determine variability in web use experience. However, education in general configures the extent of experience in such a way that scientists who have doctorates have about one year (b = 1.19) more experience than those who do not have doctoral degrees. Likewise, foreign training in general translates to higher levels of web use experience, with Australian-trained scientists having about two and half years more experience than Philippine-trained scientists. Japanese- and U.S.-trained scientists have both about 1.3 years more experience than locally trained scientists. Hence, level and place of graduate education are significant determinants of web use experience.

From a digital divide point of view, it is clear from these results that inequality in education is a significant dimension for digital inequality. These outcomes also suggest that while there is a general enhancing effect of foreign training, practices and styles derived from training at the core may not be as isomorphic as institutional theory and the limited translation model of science would have us think. While there are many similarities among the scientific training structure among the core countries, there are also many differences among them. Although this assertion is based on the assumption that scientists trained in Australia, Japan, and the United States can be said to be equivalent and comparable samples, still this assumption can be taken as acceptable and valid.

Web Use Diversity

The last column of Table 5.6 contains the regression results for web use diversity. Web use diversity is a summated index consisting of five dichotomous statements that cover all the research-related activities that scientists have ever done on the web. The web use diversity index includes items on (1) ordering a product and/or service for research, (2) using an electronic journal, (3) collaborating on a scientific project, (4) downloading any software for research, and (5) publishing/posting scientific papers on the web. The selection of these items from a list of 13 web activities was made on the basis of their empirical distribution. Those which where more of less balanced between “yes” and “no” responses were selected, while those which were mainly skewed in favor of either "yes" or "no" were excluded. As a variable, web use diversity ranges from zero to five, in which a zero means no web activities and a five is indicative of maximal diversity of activities done on the web. Mean web use diversity for the full sample is 2.43, with a standard deviation of 1.42. There is no evidence that the empirical distribution of the web use diversity index significantly deviates from the normal curve.

The coefficient of determination, R^2, for the regression model is 0.192 meaning that 19.2% of the variation in web use diversity can be explained by the model (Table 5.6). By implication, this also means that there is yet a substantial amount of variation in web use diversity that needs to be explained. However, it should be noted despite the low R^2, the model is itself statistically significant, indicating a meaningful relationship between web use diversity and the set of significant independent variables. Based on Table 5.6, it is clear that contextual factors as measured by location and sector do not exhibit any significant effect on web use diversity. This means that diversity of use is not in any way structured by either differences in location or differences in sector. Of the personal factors, only age had a significant effect such that younger scientists use the web in more diverse ways than older scientists. Gender, marital status, and number of children have no effect on web use diversity. Of the professional factors, only membership in professional organizations exhibits a significant effect. Scientists who hold membership in professional organizations have significantly more diverse use of web facilities.

Indeed, neither number of persons sharing a work PC nor having computers in personal offices matters in configuring diversity of web use. In contrast, both level and place of graduate education significantly enhances web use diversity. Scientists with doctoral degrees exhibit more diversity in using the web than scientists who only hold a master's degree. Foreign education yields higher levels of diversity in web use as compared to those scientists who were trained in Philippine graduate schools. It appears that the digital divide along diversity of web use is sensitive to differential levels in education and to places of graduate education, implying that education is an important dimension in digital inequality. It is also obvious that at more advanced forms of hardware-software-user interaction, the Australian, Japanese, and U.S. training systems seem to form an isomorphic system.

Based on the regression results for web use diversity, it is clear that younger scientists who are members of professional organizations, those with doctorates, and those who were trained abroad translates to more diverse use of the web. Location, sector, gender, marital status, number of children, number of people sharing a computer, and whether or not work computers are located in personal offices do not affect web use diversity. It is noteworthy that even among scientific knowledge producers who already have advanced education, differences in their level and place of graduate education further serve as bases for digital inequality. **These results imply that the digital divide could be shifting from simple access and use to more advanced issues of hardware-software-user interaction where actors who possess higher level and quality of human capital tend to have the upper hand**. Also, at advanced levels of hardware-software-user interaction, there seems to be convergence among the foreign places of graduate education with respect to information search in and information acquisition from the Internet.

CHAPTER 6: PROFESSIONAL NETWORKS

Introduction

Much of the excitement about the advent of new ICTs emanates from their perceived potential for local integration to and universal participation of knowledge producers from both the developed and developing world in international science, and the global interaction and information exchange among scientists working in different contexts, locations, and time zones. In a way, the potential of ICTs to facilitate interaction and exchange among non-collocated scientists with high-quality data transmission with almost zero time-lag seems to have made the "utopian" norm of communalism and universalism in scientific knowledge production attainable and within reach.

In this chapter, I delve into the professional network of Philippine scientists. I begin the chapter by discussing the concept of **social network** as it relates to the generation and production of scientific knowledge. I then go on to describe the characteristics of the professional network of Philippine scientists. In addition, I explore the relationship between scientists' contextual, personal, professional, and educational characteristics and their professional network. Toward the end, I examine how aspects of Internet use in general, and aspects of email utilization in particular, configure professional network structure after contextual, personal, professional, and educational factors are controlled for.

Earlier, I mentioned that the concept of networks occupies a central role in this study. From a science and technology studies perspective, new ICTs are viewed as an "essential tool" in knowledge production mainly because they have the potential to facilitate interaction, networking, and information exchange among non-collocated knowledge producers. Instead of adhering to either one or the other, I take the middle ground between the "elixir" and the “affliction” argument. In other words, the expansion of new ICTs into the research systems of the developing world will have both positive and negative implications depending on the places, contexts, and identities. From the sociology of science perspective, earlier discussed in the literature review, the extended translation view of science (Callon 1995) frames the nature and dynamics of science in contemporary society as a translation network consisting of human and non-human actors.

From a contemporary sociology of international development standpoint, the global system perspective with a more “situated” emphasis talks about transnational networks of science actors, or knowledge producers. Indeed, the study of the actual and the potential impacts of new ICTs on the nature and dynamics of science at the global periphery is essentially the study of the social networks of actors involved in knowledge production. In consideration of the convergence and integration of the various concepts and principles from different perspectives, a hybrid notion of social network is in order. I talk about a **transnational socio-technical network** that consists of an interrelated system of ties between a focal actor (or ego) and the people to whom this actor is connected (or alters), wherein ties are configured not only by an actor’s position in the social structure, but also by the technology needed to facilitate interaction and exchange.

In other words, I do not limit the structure of networks to social aspects alone, but also to include those that pertain to the technical aspects as well. Hence, in the empirical analysis of the professional network of Philippine scientists, I delve into the contextual, personal, educational, and technical circumstances, and the situation of egos and how these factors configure the constellation of their core alters. In exploring and characterizing this constellation of alters, I deconstruct the concept of professional network into its fundamental components, namely: range of compositional quantity and quality, heterogeneity, multiplexity, and homophily (Schott 1993, Shrum and Beggs 1997).

Characterization of Scientists' Professional Network

The name generator used in my survey solicited the names of up to a maximum of 12 alters, or contacts.[17] Information about alters' gender, location, and means of contact were also obtained for all n = 312 respondents, which may also be called egos. From Tables 6.1a and 6.1b, the frequency distribution for total number of contacts, or network size, seems not to be exactly normally distributed in the sense that it has a thicker right and a thinner left tail. The bulk of the distribution lies within the range of two to five alters, inclusive. The distribution's centrality estimates are as follows: mode, 3.0; median, 4.0; and mean, 5.2. Responses range from absolutely no professional contact at all to having as many as 12 contacts. Further examination of the frequency distribution indicates that 3.2% of respondents have no contacts at all and thus are considered isolates. At the opposite end, 7.6% have 12 contacts, the maximum number of alters solicited by the survey questionnaire name generator. Standard deviation is 3.25, which implies that about 68% of the population responses are between 2.00 to 8.00 alters. These estimates are indicative of a slightly positively skewed distribution, but do not represent a drastic departure from the normal curve when generalized to the population level. Hence, it can be safely assumed that the empirical distribution of network size follows the theoretical normal distribution.

Classifying alters as either foreign or domestic reveals certain gaps in the notion of science as a universal and communal activity. Almost half (48.3%) of Philippine scientists have no foreign contacts at all, meaning that scholarly interaction and intellectual exchange of ideas

[17] As mentioned earlier, in this research a name generator refers to a set of questions, which elicits from respondents names of people whom they consider important in their research work and professional career (see Appendix B).

Table 6.1a: Professional Network Profile of Philippine Scientists

Professional Network Characteristics	Mean	Median	Mode	SD	Skew[1]	Mim	Max	Percentiles		
								25	50	75
No. of Contacts	5.21	4.00	3.00	3.25	0.65	0.00	12.00	3.00	4.00	7.00
No. of Male Contacts	3.32	3.00	2.00	2.67	0.90	0.00	11.00	1.00	3.00	5.00
No. of Female Contacts	1.89	2.00	0.00	1.82	1.34	0.00	10.00	0.00	2.00	3.00
Prop. of Male Contacts	0.62	0.67	1.00	0.32	-0.54	0.00	1.00	0.40	0.67	0.90
Gender Diversity	0.54	0.75	0.00	0.41	-0.37	0.00	1.00	0.00	0.75	0.89
Gender Heterophily	0.35	0.33	0.00	0.31	0.44	0.00	1.00	0.00	0.33	0.61
Prop. of Contacts on Site[2]	0.36	0.33	0.00	0.33	0.47	0.00	1.00	0.00	0.33	0.60
Prop. of Contacts in Philippines	0.42	0.40	0.00	0.34	0.24	0.00	1.00	0.00	0.40	0.67
Prop. of Contacts in Australia	0.04	0.00	0.00	0.12	4.05	0.00	1.00	0.00	0.00	0.00
Prop. of Contacts in Japan	0.05	0.00	0.00	0.14	3.72	0.00	1.00	0.00	0.00	0.00
Prop. of Contacts in the U.S.	0.04	0.00	0.00	0.12	4.12	0.00	1.00	0.00	0.00	0.00
Prop. of Contacts in Other Sites[3]	0.09	0.00	0.00	0.17	2.30	0.00	1.00	0.00	0.00	0.17
Prop. of Contacts at the Core	0.13	0.00	0.00	0.21	1.84	0.00	1.00	0.00	0.00	0.22
Prop. of Foreign Contacts	0.22	0.13	0.00	0.28	1.21	0.00	1.00	0.00	0.13	0.39
Location Diversity (all sites)[4]	0.46	0.53	0.00	0.29	-0.57	0.00	0.98	0.29	0.53	0.61
Location Diversity (Domestic;Foreign)[5]	0.39	0.00	0.00	0.42	0.30	0.00	1.00	0.00	0.00	0.89
Prop. Contacted thru Face-to-Face	0.71	0.83	1.00	0.33	-0.94	0.00	1.13	0.50	0.83	1.00
Prop. Contacted thru Land Line Phone	0.53	0.57	0.00	0.37	-0.18	0.00	1.13	0.17	0.57	0.86
Prop. Contacted thru Fax	0.16	0.00	0.00	0.29	1.82	0.00	1.00	0.00	0.00	0.25
Prop. Contacted thru Letters	0.14	0.00	0.00	0.25	1.87	0.00	1.00	0.00	0.00	0.25
Prop. Contacted thru Email	0.47	0.50	0.00	0.38	0.12	0.00	1.33	0.00	0.50	0.83
Prop. Contacted thru Mobile Phone	0.51	0.50	0.00	0.37	-0.12	0.00	1.13	0.17	0.50	0.83
Multiplexity for Means of Contact	1.14	0.83	0.50	0.92	1.56	0.00	5.42	0.50	0.83	1.58

[1] measures the extent and direction of asymmetry. A symmetric distribution such as the Gaussian curve (or the normal distribution) has a skewness of 0, and a distribution that is skewed to the left, e.g. when the mean is less than the median, has a negative skewness. A distribution that is skewed to the right, e.g. when the mean is greater than the median, has a positive skewness.

[2] On site refers to contacts who are based on the survey sites

[3] Other sites refers to all other sites excluding sites in Australia, Japan, the United States, and the Philippines

[4] Index of qualitative variation (IQV) is based on the categories on-site, in other Philippine locations, Australia, Japan, the United States, and other foregin sites

[5] Index of qualitative variation (IQV) is based on two categories, namely domestic and foreign

Table 6.1b: Frequency Distribution of Philippine Scientists' Number of Contacts (Network Size)

No. of Contacts[1]	Frequency	Percent (%)	Cumulative Percentage
0	10	3.2	3.2
1	19	6.0	9.2
2	32	10.2	19.4
3	58	18.4	37.8
4	41	13.0	50.8
5	34	10.8	61.6
6	31	9.8	71.4
7	13	4.1	75.6
8	18	5.7	81.3
9	19	6.0	87.3
10	7	2.2	89.5
11	9	2.9	92.4
12	24	7.6	100.0
Total[2]	315	100	100

[1] The survey questionnaire's name generator solicited up to a maximum of 12 names only

[2] When cross-tabulated with place of graduate education, effective sample size reduces to 312.

are mainly through a form of "domestic in-breeding." Clearly, there still is substantial exclusion of Philippine knowledge producers from the global scientific community. Optimistic expectation suggests that ICTs and the Internet are expected to diminish this excluded population of knowledge producers in the long run, if not in the short run. In contemporary global society with its embedded social institutions, it appears that science as an institution should also rapidly transmute into a global system and process if it is to generate and produce knowledge that has utility to global society. As it is right now, especially in developing areas like Ghana, India, Kenya, and the Philippines, the impact of ICTs and the Internet on science communication seem to be have been delayed and impeded by factors associated with place, context, and identities.

Further classifying alters as either from the core or not, 64.1% have no contacts at the scientific core. Put another way, a majority of Philippine scientists have no contacts in research institutes and universities in Australia, Japan, or the U.S. While this situation does not directly or indirectly mean that this is a disadvantage or an advantage for the Philippine science research system, this represents more lost opportunities for scholarly interaction and intellectual exchange among scientists. Indeed, these summary statistics vividly suggest that a large segment of Philippine scientists is still unable to participate in global science, which is a dismal situation given that science per se claims universal participation and communal sharing of knowledge. I am in no way suggesting that this is only disadvantageous to developing-world scientists. What I am pointing at is that the exclusion of other places, contexts, and identities--be it developed or developing world research systems--is generally a disservice to and dysfunction for science itself, as it alludes to the fact that there is still a lot about this earth that we do not know about as a result of the non-interaction among science actors in various contexts. New ICTs and Internet are eagerly anticipated to fill this communication and interaction gap among these scientists.

Table 6.2 presents the professional network characteristics of Philippine scientists disaggregated by place of graduate education. With reference to Table 6.2, Philippine scientists report having about five contacts (5.21) on average, which could fluctuate from two to eight contacts on average. Fluctuations in the mean number of contacts across places of graduate education are not significant at the 5% level. In terms of the average gender distribution of alters, the majority (3.32) are men and a minority (1.89) are females, which depicts a network structure that is male dominated. Based on the average male and female counts, this pattern of a male-dominated network structure is consistent across places of graduate education with no significant differences among training structures. Based on proportions, 62% of contacts are male, consistently alluding to a male-dominated network structure. Although this pattern holds true across places of graduate education, rates are significantly higher for Japanese- (74%) and U.S.- (70%) trained scientists as compared to Australian- (65%) and Philippine- (54%) graduates.

As mentioned earlier, Japan and U.S. graduates have significantly higher proportions of male contacts registering seven in ten; with Australia and Philippine graduates registering six in ten, and five in ten, respectively. In terms of gender diversity and gender heterophily, scientists spins toward mediocrity in terms of diversity (0.54), and slightly toward homophily (0.35). There are no significant differences across places of graduate education for both gender diversity and gender homophily. Scientists tend to have more contacts with the same gender as the respondents themselves, and because male respondents make up the majority of the sample, it is expected that the proportion of male alters is larger than the proportion of female alters.

On the face of it, these results corroborate the assertions of Hurlbert et al. (2000) that homophilous ties are most likely to reside in a focal actor's core network. What is interesting is

Table 6.2: Mean Comparison of Philippine Scientists' of Professional Network Characteristics

Professional Network Characteristics	Place of Graduate Education: Australia (n=37)		Japan (n=47)		United States (n=60)		Philippines (n=168)		All Scientists (n=312)		LSD Pairwise Comparison [1]					
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD						
	[1]		[2]		[3]		[4]				1-4	2-4	3-4	1-3	2-3	1-2
No. of Contacts	4.97	3.28	5.23	2.93	5.33	3.19	5.18	3.37	5.21	3.25						
No. of Male Contacts	3.22	2.30	3.68	2.34	3.77	2.78	3.08	2.80	3.32	2.67						
No. of Female Contacts	1.76	1.77	1.55	1.98	1.57	1.51	2.10	1.84	1.89	1.82						
Prop. of Male Contacts	0.65	0.29	0.74	0.28	0.70	0.29	0.54	0.33	0.62	0.32		*	*			
Gender Diversity	0.59	0.43	0.46	0.38	0.52	0.41	0.55	0.42	0.54	0.41						
Gender Heterophily	0.42	0.31	0.31	0.32	0.30	0.29	0.37	0.31	0.35	0.31						
Prop. of Contacts on Site[2]	0.31	0.34	0.28	0.26	0.33	0.30	0.41	0.35	0.36	0.33						
Prop. of Contacts in Philippines	0.32	0.33	0.37	0.34	0.37	0.31	0.47	0.34	0.42	0.34	*		*			
Prop. of Contacts in Australia	0.18	0.25	0.01	0.04	0.04	0.11	0.02	0.07	0.04	0.12	*			*		*
Prop. of Contacts in Japan	0.01	0.05	0.23	0.25	0.03	0.08	0.02	0.06	0.05	0.14		*			*	*
Prop. of Contacts in the U.S.	0.02	0.07	0.03	0.11	0.12	0.21	0.02	0.07	0.04	0.12			*	*	*	
Prop. of Contacts in Other Sites[3]	0.17	0.26	0.07	0.14	0.12	0.19	0.07	0.14	0.09	0.17	*		*			*
Prop. of Contacts at the Core	0.20	0.25	0.27	0.27	0.18	0.23	0.05	0.13	0.13	0.21	*	*	*		*	
Prop. of Foreign Contacts	0.37	0.34	0.35	0.32	0.30	0.28	0.12	0.19	0.22	0.27	*	*	*			
Location Diversity (all sites)[4]	0.47	0.27	0.54	0.25	0.54	0.24	0.40	0.30	0.46	0.29		*	*			
Location Diversity (Domestic;Foreign)[5]	0.49	0.42	0.50	0.42	0.53	0.45	0.28	0.39	0.39	0.42	*	*	*			
Prop. Contacted thru Face-to-Face	0.61	0.36	0.61	0.35	0.63	0.39	0.79	0.28	0.71	0.33	*	*	*			
Prop. Contacted thru Land Line Phone	0.35	0.34	0.40	0.38	0.46	0.35	0.63	0.35	0.53	0.37	*	*	*			
Prop. Contacted thru Fax	0.17	0.32	0.14	0.31	0.15	0.30	0.16	0.27	0.16	0.29						
Prop. Contacted thru Letters	0.17	0.28	0.19	0.31	0.08	0.19	0.15	0.24	0.14	0.25						
Prop. Contacted thru Email	0.58	0.41	0.54	0.39	0.50	0.36	0.41	0.37	0.47	0.38	*	*				
Prop. Contacted thru Mobile Phone	0.40	0.37	0.47	0.36	0.36	0.36	0.60	0.34	0.51	0.37	*	*	*			
Multiplexity for Means of Contact	0.97	0.85	1.09	0.90	1.00	0.71	1.24	0.99	1.14	0.92						

* significant at the 5% level; ns - not significant at the 5% level

[1] LSD means least significant difference test

[2] On site refers to contacts who are based on the survey sites, namely Los Baños and Muñoz.

[3] Other sites refers to all other sites excluding sites in Australia, Japan, the United States, and the Philippines

[4] Index of qualitative variation (IQV) is based on the categories on-site, in other Philippine locations, Australia, Japan, the United States, and other foreign sites

[5] Index of qualitative variation (IQV) is based on two categories, namely domestic and foreign

that the conclusion of Hurlbert et al. (2000) was derived from a population of household members in the southern region of the United States, which is very different from the population of developing world knowledge producers. I had initially expected these two populations to behave differently as a result of their differences in scientific training. Also, the higher proportion of male contacts, especially among foreign graduates, should not be taken as being inconsistent with the slight tendency toward homophily, especially when a majority of those who are trained abroad are male scientists.

In terms of the location base of alters, about 36% of alters are in the same location as ego. This means that about three to four out of ten close contacts are located in the same survey locations as the respondent scientist. Results of a least-significant-difference t-test, after analysis of variance, indicate that this estimate of on-site contacts is consistent across places of graduate education, as there are no significant differences at the 5% level of significance. Excluding on-site contacts, other contacts were distributed in other sites as follows: other Philippine sites, 42%; Australia, 4%; Japan, 5%; United States, 4%; and other foreign sites, 9%. Put another way, on average 78% of close contacts reside within the Philippines, while 22% are outside the country.

Indeed, respondents tend to communicate and interact closely with other scientists within the Philippines. Having close professional contacts residing outside the Philippines is still a minority behavior. By implication and consistent with discussions in the preceding paragraphs, Philippine knowledge producers are still generally locally oriented and still have a long way to go in attaining full participation in the global scientific community. The question that emerges from these results is: Will the introduction of ICTs in Philippine scientific research systems change this mix of location-based contacts? I will attempt to provide an answer to this question when I touch on the topic of ICTs and professional network structure later in this chapter.

A detailed examination of the descriptive statistics in Table 6.2 reveals an interesting network configuration based on location. The plurality of contacts for Philippine scientists in general are neither located on-site nor in foreign sites. Instead, they are located in other Philippine sites. Meaning not in the immediate environment but in some other domestic locations and their rates are as follows: Australian-trained, 32%; Japanese-trained, 37%, U.S.-trained, 37%, Philippine-trained, 47%; full sample, 42%. Another observation is that the majority of contacts of Philippine scientists in general are domestic. And, if ever scientists report having foreign contacts, the largest portion of these foreign contacts will be from sites where Philippine scientists obtained their foreign degrees. To illustrate these findings, let me point you to the columns in Table 6.2 pertaining to Australian-, Japanese-, U.S.- and Philippine-trained scientists. In the case of Australian-trained Filipino scientists, 63% of contacts are from the Philippines, 18% in Australia, 1% in Japan, 2% in the U.S., and 17% in other foreign sites. In the case of Japan graduates, 65% are in the Philippines, 1% in Australia, 23% in Japan, 3% in the U.S., and 7% in other foreign locations. In the case of U.S. graduates, 70% are in the Philippines, 4% in Australia, 3% in Japan, 12% in the U.S., and 12% in other sites. And finally, in the case of Philippine graduates, 88% of contacts are in the Philippines, 2% in Australia, 2% in Japan, 2% in the U.S., and 7% in other foreign sites.

In addition, the proportion of contacts at the core, and in foreign sites in general suggests that training at the scientific core yield significantly higher rates than training locally. Philippine-trained scientists have lower proportions of core and foreign contacts. All these empirical findings are consistent with expectation and lend support to the assertion of the socio-cultural practice, and extended translation view of science that there are differences among scientific cultures. It is clear from these basic statistics pertaining to location base of alters that scientific training in different locations generates differences in professional network structure. In a way, these pieces of evidence suggest that training in different scientific communities produces differences in scientific practices in networking. For example, differences between foreign- and domestically-trained scientists with respect to the proportion of contacts alludes to and implies a cognitive response by scientists when trained and embedded in a particular scientific, social, and cultural system. Somehow these findings show that scientists not only learn explicit and codified knowledge when they are trained in other places, they also learn tacit knowledge and skills as they interact with identities of a place. Examples of which are a particular location's oral and written communication skills that enable them to establish and foster strong informal relationships (e.g., acquaintances and friendships) with their professors and classmates long after their graduation and return to the Philippines.

Definitely, there seems to be promising evidence that international scientific training in general results in a significantly higher number of foreign contacts when compared to local training and seems mainly a result of the social interaction between Philippine and foreign scientists. A personal example relates to my own training experience here in the United States. During my first few months in the United States, professors, classmates and friends said that I spoke good English but somehow it still sounded strange to them--how I used words, how I pronounced words. At that time, I was sure that if I ever submitted a manuscript to a journal it would be immediately rejected as I still did not have the skills to write in the way Americans express themselves in formal discourse. Over the years that followed, however, I realized that my skills and proficiency in the American way of saying things improved which made me a lot more understandable to professors, classmates and friends and also increased my probability of a revise and resubmit from American journal reviewers.

Higher diversity of contacts in general implies integration into several spheres of society, which translates to an upper hand in instrumental actions like access to material resources, gathering information, and diffusion of innovations (Granovetter 1973 and 1974; Marsden 1987; Rogers 1995). In this research, higher diversity in terms the location of alters implies integration into a respondent's immediate scientific community (Los Baños or Muñoz), to the wider Philippine national research system outside Los Baños or Muñoz, to the scientific research systems at the core (i.e., Australia, Japan, and the United States), and to the global scientific community. For example, connections with alters (or contacts) in all of these domains result in greater chances of having access to local equipment and material resources in the immediate environment; access to large-scale facilities, to advanced and high-tech apparatuses usually only available at the national-level science institutions; and access to other resources important to advancing one's scientific and professional career, like visibility in the international science.

In Table 6.2, I present two measures of location diversity, both of which range from 0.00 to 1.00, where the former represents no diversity and the latter represents maximum diversity. The first measure comprises six mutually exclusive categories, namely: on-site (i.e., either Los Baños or Muñoz), other Philippine sites, Australia, Japan, the United States, and other foreign sites. The second measure employs only two categories, namely domestic and foreign. In terms of the first measure of diversity, the sample mean is 0.46, which is more or less at the center of the continuum, but slightly toward being less diverse than the center point. Japan (0.54) and United States (0.54) graduates have relatively more diverse alters than graduates from Australia (0.47) and the Philippines (0.40). Given Philippine and Australian graduates' large and small sample sizes, respectively, their contacts are comparatively less spread across the six categories when compared to Japanese- and U.S.-trained scientists.

Results from the second measure of location diversity give a much clearer pattern than the first. From the estimates in Table 6.2--Australia, 0.49; Japan, 0.50; United States, 0.53; and Philippines, 0.28--it is outstandingly obvious that Philippine graduates have very limited variety of contacts in terms of location base. Definitely, foreign graduates exhibit significantly higher location diversity than Philippine graduates, which could mean that domestic training may be limiting graduates in terms of their ability to establish formal and informal relationships with scientists outside the Philippines. Whether or not domestic scientific training simply falls short of developing the communication and interaction skills essential for participation in international science is a matter for further research, which is beyond the purview of this study.

I now shift the discussion to the connection between professional network and forms of communication. This naturally turns to the topic of social network and its relationship with ICTs (e.g., landline phones, cellular/mobile phones, fax/tele-fax machines, and the traditional postal system). The lower third portion of Table 6.2 shows descriptive statistics relating to the types of communication technologies respondents (or egos) most often use to contact people who have similar interests or work on the same kinds of things as they do (or alters). Essentially, this portion of Table 6.2 provides information about the types of ICTs ego and alters use to maintain their professional ties. Egos, alters, and ICTs framed in the context of knowledge production allude to a familiar conceptual terrain: that of translation networks (Callon 1995), which as mentioned earlier in the literature review refers to an aggregation of reality where statements, technical devices, and human actors converge and interact with one another (Bijker 1995 and 1999). I discuss what means of communication respondents (or egos) and each of their professional contacts (or alters) use. Put another way, what technical devices are important in facilitating ego-alter interaction and exchange in peripheral knowledge production systems.

For Philippine scientists in general, face-to-face interaction (71%), landline phones (53%), and cellular/mobile phones (51%) are the three most popular means to communicate with people important to their research work and scientific careers. Communication by email, a very recent technological phenomenon in the Philippines, occupies a rather large proportion of the total volume of communication means used (47%). Communication by fax (16%) and postal mail (14%) are clearly the least utilized means. Across places of graduate education, significant differences are observed for face-to-face, landline phone, cellular and/or mobile phone, and email communication. No significant differences for fax and postal mail communication are observed. Although face-to-face is the most popular form of communication, email tends to be the second most popular means among foreign graduates, and landline phone among domestic graduates.

To give specific details, in the case of Philippine graduates, the top three means for scientific communications are face-to-face (79%), landline phone (63%), and cellular/mobile phone (60%). In the case of foreign graduates, while face-to-face remains the dominant form of communication, there is an accompanying substantial preference for email, which displaces landline phone from its second-place position in the full sample. In a way, these estimates hint at the increasing salience of email over fax and postal mail as a form of communication among Philippine scientists, and email's prominence over landline phone in the case of foreign-trained scientists. **This ordering among preferred forms of communication conveys that Philippine scientists give priority to a communication style that involves co-presence and face-to-face interaction, and least preference to a style epitomized by the traditional postal mail. These findings suggest that preference for communication means somehow involves the following parameters of consideration: co-presence, cost efficiency, and speed of feedback**.

For scientific communication in particular and social interaction in general, these results, are neither outlandish nor counter intuitive when set in the Philippine context. In fact, they are consistent with "contextually-based common sense." In developed areas like the U.S., my personal experience is that non-collocated domestic actors communicate mainly through email; use of landline phones and cellular/mobile phones is not typical behavior in scientific communication. This behavior, although different from that of Philippine scientists who communicate mainly through cellular/mobile than email with non-collocated domestic contacts, is equally a "contextually-based common sense" behavior. In the U.S., email facilities are readily accessible and available in almost every scientific institution. In contrast, email facilities in Philippine scientific research systems are a rarity and can be "painfully" slow and difficult to access.

The high preference rates for face-to-face, landline, and cellular/mobile phone communication among domestic-trained scientists can be explained by the empirical fact that these scientists have larger proportions of domestic contacts. These contacts are much cheaper and easier to contact by way of face-to-face, landline, or cellular/mobile phone communication. But again, Philippine-based alters can be either in the immediate site as ego, or in other Philippine sites different from that of ego, so that there is a need to clarify if there is yet a bifurcated preference in the type of communication technologies used. Simple correlation coefficients presented in Table 6.3 helps clarify this.

It is observed that alters located in the same site as ego prefer face-to-face and landline phone communication. For Philippine-based alters not collocated with ego, cellular/mobile phone is the preferred mode of communication because of its widespread use, and its ability to switch between calling and texting. **It is noteworthy that unlike in the U.S., cellular/mobile**

Table 6.3: Pearson Correlation Matrix for Professional Network Variables[1]

	% male alters	% core alters	No. of Comm Means	Gender diversity	Location diversity	% local alters	% alters in other Phil site	% Alters in Australia	% Alters in Japan	%Alter in U.S.	% Alters other Foreign Sites	% F2F	% Land line	% Fax	% Letter	% Email	%Mobile Phone
% male alters	1.00																
	.																
% core alters	0.21	1.00															
	0.0003	.															
No. of Comm Means	0.04	-0.06	1.00														
	0.4734	0.3269	.														
Gender diversity	-0.19	0.00	0.30	1.00													
	0.0012	0.9536	0.0000	.													
Location diversity	0.22	0.30	0.25	0.20	1.00												
	0.0001	0.0000	0.0000	0.0005	.												
% local alters	-0.17	-0.31	-0.04	-0.03	-0.13	1.00											
	0.0030	0.0000	0.4966	0.6008	0.0264	.											
% alters in other Phil site	-0.04	-0.33	0.09	-0.03	-0.20	-0.66	1.00										
	0.4868	0.0000	0.1311	0.6599	0.0004	0.0000	.										
% Alters in Australia	0.11	0.53	-0.04	0.06	0.19	-0.16	-0.19	1.00									
	0.0631	0.0000	0.5205	0.2753	0.0010	0.0053	0.0008	.									
% Alters in Japan	0.22	0.60	-0.03	-0.09	0.16	-0.18	-0.19	-0.08	1.00								
	0.0001	0.0000	0.5993	0.0991	0.0060	0.0012	0.0010	0.1800	.								
%Alter in U.S.	0.00	0.54	-0.03	0.04	0.16	-0.17	-0.18	-0.02	0.00	1.00							
	0.9550	0.0000	0.6380	0.5140	0.0040	0.0033	0.0018	0.6907	0.9873	.							
% Alters other Foreign Sites	0.15	0.01	0.00	0.14	0.28	-0.25	-0.27	0.03	-0.02	0.01	1.00						
	0.0105	0.8289	0.9378	0.0143	0.0000	0.0000	0.0000	0.5991	0.7720	0.8661	.						
% F2F	-0.12	-0.40	0.22	-0.01	-0.17	0.41	0.00	-0.17	-0.26	-0.23	-0.29	1.00					
	0.0408	0.0000	0.0001	0.8880	0.0037	0.0000	0.9669	0.0038	0.0000	0.0001	0.0000	.					
% Land line	-0.25	-0.31	0.30	-0.03	-0.10	0.33	0.00	-0.17	-0.18	-0.17	-0.25	0.28	1.00				
	0.0000	0.0000	0.0000	0.6471	0.0959	0.0000	0.9565	0.0029	0.0019	0.0029	0.0000	0.0000	.				
% Fax	0.00	0.03	0.39	0.06	0.00	-0.16	0.15	0.15	-0.06	-0.04	0.00	-0.03	0.31	1.00			
	0.9403	0.6619	0.0000	0.3005	0.9449	0.0043	0.0096	0.0075	0.2750	0.4481	0.9322	0.6513	0.0000	.			
% Letter	0.04	0.07	0.44	0.07	0.06	-0.10	0.05	0.10	0.05	-0.04	0.04	0.03	0.16	0.44	1.00		
	0.4527	0.2150	0.0000	0.2328	0.2870	0.0764	0.3870	0.0772	0.3485	0.4681	0.5045	0.5737	0.0043	0.0000	.		
% Email	0.14	0.41	0.27	0.13	0.23	-0.39	-0.06	0.25	0.23	0.20	0.38	-0.32	-0.19	0.21	0.23	1.00	
	0.0176	0.0000	0.0000	0.0278	0.0001	0.0000	0.2644	0.0000	0.0000	0.0005	0.0000	0.0000	0.0008	0.0002	0.0001	.	
%Mobile Phone	-0.12	-0.36	0.28	0.03	-0.14	-0.04	0.39	-0.16	-0.20	-0.24	-0.24	0.19	0.28	0.15	0.12	-0.10	1.00
	0.0412	0.0000	0.0000	0.6404	0.0140	0.5034	0.0000	0.0048	0.0004	0.0000	0.0000	0.0009	0.0000	0.0080	0.0418	0.0712	.

[1] Numbers on top are correlation coefficients; those below are p-values. P-values less than 0.05, 0.01, and 0.001 are significant at the 5%, 1%, and 0.1% levels, respectively.

phones are predominantly used for text messaging and not for calling. While it is true that cellular/mobile phones are very popular in the Philippines and in the U.S., their use is very much different as a result of large differences in the domestic and international call rates. Obviously, there is a strong proclivity not to use email for domestic contacts ($r = -0.39$ for email use and on-site alters, $r = -0.06$ for email use and other Philippine sites). Again, the low preference rate for email communication in domestic scientific communication mainly rests on its inaccessibility even in domestic research systems and its slow and unstable connectivity as a result of low-band width and dial-up connections.

In contrast, the use of fax and postal mail are obviously the two least popular communication styles among Philippine scientists in general. This is a consistent finding regardless of place of graduate education. The reason is that the Philippine postal system is extremely inefficient and slow. Mailed documents, if not sent as "registered mail," have a high likelihood of getting lost and not reaching their final destination. If sent as "registered mail" then it is almost sure that it will reach its destination, but the fees are much higher. Also, this choice makes the mail take longer than usual to reach its destination because documents are manually logged in each of the post offices that they pass through. Fax machines, on the other hand, are not that accessible to Philippine scientists and are typically used for extremely important formal communications. Another reason fax messaging is unpopular emanates from the difficulties and hassles in transmitting messages when fax machines and the primary office telephones share a single line where competition for use is almost always the case. For example, I recently experienced sending a fax message to an office in UPLB from the U.S. I had difficulty establishing contact and had to make an overseas call to that office to tell them that I was attempting to fax a message. The answer was: "Please hold on, I will ask the manager not to use the phone in the next few minutes so that your fax message can come through." Such an answer never ceases to mesmerize me. In fact, I felt a little embarrassed to have had the manager delay his in-coming and outgoing calls just for my message to come through. Hence, if respondent scientists have to send important documents domestically, this would usually be done through private companies like DHL, Federal Express, Junior Express, and LBC. But again, these are expensive services which are typically used for official rather than personal transactions.

From Table 6.2, it is obvious that foreign graduates are more likely to use email than Philippine graduates, i.e., the use of email among foreign graduates is a majority behavior. Table 6.3 shows that frequency of email as a mode of communication is significantly and positively correlated with number of foreign contacts, and significantly and negatively associated with number of contacts in the same location as respondent. Face-to-face communication is significantly and positively associated with number of contacts in the same location as respondent, but is significantly and negatively associated with the number of contacts in Australia, Japan, the United States, and other foreign sites. Frequency of cellular/mobile phone use is significantly and positively associated with number of contacts in other Philippines sites, and negatively associated with all foreign sites. In other words, the way Philippine scientists use ICTs is as follows: for contacts (alters) in the same site as respondents (egos), either face-to-face interaction, landline phone, or both are preferred modes of communication; for contacts in other Philippine sites, cellular/mobile phone; for contacts in foreign locations, email. **These results suggest and exemplify that technical devices like information and communication technologies (ICTs) configure the egocentric network structure of Philippines scientists. Relevant parameters that mediate the use of a particular mode of communication are the following: for technical devices, the capacity for co-presence, cost efficiency, and speed of**

feedback; for egos their place of graduate education; and for alters their location in geophysical space.

These results suggest that professional network when linked to means of communication constitutes a translation network, or a socio-technical ensemble, where attributes of actors (egos and alters) tend to interact with the means of communication (technical devices) and the larger contextual factors (call rates, type of connectivity). The result is a social network that remains and will remain primarily face-to-face and predominantly on-site based, with multiple secondary forms of communication (non-face-to-face) aided by technology (landline phone, cellular/mobile phone, and email) for non-onsite-based interaction. At present, the empirical evidence from this study does not support the assertion concerning the demise of personal, face-to-face interaction. What seems to be happening is that personal, face-to-face interaction will maintain its hegemonic status as a preferred mode of interaction. There seems to be an empirical trend that non-face-to-face forms of communication will undergo a series of reordering and shifting within the preference hierarchy such that newer forms of technology-aided non-face-to-face communication (landline phone, cellular/mobile phone, and email) that prove to be more contextually practical and efficient will replace and make obsolete traditional ones (e.g., fax and postal mail).

Determinants of Scientist Professional Network

In Table 6.4, ordinary least squares regression analyses of professional network structure on contextual, personal, educational, professional, and email utilization are presented. The dependent variables include the following: (1) network size, (2) proportion of male alters, (3) proportion alters residing at the scientific core, (4) gender mix of alters, (5) location mix of alters, (6) ego-alter gender heterophily, and (7) ego-alter multiplexity of communication means. I present two models for each dependent variable: M1 refers to regression models, which do not

Table 6.4: Correlates of Philippine Scientists' Professional Network Characteristics[1]

Independent Variables	Professional Network Characteristics													
	Network Size		% Alters Who Are Male		% Alters at the Core		Gender Diversity		Location Diversity		Gender Heterophily		Multiplexity of Means	
	M1	M2	M1	M2	M1	M2	M1	M2	M1	M2	M1	M2	M1	M2
Intercept														
Location (1=Los Baños, 0=Muñoz)	-0.06	-0.11	-0.08	-0.07	-0.02	0.00	-0.04	-0.07	0.02	0.00	0.02	0.01	-0.02	-0.06
Sector (1=research inst., 0=state univ.)	0.20 **	0.15 *	-0.02	-0.02	0.17 **	0.17 **	0.13 *	0.11	0.10	0.07	-0.04	-0.05	0.10	0.05
Age (in years)	-0.12	-0.07	-0.05	-0.04	-0.02	-0.01	-0.09	-0.05	-0.03	-0.02	0.00	0.00	-0.12	-0.05
Gender (1=male, 0=female)	-0.05	-0.08	0.35 **	0.34 ***	-0.05	-0.07	-0.21 **	-0.23 ***	0.04	0.02	-0.39 **	-0.39 ***	-0.06	-0.10
Marital status (1=married,0=not married)	0.02	0.03	0.11	0.10	-0.04	-0.05	-0.07	-0.07	0.01	0.00	0.06	0.06	0.02	0.04
Number of children	0.16 *	0.15 *	-0.01	-0.01	-0.14 *	-0.15 *	0.10	0.09	0.13	0.13	-0.05	-0.04	0.15 *	0.14 *
Computer in personal office (1=yes, 0=no)	0.06	0.04	0.13 *	0.12 *	0.06	0.05	0.07	0.06	0.10	0.08	-0.02	-0.02	0.06	0.03
No. of people sharing office computer	-0.05	-0.03	-0.01	-0.01	0.02	0.03	-0.04	-0.03	-0.01	0.00	-0.09	-0.08	-0.04	-0.01
Member of professional org (1=yes, 0=no)	0.04	0.00	0.00	-0.02	0.08	0.07	0.06	0.03	0.01	-0.03	0.09	0.08	0.06	0.01
Has a Ph.D. (1=yes, 0=no)	0.19 **	0.11	0.07	0.05	0.18 **	0.15 *	0.17 *	0.13	0.17 *	0.12	0.04	0.05	0.15 *	0.05
Australian trained (1=yes,0=no)	-0.02	-0.09	0.06	0.05	0.22 **	0.22 ***	0.05	0.01	0.06	0.04	0.09	0.08	-0.10	-0.18 **
Japanese trained (1=yes,0=no)	-0.10	-0.12	0.11	0.12	0.30 **	0.31 ***	-0.13	-0.14 *	0.09	0.09	-0.01	-0.02	-0.15 *	-0.17 *
United States trained (1=yes,0=no)	0.01	-0.02	0.08	0.10	0.23 **	0.25 ***	0.02	0.00	0.13	0.13	-0.04	-0.04	-0.14 *	-0.17 *
Current email user (1=yes, 0=no)	-	0.00		-0.11	-	0.00	-	-0.02	-	-0.06	-	-0.04	-	0.03
Has ready email access (1=yes, 0=no)	-	0.13 *		0.02	-	-0.02	-	0.03	-	0.10	-	0.05	-	0.09
Hours in a week using email	-	0.05		0.05	-	0.02	-	0.01	-	-0.04	-	0.02	-	0.09
Years using email	-	0.07		-0.05	-	-0.07	-	0.08	-	-0.02	-	0.03	-	0.08
Email use diversity (6=diverse, 0=not diverse)	-	0.22 ***		0.15 *	-	0.15 *	-	0.11	-	0.22 ***	-	-0.02	-	0.26 ***
Coefficient of determination (R-square)[2]	0.12	0.20	0.25	0.28	0.24	0.26	0.11	0.13	0.12	0.16	0.17	0.17	0.09	0.20

[1] *, **, *** denote coefficients which are significant at the 5%, 1%, and 0.1% level.

[2] R-square is associated with the normal error regression approach

include aspects of email utilization as independent variables. M2 pertains to regression models, which include aspects of email utilization as independent variables. The goal is to explore possible correlates of the professional network structure, and how email utilization figures into the causal equation.

Results indicate that network size is significantly associated with differences in sector (b = 0.15), number of children (b = 0.15), whether or not ego has ready email access (b = 0.13), and diversity of email use (b = 0.22). The effects of these factors on network size are such that knowledge producers in the research sector, who have more children (within the range of 0 to 6 children), who have ready email access, and who use email in a variety of ways tend to have larger networks, or more contacts. Larger networks represent greater diversity, offer access to a wide variety of capital, resources, and opportunities; and increase access to non-redundant and at times innovative information (Beggs et al. 1996; Rogers 1995; Shrum and Beggs 1997). Contrary to expectation, level of graduate education exhibit a non-robust influence which readily dissipates when email access and use are included in the model, while place of graduate education does not play any significant role in network size determination. It could be that level and place of graduate education configure network structure along qualitative rather than quantitative aspects of network, wherein network size is a case in point.

Why do scientists in government research institutes tend to have larger networks than their counterparts in state universities? One possible explanation is the emphasis of Philippine science on applied and real-problem-oriented research. It is possible that research-sector scientists have more opportunities to attend professional meetings, research and extension missions, human development training, professional conferences, and educational trips within and outside the country. These opportunities could immediately translate to being exposed to different spheres of scientific research activities and acquiring new contacts. In contrast, scientists in state universities may be more constrained to leave their workstations due to limited opportunities, budgetary constraints, lower standing in the priority ladder, and the demands of teaching. This is reminiscent of the urban-bias theory (Bradshaw 1987; Bradshaw et al. 1993a) where material resources and foreign funding and investment are systematically channeled to the urban industrial sector instead of to the rural agricultural sector. In a way, within the framework of scientific institutions in developing areas, we can think of government research institutes as functionally and structurally analogous to the urban sector, and universities to the rural sector. This conceptual bifurcation between the urban and rural sectors in the wider social system resonates, is mirrored, and is replicated in the embedded scientific institution. This pattern is akin to the socio-cultural practice view of science (Callon 1995) that posits that the general attributes of the general cultural and social systems resonate into the various subordinate social institutions, of which science is one.

In a seemingly rational and objective system such as scientific research systems, why does number of children, a basically ascribed status and not intrinsically related to knowledge production, tend to increase the number of professional contacts? In the Philippines, there are still strong "patronage systems." One such system is the parent-child-godparent patronage system.[18] When an employee in an organization, say, is expecting a baby, it is typical to have officemates who are well-positioned in the organization (e.g., director of the institute, chair of a department, college dean, college secretary, etc.) to be solicited as the child's godparents. It is considered unethical and rude to decline such solicitations to godparent a child. The resulting affective relationship between the child and the godparents typically results to a close bond between the parents and the godparents. The purpose of god-parenting is to ensure that there

[18] This is commonly known as the *ninong* and *ninang* tradition.

will be someone in the future, who will guide the child as he/she goes through the challenges of life, especially during milestone events in the child's life like finding a job and getting married. To ensure that the child will have a bright future, godparents are almost always obligated to help the child's parents not only in raising the child, but also in helping them do well in the organization so that the child will prosper by whatever benefits the parents will have through rank and salary promotions. Hence, the relationship between parents and godparents transcends affective bounds and easily shifts into the domain of an instrumental relationship. But what do the godparents get out of this relationship? The answer: It is neither monetary nor material; it is more of prestige or the esteem of others in the organization and in the community that the godparent gets in return for all this "trouble." This perception of prestige immediately translates to having increased influence and securing more social power in the organization and in the community.

How do ready email access and diversity of email use increase network size? The effects of ready access and diversity of use are mainly through their potential to increase the number of foreign alters, while the effects of sector and the number of children have the general tendency to increase domestic contacts. The ability of email to increase network size can be taken as consistent with the claims of the "elixir" argument. Most probably ready access gives scientists the sustained momentum to communicate at the immediate time and place that they feel like doing so. It is indeed frustrating and discouraging when one is in the mood to write an email only to find out that the server is down, or that the system has kicked you off in the middle of intense and fully involved writing. As to the effect of diversity of use, it is possible that participation in science and technology discussion groups, communicating with funding agencies, reviewing and submitting journal articles on-line are all activities that tend to result in getting to know new people and thereby increase contacts. The greater the diversity of involvement in on-line activities the more one becomes integrated into the various spheres and facets of social life. This is similarly true with scientific careers and as well as research work.

The regression analysis of the proportion of alters at the scientific core yields interesting results. Scientists who are in the research sector, with fewer children[19], have doctorates, were trained at the scientific core, and use email in diverse ways all lead to a larger proportion of alters at the core. Clearly, foreign training has the strongest effect; with level of education contributing significantly to the variation in the proportion of alters at the core. It could be that foreign training translates to learning not only codified knowledge, but also tacit skills which render scientists proficient in communicating, formally and informally, in writing and orally with scientists at the core, not to mention their professors, classmates, and friends in graduate school. Such formal and informal ties with science actors at the core could potentially expand the number of contacts in Australia, Japan, and the U.S. The "disenhancing" effect of number of children on number of alters at the core is expected, given the well-recognized fact that people can only maintain a more or less fixed number of close contacts. Typically, individuals are unable to maintain a large pool of contacts. There is an optimum number of contacts beyond which level, any additional contact will mean dropping others who were previously considered as core set.

In the Philippine case, as the number of children increases, there is a tendency to increase the number of local contacts as a result of what was earlier described as the patronage system of god-parenting (or the *ninong-ninang* system). If on average, a child has four god-parents, then by the time scientists have two or three children, they will have a large number of alters in their network. Such a large number of close and personal contacts easily deluge scientists, thus

[19] Number of children ranges from 0 to 6, inclusive.

resulting to having less time to communicate with foreign contacts, thereby eventually weakening foreign ties.

In this study, I focus on two distinct dimensions of diversity in professional network structure: gender and location. Gender diversity of alters is mainly configured by ego's gender, and whether or not ego trained in Japan. Male and Japanese-trained respondent scientists have less gender diverse alters than female and non-Japanese-trained respondent scientists. Diversity with respect to location is solely configured by email use diversity. Scientists who report greater email use diversity have greater location diversity among alters. Diversity in email use, however, does not play any influencing role in gender diversity. In other words, sophisticated email use helps in the diversification of alters with respect to location, but not gender. The result is intuitive in the sense that there are no significant differences in email access and use between male and female Philippine scientists, but there are significant differences in email access and use by location of alters.

Except for gender of respondent, there are no other contextual, personal, educational, professional, and email use behavior variables that influence gender heterophily. Male respondent scientists are more likely to have gender homophilous alters. Female and male respondents are more likely to have a network structure that is male dominated. In other words, male scientists are more likely to have homophilous networks, while female scientists are more likely to have heterophilous ones. Both male and female scientists are, on average, inclined to have more men in their professional networks. Why? A possible reason could be that, although men and women are almost equal in number in the Philippine research system, there are more male scientists in higher positions than females. This is especially true in the more traditionally male-dominated fields of agriculture, entomology, forestry, plant breeding, horticulture, and veterinary sciences. And, if the selection of alters is mainly through the "patronage system" discussed earlier, then males will be disproportionately favored as alters in professional networks.

The regression results for gender heterophily are similar, if not the same, as those of the results for the proportion of alter who are male. It is clear from these results that differences or inequality in gender heterophily is mainly determined by respondents' gender and that the valence between gender heterophily and respondents' gender is negative. It is also interesting to note that the magnitude and direction of the effect of respondents' gender do not change with the incorporation of email use variables into the regression model. These results convey that email access and use have nothing to do with gender heterophily. If the majority of alters are domestic, and if email is mainly used to communicate with alters abroad, then it is expected that email will not have any effect on gender heterophily.

In Table 6.4, it is evident that foreign training is associated with decreased multiplexity in communication means, while having more children and using email in more diverse ways enhance multiplexity. This makes sense as having trained abroad increases foreign contacts, of which the primary mode of communication is through email. An increase in foreign contacts limits the available means of communication between ego and alters to predominantly email based because other means are either impossible (face-to-face), too expensive (fax machine, landline, and cellular phone) or too inefficient (letters) for sustained and frequent international interaction.

What is the causal mechanism between email use diversity and multiplexity? Using email in diverse ways plays a direct and dominant role in expanding network size internationally. But it must be recalled that all Philippine scientists, whether foreign trained or not, have domestic contacts to begin with and with whom they communicate through face-to-face, landline, or cellular/mobile phone. Hence, the inclusion of international contacts into the list of an ego's alters introduces yet another mode of communication, email, thereby increasing the multiplexity of communication means.

Why does having more children enhance multiplexity? Based on the frequency distribution of number of children, which ranges from 0 to 6, and the regression results in Table 6.4, it is clear that more children increases network size, but reduces the proportion of foreign alters. However, the expansion of local alters as a result of more children does not totally eliminate all foreign contacts, as shown by the predicted number of core contacts will show when all dummy variables are set to zero, number of children set to six children, and all other interval/ratio variables set at their respective mean values. Having a non-zero value for number of foreign contacts could well imply the use of email in maintaining communication with these foreign contacts. Given the positive and significant association between foreign alters and email as a mode of communication, it is indeed very likely that mode of communication will be email; thereby adding another mode of communication that eventually enhances the multiplexity of communications means.

Among contextual factors, sector has substantial influence on the quantitative composition of network as measured by network size, and on qualitative composition of network as measured by proportion of alters residing at the core. The research sector has the upper hand in possessing larger networks, and networks that comprise a larger proportion of foreign contacts. The bias in favor of research sector scientists is something akin and near in description to the urban bias theory of development, where much of the material resources and foreign investments are channeled to the development of the urban sector. In a way, the concept and mechanism of urban bias is analogous to the concept and mechanism of research-sector bias, where more of the manpower development, investment on research and equipment, and donor funding are channeled to government research institutes than to state universities.

Among the personal factors configuring scientists' professional network structure, empirical results reveal that gender and number of children are relevant factors to consider. It is intuitive and expected that gender of respondents is related to the proportion of male alters, gender diversity of alters, and gender heterophily between ego and alters. Number of children, on the other hand, affects network size and the proportion of alters residing at the core. As earlier discussed, the "patronage system" in Philippines has much to do with the effect of number of children on the quantitative and qualitative composition of scientific professional networks. These results, although tending to be counter-intuitive, are essentially noteworthy in the sense that these lend evidence to the claims of the socio-cultural practice model of science that knowledge producers interact with other knowledge producers not only on the basis of achievement-based and objective criteria, but also on the basis of ascribed-based and subjective criteria. This implies that the orientation encapsulated in gender relations practiced at the level of Philippine cultural and social systems finds expression within Philippine scientific research systems, which the limited translation model of science views as a special system not amenable to social analysis or influence by social factors.

Professional factors, represented by a computer in one's personal office, number of people sharing an office computer, and membership in professional organizations, do not play any outstandingly central role in the determination of professional networks. It is quite surprising that these factors are almost totally without any efficacy given that these could either enable or disable a network structure. For example, a computer in the personal office could either lead to the expansion or contraction of network size, depending of how the computer is used or whether it is internet connected or not. In like manner, the number of people sharing a computer could either expand a local network, especially if sharing serves as a means to social interaction, or diminish network size if computer sharing already discourages and dampens the momentum of scientists in using the computer and the Internet to establish international contacts.

Educational factors configure professional network structure through the proportion of alters residing at the core and the multiplexity of communication means. Educational factors split into level and place of graduate education; the latter has a more visible and dominant effect than the former. Foreign education in general increases the proportion of alters residing at the core and decreases the degree of multiplexity of communication means. If level of graduate education is indicative of codified knowledge and place of graduate education is indicative of tacit skills, then on the basis of these empirical results, it can be posited that tacit skills somehow play an important role in initiating, maintaining, and sustaining ties with knowledge producers at the core. Also, those who train abroad tend to have more contacts at the core so that the proportion of domestic contacts diminishes. This lesser volume of interaction with domestic contacts means that other forms of domestic communication give way to email.

Among the various aspects of email use behavior, diversity of email use plays a salient and dominant aspect. Diversity of email use enhances network size, proportion of male alters, proportion of alters residing at the core, location diversity of alters, and multiplexity of communications means. Basic email access and use are not significant dimensions in configuring networks; more advanced and sophisticated levels of use are important in determining network structure. Indeed, what matters in having better quantity and quality of contacts no longer resides in having basic access and use of email. Larger and quality contacts are now becoming a function of having more advanced hardware-software-user interaction skills. The digital divide based on simple access and use ceases to be an important factor in configuring social networks; a digital divide based on advanced and diverse hardware-software-user interaction skills appears to be the emerging new dimension in the configuration of socio-technical networks.

Summary

In this chapter, I characterized the professional network of Filipino scientists, linked it with different means of communication, and examined what contextual, personal, professional, educational, and email utilization aspects configure network structure. Results suggest that scientists still prefer face-to-face interaction as their primary mode of communication. There is no compelling evidence that supports the claim that new ICTs will soon replace and render obsolete traditional, meaningful face-to-face interaction. What is evident is that among non-face-to-face modes of communication, a reordering maybe in progress. New ICTs have relegated the use of fax and postal mail to the margins. Landline phone, cellular/mobile phone, and email have taken a central role, second only to face-to-face interaction.

Filipino scientists communicate primarily through face-to-face, and secondarily through landline telephone with a network that predominantly consists of on-site alters. For alters in other Philippine sites, the cellular/mobile phone in text messaging mode is preferred. For scientific communication with foreign alters, email is the preferred mode of communication. Much of the effect of email--expressed through diverse hardware-software-user interaction skills--lies on those structural components of professional network that have to do with network size, proportion of male alters, proportion of alters residing at the scientific core, location diversity, and multiplexity of communication means.

It is equally surprising to unravel how ascribed factors, like gender and number of children, can configure the network structure of actors, who have been traditionally viewed as the epitome of objectivity, rationality, and achievement-oriented. This study has attempted to demonstrate how such ascribed attributes figure in the knowledge production process through a system of patronage. Clearly, all these lend support to the proposition of the extended translation view of science that actors, factors, and entities outside the knowledge production system affect the dynamics and relationships with that system. This chapter also highlights how interaction between human (scientists/users) and non-human (hardware-software) actors configure the network structure of knowledge producers.

CHAPTER 7: SCIENTIFIC COLLABORATION

Introduction

Several chapters ago, I mentioned that contemporary societies (developed and developing, HDC and LDC, First and Third World, center and periphery, core and satellite, in other words, rich and poor nations)[20] are increasingly becoming knowledge societies which present analysts with new social realities. Stehr (2000) argues that social analysis must focus on (1) the nature and function of knowledge in social relations, (2) the carriers of such knowledge, one of which is the Internet, and (3) the resulting changes in power relations, patterns of inequalities, and sources of social conflict. Escobar (1995) argues that knowledge has a central role in social change and describes it as a historically singular experience: the creation of a domain of thought and action, which has relied extensively on one knowledge system: the modern Western. Most dependency theorists argue that the dominance of the Western knowledge system has dictated the marginalization and disqualification of non-Western knowledge systems.

One salient feature of knowledge production in contemporary global society is the increasing role of collaborative work, or scientific collaboration (Bordons and Gomez 2000; Castells 2000; Thorsteindottir 2000). As Hacket (2005:667) puts it, "Collaborators today communicate from different continents and cultures, synchronously and asynchronously, in the language of different nations and disciplines, through a spectrum of technologies, using diverse forms of expertise to produce heterogeneous mixes of knowledge, products, and solutions to problems." For science studies at the scientific core, collaboration is seen as an important facet of the evolving nature of knowledge production. Further, these studies indicate that science

[20] In this dissertation, LDC is used interchangeably to mean the Third World, the developing world, and the periphery or satellite countries. On the other hand, HDC is used interchangeably to mean the First World, the developed world, and the center or core countries.

activities in academe and in research institutions are steadily becoming collaborative rather than competitive (Thorsteindottir 2000). In contrast, for science studies at the periphery, scientific collaboration as a social phenomenon has yet to gain ground and momentum because most of extant understanding of developing-world scientific collaboration is based from "views from far and away," which are far from accurate and reliable as a result of their inability to truly capture the essence and complexity of peripheral scientific work (Shrum 1997). With current understanding of peripheral collaborative work still very preliminary and inchoate, systematic studies are imperative and remain an important research agenda. Typically, insights and perspectives about collaborative work in general emanate from systems and identities at the scientific core. Of the very few studies done on peripheral science, none have actually been carried out that analyze it from the perspective of the periphery. This research study attempts to rectify this lopsided treatment and provide an understanding of scientific collaboration that is sensitive to differences across contexts, places, and identities.

Internet and Scientific Collaboration

With collaboration becoming a central and vital process in knowledge production (Shrum and Campion 2000), the Internet becomes a potentially important facilitating medium for long-distance collaborative work. Specifically, Internet access and use facilitate communication flow and data interchange, which are vital to the transmission and dissemination of knowledge in general and scientific knowledge in particular. Given the importance of advancing scientific knowledge as a space for directed social change at the periphery, issues concerning Internet access and use, and their effects on scientific collaboration at the periphery become relevant areas for social research. This chapter attempts to provide insight on how Internet utilization and professional social network affect their collaborative behavior. Put another way, do differential

Internet access and use, and network determine participation behavior with respect to scientific collaboration? If so, I then go back to the causally prior question: what contextual, personal, professional, and educational attributes of Philippine scientists affect patterns of Internet access and use? In general, the results of this chapter's analysis will be relevant to the area of social stratification, and more specifically, digital inequality. The study of differential participation in collaboration is also relevant to stratification studies, both at the macro and micro levels. At the macro level, it is relevant because socio-economic development largely depends on superior scientific communities and research infrastructure that are able to participate in, and contribute to mainstream scientific knowledge generation and global technological production.

At the micro level, the study of differential participation in collaboration is important because scientists' career development (or upward social mobility), visibility in mainstream science, and access to funding agencies can be potentially enhanced by personal contacts in domestic and international scientific communities. In other words, scientific collaboration translates to an upper hand for nations and scientists that engage in it. As an area of interest in the study of social stratification, access to collaborative work has the potential to propel intra-generational social mobility and transmit inter-generational inequalities both at the macro and micro level so that a deeper understanding of its mechanisms would be relevant in informing national and international policy options, and social engineering alternatives that can make access and participation more equitable.

What Is Scientific Collaboration?

A prominent feature of science in contemporary global society--a society with an increasingly network morphology and a mode of production fast becoming knowledge-based-- is the expanding role and rapid growth of scientific collaboration (Bordons and Gomez 2000;

Castells 2000; Stehr 2000). Recent studies on the subject have elaborated on questions like: what is scientific collaboration? How is it measured? What are the reasons for collaboration? What are its impact--negative and positive, first-order and higher-order--on the production of knowledge? What social policy and social engineering implications do collaborative activities have for researchers themselves and for techno-scientific systems (Melin 2000)? These are but a few of the sample questions that social scientists are trying to answer in order to gain a better understanding of science as a system of knowing and as a social institution.

Interaction among producers of knowledge has for long been the essence of scientific practice (Melin and Persson 1996). Although most phases of the research process are associated with a significantly large number of communication activities, scientists do not only communicate research results and information between and among themselves, they also co-produce and co-report research results. In other words, scientists not only communicate but also collaborate. Prominent scholars in science studies, like Bordons and Gomez (2000) and Katz (1994) have provided definitions of what scientific collaboration is, and others have raised issues about these definitions. These scholars define scientific collaboration as the specialized interaction between two or more scientists, where a goal (or significant conclusion) is projected and attained by means of shared knowledge and effort. Melin and Persson (1996) define collaboration as an intense form of interaction, which allows for effective communication as well as the sharing of competence and resources. Katz and Martin (1997) define it as the joint work of researchers to achieve the common goal of generating new knowledge.

It is clear from these definitions that collaboration implicitly involves social interaction and social relations among science actors with the objective of producing new knowledge. These definitions allude not only to the prior existence of a social group, but also of a social network among knowledge producers. The need to fathom and understand collaborations in science is important because science is itself central to the production of knowledge in contemporary global society. This dissertation focuses on the dynamics of collaboration of peripheral scientists with other scientists who are located within the country, or are outside of the country. As mentioned earlier, a number of studies at the scientific core identify collaboration as an important facet of the changing nature of science. These studies indicate that knowledge production is fast shifting to being collaborative rather than competitive. In contrast, studies on the collaboration of peripheral scientists have yet to gain ground and momentum because extant knowledge about collaboration at the periphery is, at best, based upon "views from far and away" which typically render an account and interpretation of the impact and rationale of collaboration from core science actors' value and meaning system (Shrum 1997).

With the globalization of contemporary societies, coupled with the rapid diffusion of the Internet in peripheral scientific communities, it is argued that collaborative work in science is fast emerging and evolving at the periphery so that increased participation in collaboration would seem profitable and rational for peripheral scientists, most especially if construed as a potent means (1) to participate in and contribute to mainstream science, (2) to augment, inform, upgrade, and update the existing local peripheral scientific knowledge base, (3) to strengthen local scientific infrastructure by way of possible funding of material resources and equipment, and (4) a means to gain visibility and establish ties to mainstream scientific communities. Current thinking among scholars of science and technology studies hypothesizes that scientific collaboration may be one of the avenues in attaining the ends listed above because peripheral scientific systems rarely possess and have access to specialist skills, competencies, and material resources deemed imperative in contemporary multi-disciplinary and high-technology research.

Other global concerns that make collaboration practical and advantageous are (1) the rapidly declining funds for international technical assistance from core countries and multilateral financing organizations (e.g., African Development Bank, Asian Development Bank, Inter-American Development Bank, IDRC, IBRD and IMF)[21] to peripheral in-country projects, (2) the advent of the Internet that, theoretically and ideally, would allow peripheral scientists to communicate and interact with scientists at the core in real time and facilitate the dissemination and exchange of data, ideas, and information with virtually zero time lag, (3) the increasing pervasiveness of science in almost all facets of everyday life, and (4) the increasing complexity and specialization needed in solving scientific and technical problems, which makes it increasingly practical for scientists to work together or develop joint ventures.

Impacts of Scientific Collaboration

At the macro level (at the community or country level), collaboration between core and peripheral scientific communities typically provides a means to improve and upgrade the latter's scientific manpower and infrastructure, and make mainstream knowledge relevant to local peripheral situations. For example, formal and informal linkages between the Philippine Rice Research Institute (PhilRice) and the University of California in Davis provide the former with access to agricultural education and training opportunities in the latter. On the other hand, collaboration among local research systems is a means not only to diversify peripheral scientific manpower and infrastructure, but also a way to strengthen and unify the national capacity for research and development. Somehow, these imply that increased participation in collaboration paves the way to self-sufficient peripheral scientific communities and infrastructures that are able to provide technical and scientific knowledge needed for national development efforts.

[21] These acronyms are defined as follows: IDRC-International Development Research Council, IMF-International Monetary Fund, IBRD – International Bank for Reconstruction and Development.

At the micro level (at the individual scientist level), scientific collaboration provides scientists with access to knowledge, skills and competencies, material resources, national and international appointments to regular and/or consultancy job, and funding for research projects from prestigious funding agencies. As a concrete example of how scientific collaboration can benefit scientists, it can be laborious and time-consuming for scientists to update their knowledge and skills so that collaboration would be a more cost-effective way to obtain updates on needed knowledge and the current literature. Scientific collaboration also provides both the formal and informal links needed to initiate interaction with other scientists, and to be visible in mainstream science and funding agencies (Katz and Martin 1997:8).

In other words, scientific collaboration at the micro level holds great potential for social mobility because it can enhance scientists' career development and socio-economic status through the establishment of social networks and social contacts. Social contacts have been shown to positively affect socio-economic status (Katz and Martin 1997; Granovetter 1973 and 1974). Katz and Martin (1997) argue scientific collaboration has the effect of "plugging" scientists into a wider network of contacts in scientific communities. They provide an example where a scientist may have ties with 50 to 100 other scientists in his/her field globally whom he/she can contact for information or advice, not only for scientific purposes but also for such ends as finding a job, training as a postdoctoral fellow, being recommended to high-paying consulting jobs, or getting grants from funding agencies (Katz and Martin 1997).

Scientific Collaboration as a Social Resource

If, at the macro level, scientific collaboration is perceived as a means (1) to improve and upgrade peripheral scientific manpower and infrastructure and make mainstream knowledge relevant to local situations and aspirations, (2) to diversify the local peripheral scientific manpower and infrastructure, (3) strengthen and unify the national capacity for research leading to human and economic development; and if at the micro-level, scientific collaboration is perceived as a means (1) to enhance scientists' competency, knowledge, and skills, and translate them to significant paths for career development, (2) to make scientists visible in mainstream science and funding agencies by being "plugged" into wider networks in scientific communities and among science-research-funding agencies, which scientists can contact for information or advice, not only for scientific purposes but also for such ends as finding a job, being recommended for high-paying consultancy jobs, or getting grants from funding agencies, then it is important to find answer to the question: **Who among peripheral scientists are able to engage in scientific collaboration? Put another way, what contextual, personal, professional, educational, Internet utilization, and professional network factors determine participation in scientific collaboration?**

The concept of social capital (or social resource) is a useful conceptual tool in answering these questions (Coleman 1988; Lin et al. 1981; Portes 1998). The conceptual definition of social capital provided by Bourdieu (Portes 1998) and Coleman (1988) are particularly useful in this case. On the one hand, Bourdieu defines social capital as "the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition" (Portes 1998:3). From this definition, it is clear that social capital has two main elements: (1) the social relationship per se that allows individuals to claim access to resources possessed by their associates, and (2) the amount and quality of those resources (Portes 1998). On the other hand, Coleman defines social capital by its function as "a variety of entities with two elements in common: They all consist of some aspect of social structure, and they facilitate certain action of actors within the structure"

(Coleman 1988:S98; Portes 1998:3). Both of these definitions imply that social capital resides in the structure of relations between and/or among actors; this structure of relations can translate to either potential or actual social resources that can be used to facilitate action (Coleman 1988; Portes 1998).

Scientific collaboration, by its very definition, is founded upon the structure of social relations among science actors. It can translate into an actual resource in facilitating social actions such as the advancement of scientific knowledge, or the attainment of specified objective in the case of scientific research projects. It can also transmute into a potential resource in facilitating vertical social mobility such as career development, or prominence in the mainstream science and research system. As a means of achieving macro and micro level benefits mentioned earlier, scientific collaboration can be viewed as a form of social capital. For the reason that it is a cost-effective means to primarily update and advance knowledge, skills, and competencies of science actors in general, scientific collaboration can be viewed as social capital serving as an "information channel" (Coleman 1988:S104).

Social capital understood as an information channel is the access to relevant information that is inherent in social relations, which is important in providing a basis for action, but may be expensive to obtain (Coleman 1988). He further suggests that one way to circumvent the problem of expensive information is to use social relations that are maintained for other purposes. Coleman gives the example of a social scientist who is interested in being up to date on research in related fields and who can make use of everyday interactions with colleagues to do so. In like manner, scientific collaboration can be viewed using the same approach and logic. Hence, collaboration can be viewed as serving as an information channel among knowledge producers.

Social capital has three outstanding attributes: (1) it is productive, (2) it is not completely fungible but may be specific to certain activities, and (3) unlike other forms of capital, it inheres in the structure of relations among actors (Coleman 1988; Portes 1998). Given that scientific collaboration is broadly defined as two or more scientists working together on a joint research project, sharing intellectual, economic, and material resources (Bordons and Gomez 2000), it is can easily be seen that scientific collaboration is a productive process, not completely fungible, and inheres in the structure of relations among science actors. Treating scientific collaboration as a form social capital (or social resource) makes it a basis for social inequality. So that concern as to "who participates" and "who do not participate" in scientific collaboration becomes a recognized issue. In particular, what contextual factors, individual characteristics, and human capital attributes pave the way for participation and non-participation in scientific collaboration? And with the advent of the Internet, are these inequalities attenuated or are they further exacerbated.

Campion and Shrum (2003) provide theoretical material and empirical results on the matter of gender-based differential access to scientific collaboration, which can be extended to yet other bases of differential access (e.g., organizational type, marital status, number of children, age, level and place of graduate education, and others). They argue that a combination of educational and research localism increases the likelihood of restricted professional networks (or scientific collaboration) for women. Gender inequality in the research systems of the developing world may be based on systemic deficits in the acquisition of and access to social rather than material resources. Campion and Shrum's (2003) argument is substantiated by their empirical results that the primary gender difference emerges in the average number of contacts outside the local research system. Men have significantly more relationships with foreign professionals than women. In other words, gender inequality lies primarily in linkages to developed countries rather than those in other developing areas. They further assert that men named an average of 2.48 contacts outside their location, including 1.09 in developed countries, while women named an average of 1.90 outside contacts, with only 0.71 in developed countries. Both differences were significant at the 0.05 level.

Collaboration Profile of Philippine Scientists

Traditionally, Filipinos practice communal help, which is best captured and described by the concept of *bayanihan*. It refers to the customary practice wherein neighbors help each other in attaining a particular objective. The original notion of *bayanihan* is akin to collaborative work of the community for members who are, for example, building their houses or are moving into a new neighborhood, wherein the community helps a member/family literally carry his/her/their household to a new location. When I was a little boy, I witnessed one of these instances when the whole house of Mang Binoy--a neighbor--in Anos, Los Baños, Laguna, was carried by adult male members of the community from the other side of the national highway to our side. In this section, I delve into a phenomenon akin to the concept of *bayanihan* not in the context of neighborhood help, but in the context of professionals working together in scientific research systems. In other words, I empirically explore and present findings on the collaborative behavior of Philippine knowledge producers.

In this study, respondents are asked to provide information about their main projects and activities and if each one of these main projects is done in cooperation with someone in another organization. Joint works with someone in the same department for state universities or in the same research center for government research institutes **do not** count as collaborative projects or activities. Given this definition of collaboration, if respondents report involvement in collaborative projects, for a maximum of three, they are asked to provide information on where their collaborators were located. The location of collaborators consists of six categories (1) in the immediate survey location, which is either Los Baños or Muñoz, depending on the location of the respondent, (2) not in the immediate survey location, but in some other Philippine location, (3) in Australia, (4) in Japan, (5) in the U.S., or (6) in some other foreign country. To illustrate, a scientist based in Los Baños who has collaborators in Muñoz, Japan, and South Korea would have his responses coded as having contacts in 2, 4, and 6. A scientist based in Los Baños who reports having collaborators in other departments or research centers in Los Baños, Muñoz, Japan, and South Korea would have his responses coded as having contacts in 1, 2, 4, and 6. Categories pertaining to where collaborators are located are each converted into binary dummy variables, which are used in Tables 7.1 to 7.4 and later on in Tables 8.3 to 8.6.

A collaboration profile for Philippine scientists in the form of descriptive statistics for the eight collaboration measures is given in Table 7.1. These indicators include (1) whether or not respondent collaborates (1=yes, 0=no), (2) number of collaborative projects respondent has, for a maximum of up to three projects only; (3) whether or not respondent has collaborators residing in the immediate survey sites (1=yes, 0=no), (4) whether or not respondent has collaborators in other Philippine sites (1=yes, 0=no), (5) whether or not respondent has collaborators in Australia (1=yes, 0=no), (6) whether or not respondent has collaborators in Japan (1=yes, 0=no), (7) whether or not respondent has collaborators in the U.S. (1=yes, 0=no), and (8) whether or not respondent has collaborators in other foreign locations (1=yes, 0=no). Descriptive statistics are calculated and presented for each of these eight measures (Table 7.1).

From Table 7.1 it is clear that a large majority (86%) of Philippine scientists report current involvement in collaborative projects. Having no collaborative projects, which stands at

Table 7.1: Scientific Collaboration Profile of Filipino Scientists

Collaboration Indicators[1]	Mean	Median	Mode	SD	Skew[2]	Min	Max	Quartiles		
								25th	50th	75th
R collaborates	0.86	1.00	1.00	0.35	-2.1	0.0	1.0	1.0	1.0	1.0
Number of collaborative projects (range: 0-3)	1.91	2.00	3.00	1.08	-0.5	0.0	3.0	1.0	2.0	3.0
R has collaborators in immediate survey site	0.41	0.00	0.00	0.49	0.4	0.0	1.0	0.0	0.0	1.0
R has collaborators in other Philippine sites	0.57	1.00	1.00	0.50	-0.3	0.0	1.0	0.0	1.0	1.0
R has collaborators in Australia	0.06	0.00	0.00	0.24	3.7	0.0	1.0	0.0	0.0	0.0
R has collaborators in Japan	0.09	0.00	0.00	0.28	3.0	0.0	1.0	0.0	0.0	0.0
R has collaborators in the U.S.	0.05	0.00	0.00	0.21	4.3	0.0	1.0	0.0	0.0	0.0
R has collaborators in other foreign sites	0.13	0.00	0.00	0.34	2.2	0.0	1.0	0.0	0.0	0.0

[1] except for number of collaborative projects, all other indicators are dichotomous (1=yes, 0=no)

[2] measures the extent and direction of asymmetry. A symmetric distribution such as the Gaussian curve (or the normal distribution) has a skewness of 0, and a distribution that is skewed to the left, e.g. when the mean is less than the median, has a negative skewness. A distribution that is skewed to the right, e.g., when the mean is greater than the median, has a positive skewness.

about 14%, is obviously a minority behavior. On average, respondent scientists report involvement with two collaborative projects. However, it must be noted that the survey questionnaire solicited only up to a maximum of three projects, so that the estimated mean current involvement of two collaborative projects is “right-censored.” Nonetheless, this is arguably a sensible estimate considering that the survey questions I asked were not just about any project, but specified important and main projects. These projects are presumed to be given priority and are presumed to be highly demanding in terms of time and energy.

For collaborations located within the country, more scientists (57%) report having collaborators in other Philippine location, than scientists (41%) who report having collaborators located in the same site as respondents are in. In other words, Filipino scientists collaborate more with scientists in other Philippine locations than with other scientists based in the same location.

It is also evident from Table 7.1 that Filipino scientists collaborate more with other Philippine scientists than with either core-based or foreign scientists. Among the core-based scientists, Filipino scientists collaborate most frequently with those from Japan (9%), followed by those from Australia (6%), and then those from the United States (5%). Collaboration with scientists from the rest of the world is estimated at 13%. Hence, the collaboration practice among Filipino scientists can be described as predominantly insular with collaborators more likely to be from other Philippine sites. While foreign collaboration is a small proportion of the total aggregate collaboration, the most frequent would be with Japanese scientists and the least frequent would that be with U.S. scientists. This result is indeed surprising considering that the U.S. has been the primary destination of Filipino graduate students, although the rates may be declining in more recent years.

The overall pattern of collaboration derived from Table 7.1 is consistent with the claim that Philippine and Japanese scientists tend to develop strong collaborative linkages, especially among Philippine scientists who were trained in Japanese universities. This is not usually the case for Philippine scientists on the one hand and Australian and U.S. scientists on the other hand. Based on qualitative interviews with Philippine scientists, there are a number of reasons for the strong relationships that develop between Philippine and Japanese scientists.

First, Japanese professors typically and actively seek out collaborations with their former Filipino graduate students. In this research "joint-venture" both sides have a need for each other and have an almost equal contribution. In other words, the relationship is a "two-sided collaboration affair" characterized by mutual help and reciprocal need. Such a dyadic configuration makes a relationship durable and sustainable, as it is consistent with the norm of reciprocity: Japanese professors typically provide the equipment and materials needed in a research project, while Filipino scientists provide needed labor, necessary laboratory skills, and the English language proficiency necessary for publication in international journals and presentation at international conferences. Second, Japanese scientific training typically involves close and intense interaction, which effectively permits the transmission of tacit skills and the development of close and personal informal ties, which far outlive the duration of graduate training. For Australian and U.S. scientists, there seem to be no gains in collaborating with Filipino scientists, as Australian and American scientists have already all the needed inputs to scientific research.

At the surface, it appears that most Philippine-Australian and Philippine-American collaborations are usually lop-sided if not a truly one-sided relationships, in that most of the benefits go to Filipino scientists, while most of the costs go to their Australian and American counterparts. Also, Filipino scientists trained in Australia and the United States claim that the scientific training in these locations tends to be formal and impersonal. The impersonality of the relationship is salient when compared to the relationship of Filipino graduate students with their Japanese professors. This does not mean to say that Filipino graduate students do not develop friendships with their Australian and American professors; what this implies is that given the relatively formal and impersonal connection between Philippine graduate students and their Australian and American professors, these connections may tend to weaken and fade faster than Philippine-Japanese ties long after graduation and return to the Philippines. Without the ethnographic interviews, these insights would not have been unraveled.

Scientific Collaboration and Place of Graduate Education

With place of graduate education occupying a central role in this study's conceptual framework, this section explores differences in collaboration indicators across four scientific training structures, or place of graduate education--Australian, Japanese, U.S., and Philippine. In Table 7.2, I present results of a multiple comparison of means and/or proportions after ANOVA for the eight collaboration indicators listed in Table 7.1. Clearly, there are no significant differences in the number of collaborative research projects among Philippine scientists trained in Australia, Japan, the United States, and the Philippines. The overall mean of two collaborative projects is consistent across training structures, implying no significant collaboration advantage of one training structure over the other, and no significant collaboration advantage of core-trained scientists over locally trained scientists. For each training structure or place of graduate education, a majority of scientists in each category has a collaborative project. For each place of graduate education, having no collaboration is a minority behavior. However, given the collaboration indicators used in this study, there is no way to gauge either prestige or

Table 7.2: Mean Comparison of Philippine Scientists' Scientific Collaboration Pattern

Collaboration Indicators[1]	Place of Graduate Education: Australia Mean [1]	Australia SD	Japan Mean [2]	Japan SD	United States Mean [3]	United States SD	Philippines Mean [4]	Philippines SD	LSD Pairwise Comparisons[2] 1-4	2-4	3-4	1-3	2-3	1-2
R collaborates (1=yes; 0=no)	0.91	0.28	0.91	0.29	0.85	0.36	0.83	0.38						
Number of collaborative projects (range: 0-3)	2.06	1.00	2.09	1.06	1.91	1.06	1.81	1.10						
R has collaborators in immediate survey site	0.46	0.51	0.47	0.50	0.45	0.50	0.36	0.48						
R has collaborators in other Philippine sites	0.57	0.50	0.55	0.50	0.52	0.50	0.58	0.49						
R has collaborators in Australia	0.14	0.35	0.00	0.00	0.05	0.22	0.07	0.25						
R has collaborators in Japan	0.03	0.16	0.23	0.43	0.08	0.28	0.06	0.24		*			*	*
R has collaborators in the U.S.	0.05	0.23	0.04	0.20	0.12	0.32	0.02	0.15			*			
R has collaborators in other foreign sites	0.22	0.42	0.11	0.31	0.20	0.40	0.10	0.29						

[1] except for number of collaborative projects, all other indicators are dichotomous (1=yes, 0=no)

[2] an asterisk (*) denotes pairwise comparisons which are significant at the 5% level by a least significant difference test

[3] a Kruskal-Wallis test based on a chi-square distribution yields the same results at the 5% level

quality of a collaborative project. The indicators listed in Table 7.1 mainly measure the number of collaborations and the presence/absence of collaborators in specific locations.

For all four places of graduate education, results reveal that Philippine scientists, regardless of training background, collaborate more with other Philippine scientists and much less with foreign scientists. Having foreign collaborators is a minority behavior among the Filipino scientists surveyed. However, the tendency to collaborate with other Philippine scientists needs to be qualified: although Philippine scientists collaborate with other Philippine scientists, collaborators are typically located in different geographical locations. Furthermore, examination of Table 7.2 shows that foreign-trained Philippine scientists have most of their foreign collaborators in places where they trained. For example, those who were trained in Australia have a substantial proportion of their foreign collaborators in Australia, those were trained in Japan have a large proportion of their foreign collaborators in Japan, and those trained in the U.S. have a significant proportion of their foreign collaborators in the U.S.

The results presented in Table 7.2 suggest that core-peripheral collaborations are somehow conditioned by place of graduate education, and collaboration between foreign professors and Philippine graduate students is most frequent among Japanese professors and Japanese-trained Philippine scientists. The results from Tables 7.1 and 7.2 seem to go against expectation if indeed there is an on-going tendency for scientific institutions to be isomorphic, especially so that there are training structures that seem to be conducive to the development of stronger collaborative ties than others. While science itself may be a global institution, its specific forms and practices from one location to another seem to be configured substantially by the larger cultural and social systems in which they are embedded and immersed. It has been reiterated in this study that the scientific training practice in Japan tends to result to different collaborative practices and networking behavior compared to those of Australia, the U.S., and the Philippines.

Correlates of Scientific Collaboration

Electronic network communication (i.e., email) was developed primarily for scientific communication. With the advent of the Internet and development of electronic mail, much of the excitement and expectation centers on these technologies' ability to facilitate communalism and universalism in science through on-line scientific networking and scientific collaboration among non-collocated knowledge producers. Many studies in STS have examined scientific productivity as a function of scientific collaboration, but none have yet examined the role of social networks in understanding the relationship between scientific collaboration and scientific productivity. For example, Lee and Bozeman (2005) have explored scientific productivity mainly as a function of scientific collaboration, but do not include professional social network characteristics as entities to consider in their scientific production function. **While there are many studies concerning social network and scientific collaboration, very few have viewed them as two distinct social phenomena.** This distinction is implied when Newman (2001) argues that "there are many scientists who know one another to some degree but have never collaborated on the writing of a paper." Also, there are instances when scientists consult their close contacts on an informal or contractual basis so that in the final publication of papers these contacts are not listed as authors but are merely relegated to acknowledgment footnotes.

Hence, I argue that although there maybe a bi-directional causal relationship between professional network and scientific collaboration, the relationship basically starts off from social networks with the net flow going from professional networks to scientific collaboration rather than the other way around. In other words, social network plays a causally prior role with respect to scientific collaboration. In this section, I explore factors that influence scientific collaboration with particular emphasis on the effects of level and place of graduate education, Internet use behavior, and professional social network structure of respondent scientists.

Table 7.3 presents the results of regression analyses for (1) number of collaborative projects, (2) whether or not respondent collaborates, (3) whether or not respondent has collaborators in the immediate survey site but not in the same department or research institute, and (4) whether or not respondent has collaborators in other Philippine sites. The series of regression analyses is carried out starting with a baseline regression equation that includes contextual, personal, professional, and educational attributes as regressors. This is labeled M1. The second model builds on M1 and includes aspects of Internet use behavior in the equation, and is termed M2. The third and final equation builds on M2, which further includes aspects of respondents' social networks, and is denoted M3.[22] Number of collaborative projects is modeled by way of a normal error regression analysis. The other three measures of collaboration are modeled by employing a binary logistic regression approach.

Whether or not respondents participate in collaborative work shows no significant relationship with any of the independent variables. In contrast, the number of collaborative projects scientists have, which is at the ratio level of measurement exhibits a positive association with being male (b = 0.15), using email in diverse ways (b = 0.20), and having a large professional network (b = 0.14). A shift from a nominal to a ratio level of measurement clearly results in different findings, which imply that a binary measure of collaboration may have made the indicator much less reliable, and thus it is more difficult to detect the effects of the independent variables in the models. As previously observed in Table 7.1, domestic

[22] Social network variables in the regression models are number of contacts, proportion of contacts who are male, and proportion of contacts who are at the core. These variables best represent relevant features of Filipino scientists' professional network.

Table 7.3: Regression Analyses for Number of Collaborations, Any Collaboration, and Has Local Collaborators

Independent Variables[1]	Number of Collaborative Projects (Range: 0-3)[2]			R Collaborates (1=yes, 0=no)			R has Collaborators in Immediate Survey Site (1=yes,0=no)			R has Collaborators in Other Philippine Sites (1=yes, 0=no)		
	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3
Intercept				-1.10	-2.22	-2.59	-2.23 *	-1.37	-1.18	-0.51	-0.28	-0.36
Location (1=Los Baños, 0=Muñoz)	0.02	0.00	0.01	0.30	0.00	0.11	0.97 ***	0.94 **	0.97 **	0.18	-0.06	-0.05
Sector (1=research inst., 0=state univ.)	0.10	0.07	0.05	0.68	0.42	0.30	0.93 **	0.92 **	0.77 *	0.24	0.04	0.16
Age (in years)	0.07	0.11	0.11	0.04	0.06	0.06	0.01	0.02	0.02	0.01	0.02	0.02
Gender (1=male, 0=female)	0.12	0.10	0.15 *	0.50	0.56	0.54	0.56 *	0.57 *	0.74 *	0.67 *	0.66 *	0.60
Marital status (1=married, 0=not married)	-0.02	-0.02	-0.02	-0.37	-0.36	-0.47	0.11	0.09	0.15	-0.11	-0.21	-0.28
Number of children	0.01	0.01	-0.01	0.01	0.00	0.00	-0.19	-0.19	-0.18	0.12	0.13	0.10
Computer in personal office (1=yes, 0=no)	0.11	0.09	0.09	0.67	0.54	0.45	0.26	0.27	0.25	0.07	0.00	0.02
No. of people sharing office computer	0.07	0.09	0.09	0.07	0.08	0.09	-0.01	-0.01	-0.02	0.04	0.04	0.05
Member of professional org (1=yes, 0=no)	0.09	0.05	0.05	0.06	-0.70	-0.88	0.34	0.34	0.22	-0.20	-0.71	-0.63
Has a Ph.D. (1=yes, 0=no)	-0.02	-0.08	-0.09	-0.28	-0.57	-0.66	0.13	0.14	0.04	0.25	0.06	0.15
Australian trained (1=yes, 0=no)	0.08	0.05	0.06	1.17	0.59	0.59	0.09	0.07	-0.06	-0.16	-0.49	-0.30
Japanese trained (1=yes, 0=no)	0.08	0.08	0.10	1.06	0.85	0.70	-0.09	-0.09	-0.25	-0.53	-0.63	-0.39
United States trained (1=yes, 0=no)	-0.01	-0.03	-0.02	0.03	-0.31	-0.45	-0.10	-0.14	-0.28	-0.73 *	-0.89 *	-0.71
Current email user (1=yes, 0=no)	-	0.00	-0.02	-	-0.48	-0.35	-	-0.62	-0.76	-	-1.95	-1.93
Has ready email access (1=yes, 0=no)	-	0.03	0.03	-	0.53	0.37	-	-0.51	-0.55	-	1.23	1.19
Hours in a week using email	-	-0.06	-0.07	-	-0.04	-0.05	-	-0.02	-0.02	-	-0.03	-0.03
Years using email	-	0.06	0.05	-	0.11	0.11	-	0.02	0.02	-	0.05	0.05
Email use diversity (6=diverse, 0=not diverse)	-	0.21 **	0.20 **	-	0.30 *	0.24	-	0.02	-0.01	-	0.22 **	0.24 **
Total number of contacts	-	-	0.14 *	-	-	0.08	-	-	0.05	-	-	0.00
Proportion of contacts who are male	-	-	-0.08	-	-	0.53	-	-	-0.43	-	-	0.16
Proportion of contacts who are at the core	-	-	0.01	-	-	0.81	-	-	1.36 *	-	-	-1.40 *
Coefficient of determination (R-sqaure)[3]	0.06	0.10	0.12	0.10	0.18	0.19	0.11	0.11	0.14	0.06	0.13	0.15

[1] *, **, *** denote coefficients which are significant at the 5%, 1%, and 0.1% level, respectively.

[2] Ordinary least squares regression for number of collaborative projects; binary logistics regression for other indicators.

[3] Except for number of collaborative projects, R-square value is calculated using Nagelkerke correction of the Cox and Snell technique.

collaborators are split into two categories: collaborators in the immediate survey site and collaborators in other Philippine sites.

Descriptive statistics have shown that having collaborators in the immediate survey site is a minority behavior when compared to those having collaborators in other Philippine sites. Scientists in the premier scientific community (b = 0.97), working in government research institutes (b = 0.77), males (b = 0.74), and who have higher proportions of core-based contacts (b=1.36) tend to have collaborators in the immediate survey site. Level and place of graduate education and Internet use behavior do not play any significant role. In contrast, those who have collaborators in other Philippine sites are associated with diverse email use and lower proportions of core-based contacts. Internet use behavior this time plays an important role, although level and place of graduate education are still not significant entities. This implies that Internet use in general and advanced email skills in particular tend to link domestic non-collocated scientists. In a way, the Internet facilitates the working together of scientists located in different scientific sites in the Philippines.

Table 7.4 presents a similar set of analyses as Table 7.3. In Table 7.4, the response variables are (1) whether or not respondent has collaborators in Australia, (2) whether or not respondent has collaborators in Japan, (3) whether or not respondent has collaborators in the U.S., and (4) whether or not respondent has collaborator in other foreign locations. Male scientists (b = 2.06) and those who have a higher proportion of core-based contacts (b = 4.90) are significantly more likely to have collaborators in Australia. Scientists who are in government research institutes (b = 1.33), trained in Japan (b = 1.61), and who are not current email users (b = -3.71) are more likely to have collaborators in Japan. Philippine knowledge producers who have larger professional networks (b = 0.25) tend to have collaborators in the U.S, while those

Table 7.4: Binary Logistic Regression Analyses for Having Foreign Collaborators

Independent Variables[1]	R has Collaborators in Australia (1=yes, 0=no)			R has Collaborators in Japan (1=yes, 0=no)			R has Collaborators in the U.S. (1=yes, 0=no)			R has Collaborators in Other Foreign Sites (1=yes, 0=no)		
	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3
Intercept	-22.39	-56.19	-54.48	-19.70	-33.67	-34.75	-20.63	-53.50	-52.46	-4.87 *	-40.54	-40.72
Location (1=Los Baños, 0=Muñoz)	0.11	-0.16	-0.23	-0.92	-1.00	-0.95	0.75	0.45	0.69	0.28	0.22	0.27
Sector (1=research inst., 0=state univ.)	0.61	0.54	-0.03	1.32 *	1.40 *	1.33 *	1.74 *	1.60 *	1.49	0.27	0.19	0.19
Age (in years)	0.03	0.05	0.07	-0.03	-0.06	-0.06	-0.05	-0.02	-0.01	-0.01	0.01	0.01
Gender (1=male, 0=female)	1.48 *	1.42 *	2.06 *	0.31	0.46	0.16	-0.36	-0.75	-0.66	0.16	-0.09	-0.16
Marital Status (1=married,0=not married)	-0.88	-1.02	-1.13	-0.71	-0.96	-1.17	-1.25	-1.00	-1.13	-0.06	0.03	-0.10
Number of children	-0.09	-0.18	-0.03	0.09	0.12	0.13	0.04	0.04	-0.14	0.26	0.27	0.23
Computer in personal office (1=yes, 0=no)	-0.35	-0.71	-1.09	-0.04	0.14	-0.06	0.71	0.72	0.84	0.91 *	0.82	0.78
No. of people sharing office computer	-0.07	-0.08	-0.10	-0.08	-0.09	-0.08	0.07	0.11	0.09	0.10 *	0.11 *	0.11 *
Member of professional org (1=yes, 0=no)	18.72	18.23	17.19	18.52	18.30	18.10	16.65	16.26	16.08	0.33	-0.15	-0.11
Has a Ph.D. (1=yes, 0=no)	-0.23	-0.83	-1.29	-0.32	-0.01	0.10	2.44 *	1.84	1.79	1.31 *	1.03	1.04
Australian trained (1=yes,0=no)	0.72	0.60	0.18	-0.66	-0.21	-0.31	0.48	-0.09	0.33	1.24 *	0.91	1.08
Japanese trained (1=yes,0=no)	-18.83	-18.70	-19.04	1.83 **	2.01 **	1.61 *	-0.40	-0.41	0.08	-0.32	-0.38	-0.20
United States trained (1=yes,0=no)	-0.40	-0.24	-0.79	0.89	1.28	0.87	1.60 *	1.21	1.70	0.39	0.35	0.43
Current email user (1=yes, 0=no)	-	15.64	14.54	-	-3.93 *	-3.71 *	-	14.12	13.09	-	16.39	16.35
Has ready email access (1=yes, 0=no)	-	16.74	16.05	-	19.87	19.81	-	16.42	15.17	-	18.47	18.27
Hours in a week using email	-	-0.07	-0.09	-	0.03	0.02	-	0.08	0.06	-	0.07	0.07
Years using email	-	0.00	-0.01	-	-0.12	-0.11	-	0.14	0.10	-	0.02	0.02
Email use diversity (6=diverse, 0=not diverse)	-	0.54 **	0.39	-	0.00	-0.05	-	0.19	0.12	-	0.17	0.15
Total number of contacts	-	-	0.16	-	-	0.06	-	-	0.25 *	-	-	0.06
Proportion of contacts who are male	-	-	-1.13	-	-	1.95	-	-	0.33	-	-	0.43
Proportion of contacts who are at the core	-	-	4.90 **	-	-	0.72	-	-	-1.19	-	-	-0.90
Coefficient of determination (R-sqaure)[2]	0.17	0.27	0.39	0.27	0.33	0.35	0.24	0.30	0.37	0.17	0.22	0.23

[1] *, **, *** denote coefficients which are significant at the 5%, 1%, and 0.1% level, respectively.

[2] R-square value is calculated using Nagelkerke correction of the Cox and Snell technique.

who share computers with many others (b = 0.11) tend to have collaborators in other foreign sites. It is surprising to note that variables related to Internet use behavior do not play a centrally important role in the presence or absence of foreign collaborators. Results would have been much different had there been a significant impact of the Internet upon foreign collaboration. Among graduate-education variables, level of education is not a stable and important determinant while place of graduate education has a significant role but it is quite focused on the effect on Japanese graduate training. This puts into question the claim of institutional theory and the limited translation model of science that knowledge production as an institution has achieved isomorphism at the scientific core. Results show that Japanese training culture differs significantly with those of Australia and the U.S. in terms of collaborative work.

Essentially, the regression results presented in Tables 7.3 and 7.4 pertain to the numeric and non-numeric aspects of scientific collaboration. For the numeric aspect, it is clear that the number of collaborative activities a scientist is involved in is primarily a function of gender, email use diversity, and network size. Male scientists tend to have more collaborative projects than female scientists. This is an interesting finding because such an ascription-based attribute seems inconsistent with the norms of science, which forwards universalistic criteria and merit-based rewards. While there may be no direct intentions to relegate women to the margins, it is probably the case that male scientists tend to have access to positions and opportunities that result in collaborative work. It could also be the case that in Philippine society men are more socialized to be outgoing and engaging than women.

Hargittai (2002) has distinguished between a first-order and second-order digital divide. Sophisticated use of email, indicative of advanced hardware-software-user interaction skills and akin to the concept of second-order digital divide, is associated with more collaborative projects.

This outcome seems to support the assertion that the Internet tends to increase interaction and joint work among science actors. However, it should be noted that these phenomena are possible when actors themselves are Internet savvy, and not simply classified in terms of binary access and use, of first-order digital divide. In other words, simple binary access and use are not enough to increase the likelihood of participation in collaboration. What scientists need beyond their academic training are advanced access and use skills. Regression results indicate that network size influences the number of collaborative projects a scientist has. In a way this supports the social resource view about social networks, and alludes to the causal priority of social network over collaboration.

The non-numeric aspects of scientific collaboration have very different sets of determinants. For scientists who have Philippine-based collaborators, place of graduate education as a factor does not have any influential role. A scientist's place of graduate education does not determine the likelihood of having domestic collaborators. Among domestic collaborators, email use enhances collaborators who are in other Philippine sites, but not those in the immediate survey site. The role of core-based contacts is interesting for it tends to enhance on-site collaborators and diminish the likelihood of having collaborators in other Philippine sites. As to having foreign collaborators or not, place of graduate education is particularly influential in increasing the likelihood of having Japanese collaborators. Japanese-trained Philippine scientists are more likely to have Japanese collaborators and these collaborators are more often than not their professors. As empirical evidence suggests, such collaborative arrangements are not readily observable among Australian-, U.S.-, and Philippine-trained scientists.

Going back to this chapter's important question: **Do professional networks readily translate to scientific collaborators?** Based on my analysis, the answer is both yes and no. For the numeric (quantitative) dimension of scientific collaboration, the answer is straightforward. Network size, but not network quality, is directly and positively associated with the number of collaborative projects. It would be prudent to assert that larger networks yield better chances of being involved in collaborative projects. Whether or not networks are comprised of foreign contacts or possess a more gender-balanced configuration does not matter much among Filipino knowledge producers.

For the non-numeric (qualitative) dimensions, the answers deserve a number of qualifications. The proportion of contacts at the scientific core determines if a respondent will have domestic collaborators, but in totally opposite directions depending on the location of respondent and collaborator. For domestically collocated respondent and collaborator, the proportion of core-based contacts enhances the likelihood of such collaboration. For domestically non-collocated respondent and collaborator, the proportion of core-based contacts reduces the likelihood of such collaboration. As far as having foreign collaborators or not, the proportion of core-based contacts is important in having collaborators in the Australian research system, while total number of contacts is important in having collaborators in the U.S. research system.

Professional networks appear to be essential in having scientific collaborators, but this relationship is strongly configured by network size and quality, and the non-numeric aspect of collaborations like the geographical location of collaborators. This implies that contacts and collaborators are not one and the same entity. Networks form a larger superset than the set of collaborators and are also sequentially prior phenomena. Although networks seem to possess a strong relationship with scientific collaboration, the relationship is far from perfect. There is no guarantee that professional networks readily translate to scientific collaborations.

Summary

Results suggest that involvement in collaborative work is a majority behavior among Filipino knowledge producers. Whether or not respondent scientists collaborate is not as much of an issue as the number of collaborative projects scientists have. In other words, it is not binary participation in collaboration (i.e., does collaborate versus does not collaborate), but rather it is more in the number of collaborative projects that inequality chiefly emerges. The popular form of collaboration is one wherein collaborators are predominantly domestic, but based in different locations (domestic non-collocated collaborations). In other words, collaboration among Filipino knowledge producers can be described as largely insular and is more likely to be with actors in other Philippine sites.

Although foreign collaboration is a small proportion of the total aggregate collaboration, the most frequent would be with Japanese scientists, and the least would be with U.S. scientists. This observation can be explained by qualitative reports stating that Filipino graduate students trained in Japan develop strong affective and instrumental ties with their Japanese professors as a result of close monitoring and interaction, which is rarely the case with either American or Australian professors. This highlights that contrary to the claims about a universal model of knowledge production, there are significant differences in the production processes even among the scientifically strong nations. At least for now, this puts to question the claim of an emerging isomorphism among scientific cultures and institutions. It supports the claim of the socio-cultural practice and extended translation views of science that scientific institutions are shaped by the larger cultural and social system.

As to the question: **Do professional networks readily translate to scientific collaborators?** The answer is both yes and no. For quantitative indicators, **network size but**

not network quality, is directly and positively associated with number of collaborative projects. Larger networks are associated with better chances of getting involved in collaborative projects. Whether or not professional networks are comprised of more contacts at the scientific core or possess a more gender-balanced configuration does not matter in determining collaborative patterns.

For the dichotomous indicators of collaboration (i.e., whether or not respondent has collaborators in the immediate survey site, other Philippine sites, Australia, Japan, the U.S., or in some other foreign sites) the answers deserve a number of qualifications. The proportion of contacts at the scientific core determines if a respondent will have domestic collaborators, but it occurs in diametrically opposed directions depending on the location of respondent and collaborator. For **domestically collocated** respondent and collaborator, the proportion of core-based contacts enhances the likelihood of such collaboration. For **domestically non-collocated** respondent and collaborator, the proportion of core-based contacts reduces the likelihood of such collaboration. The proportion of contacts at the core exhibits a significant relationship only with having collaborators in Australia, but no significant relationships are observed with having collaborators in Japan, U.S., and other foreign sites.

In general, these pieces of empirical evidence suggest that professional networks may be important in having scientific collaborations, but their relationship is strongly configured by network size, network quality, and the geographical location of collaborators, meaning that not all network alters readily convert to science collaborators. In other words, professional networking covers a much larger domain and is typically a sequentially prior phenomenon to collaborations. However, empirical results indicate that professional networking, though sequentially prior to collaboration, may not necessarily translate or convert to collaborations.

CHAPTER 8: SCIENTIFIC PRODUCTIVITY

Introduction

In this chapter, I introduce and examine various productivity measures for knowledge producers in the Philippine research system. Most of these measures have not been given emphasis and studied by previous analysts. I begin the chapter with a discussion of the recent developments from literature concerning methods of collecting productivity data and the various measurement strategies employed by social analysts. I then move on to delve into the contextual, personal, professional, educational, email utilization, professional network, and scientific collaboration factors deemed to influence scientific productivity. Using data from the Philippines 2005 quantitative survey, I present a productivity profile for the full random sample of n = 312 Filipino scientists and then compare productivity measures across places of graduate education (i.e., Australia, Japan, the U.S., and the Philippines). Next, I go on to explore how contextual, personal, professional, educational, email utilization, professional network, and collaborative behavior configure research productivity in general. Toward the end of the chapter, I attempt to clarify the relationship between scientific collaboration and research productivity by accounting for the effect of professional networks.

As a concept, scientific productivity has many aspects to it--collections, inventions, patents, techniques, and written documents. Written documents in general and publications in particular represent one important dimension of productivity, which is seen as an indicator of individual merit (Keith et al. 2002). For Callon (1995:51), "Science is a vast enterprise of writing…without it the manufacture of knowledge would be unproductive." Various data collection methods and measurement techniques have been employed to capture the essence and understand the dynamics of this form of scientific output. Three prominent data collection methods stand out in the recent literature: (1) number of published articles derived from bibliometric databases (e.g., Long 1992; Kawamura et al. 1999), (2) self-reported productivity measures derived from surveys (e.g. mailed surveys in Walsh et al. 2000; face-to-face surveys in Duque et al. 2005; Sangowusi 2003; Xie and Shauman 1998; and Ynalvez et al. 2005), and (3) publication counts obtained from respondents' curriculum vitae (e.g. Lee and Bozeman 2005).

Data Collection Techniques

Bibliometric techniques have the capacity to provide valid and reliable estimates of scientific productivity for the analysis of research systems, but prove inadequate outside the domain of scientific systems in the developed world (Gaillard 1997; Shrum 1997 and 2005) for at least two reasons. First, developing-world scientific output is not well represented in international scientific databases, reflecting differences in priorities between local needs and global thematic interests (Shrum 1997 and 2005). Second, given the applied orientation of knowledge production in developing-world research systems, **productivity in terms of scholarly publications is not the only relevant form of output in peripheral science.** Publications other than those with primarily academic and scholarly thrusts, like articles in extension bulletins and terminal research reports, may be more meaningful and valuable locally, but are generally ignored or marginalized in international scientific circles and publication outlets.

Survey-based self-reported productivity (Barjak 2004; Campion and Shrum 2004; Duque et al. 2005; Walsh et al. 2000; Xie and Shauman 1998; Ynalvez et al. 2005) may be a better alternative to bibliometric approaches, which either systematically exclude output from developing areas due to differences in thematic emphasis, or make it difficult for peripheral scientists to publish due to differences in literary style, and the use of unknown home-grown methodologies, which appear suspect and of lower quality. In a way, methods of self-reported productivity allow for more balanced, unbiased, valid, and reliable measures of knowledge production output in the context of peripheral scientific systems, or in the absence of truly representative bibliometric databases. Xie and Shauman (1998:855) further elaborate on the reliability of self-reported productivity in the absence of a reliable and valid bibliometric methodology. For these researchers, "publication is a salient part of a scientist's work activities, and correct accounting of this information should be no less reliable than that for many other types of information (such as job history, cohabitation history, and voting behavior) commonly collected in social surveys and widely used in sociological research. Further, the mean level of productivity is roughly comparable across these surveys, and between these surveys and other studies that rely on bibliographic searches."

The curriculum vitae data-gathering method of assessing scientific productivity is ideal especially so if the vitae are up to date. While it may have been handy to use for the general population of developed-world scientists, it may not be that easy to employ it in the context of developing- world knowledge producers. For example, my own personal experience during my 2004 and 2005 Philippine surveys made me realize the following barriers to this supposedly promising methodology. First, respondents tend to have no updated copies of their curriculum vitae. The computer-sharing norm and the location of computers in public areas make updating not only difficult, but also a disturbance to my respondents--a disturbance that could also generate psychological stress and a vast amount of attention from kibitzers, who are usually quick to inquire about reasons why one is working on his/her vitae. Second, if ever respondents have their curriculum vitae handy, they were hesitant to provide me with a copy as it is thought of as a confidential and private document, which contains not only professional information but also personal data such as age, date of birth, and marital status. Hitherto, however, no systematic comparative analyses and rigorous tests have been made to accurately assess and evaluate the efficiency, reliability, and validity of these data-collection techniques.

Measurement Techniques

Several innovative measures of productivity have also been employed in recent literature. For example, Lee and Bozeman (2005) astutely distinguish between normal and fractional counts, where normal count refers to the number of all the peer-reviewed papers for each respondent. In contrast, fractional count was such that each paper was scored based on the reciprocal of the number of authors. An article with, say six authors, will be given a score of 1/6, and an article with two authors will receive a score of ½. Although Xie and Shauman (1998) conceptualized the notion of scientific productivity as having (1) an output and (2) an exposure dimension, Lee and Bozeman’s measures emphasize only the former dimension. In a rather indirect approach, the studies of Walsh et al. (2000), and Duque et al. (2005), both of which used self-reported number of publications in scholarly journals with the former using a two-year period and the latter a five-year period, somehow address the exposure dimension of productivity. Both of these studies use short-term measures, though, which Xie and Shauman (1998:849) argue are preferred over cumulative measures--measures wherein exposure time spans the whole career of respondents--when studying sex-based differences in scientific productivity.

The productivity measures used in Duque et al. (2005) and Ynalvez et al. (2005) are both akin to the normal-count short-term measures, but introduce a bifurcated productivity terrain that delineates outputs in domestic/national scholarly journals (i.e., number of articles published in national scholarly journals), from outputs in foreign/international scholarly journals (i.e., number of articles published in international scholarly journals). Barjak (2004), on the other hand, refers to another form of conceptual splits in scientific productivity representing different stages of the research process. Interestingly, Barjak (2004:12) coins the terms “formal” and “informal” forms of output, where formal outputs imply articles in peer-reviewed scholarly journals, while informal outputs refer to briefing notes, working papers, and papers presented at scientific meetings. The conceptual split between domestic versus foreign and formal versus informal output better captures the dual priorities and conflicting interests that scientists in peripheral areas experience and confront as a result of being thrown between the strong influential shifts and impulses in international science and the local demands for a more meaningful knowledge base that is better situated and oriented to solve immediate concerns than for highly abstract and alien thematic interests.

Combining the features of the domestic-foreign distinction and the formal-informal delineation in scientific output paves the way for a more comprehensive and representative conceptualization and operationalization of productivity in knowledge production systems in general. A balance between outputs considered relevant to both scientific research areas, which have a more basic-knowledge orientation and those that have an applied-knowledge orientation is imperative and makes more sense in the study of knowledge production systems in developing areas. In this research, I employ a self-reported productivity data-collection method obtained through face-to-face surveys. However, since my definition of knowledge producers is based on respondents’ scientific occupation or demand-based definition (Xie and Shauman 1998:848), I do not confine my productivity measures to those germane to the academic setting (e.g., number of articles in scholarly publications and number of scientific conferences or workshops attended). Instead, I also include other measures that have to do mainly with scientists in government research institutes, examples of which are number of bulletins for extension, number of reports written, and other similar forms of written output.

In this study, I gathered information relating to nine productivity indicators through self-reported face-to-face surveys. I asked respondents a series of questions pertaining to the number of papers written in the last 12 months, papers presented at national workshops and at international conferences, published and unpublished reports, bulletins for extension, articles in foreign and in national journals, number of book chapters written, and a dichotomous question pertaining to the receipt of professional awards. Except for the first item in this list, all other questions pertain to scientific productivity over a five-year exposure period (2000-2004). In addition, I derive two aggregate measures: one that combines the number of articles published in national journals with those published in international journals, and the other that fuses the number of papers presented at national workshops and those presented at international conferences.

The rationale for these derivations is to have aggregated measures of total productivity in scholarly journals (Xie and Shauman 1998; Walsh et al. 2000) and at professional meetings (Barjak 2004), which are comparable with previous studies. The methodological fusion of these indicators simply assumes equal weights between domestic and foreign output, as it is hard to ascertain which outlet or sphere would carry heavier weight and priority for respondent scientists.

Some would argue that productivity in foreign outlets carries more weight, as standards are more stringent, rigorous, and prestigious. Yet others would counter argue that local publications carry more weight, as these have more practical utility and further national interest and the realization of development goals. In the next section, I present summary statistics (Table

8.1) and graphs (Figure 8.1) for these indicators based on an effective sample size of n = 312 randomly selected scientists.

Productivity Profile of Filipino Scientists

Measures of scientific productivity have consistently exhibited skewed distributions. Data from my survey basically are consistent with this observation. From Table 8.1, it is readily obvious from the mean, median, and mode that the distributions are all skewed to the right, meaning that most cases have low productivity and only a few cases have high productivity. The means, medians, and modes are clearly far apart and non-coincident, indicating considerable departures from normal distributions. All skewness coefficients yield values greater than zero (Table 8.1), a feature consistent with that observable from the centrality measures. These findings are indeed within expectation and corroborate results from previous studies done in the developing world (e.g., Duque et al. 2005; Ynalvez et al. 2005). Positively skewed productivity measures are not only observed among scientists in developing areas. Studies in the scientific systems in North America and Western Europe, examples of which are the population of scientists studied by Xie and Shauman (1998) and Long (1992), also exhibit similar distribution. The consistency of the results presented in Table 8.1 and Figure 8.1 with those of previous studies in core and peripheral scientific communities provides the productivity measures employed in this study with a basis for them to be characterized as having some degree of stability, representative, and equivalence reliability (Neuman 2006).[23]

As can be gleaned from the modal values of the nine indicators in Table 8.1, most Philippine scientists had not been productive in the last five years. This scenario looks bleak

[23] According to Neuman (2006), there are three types of measurement reliability which the social researcher should shoot for: (1) stability reliability, (2) representative reliability, (3) equivalence reliability. Stability reliability refers to the stability of a measure across time; representative reliability pertains to the stability of a measure across different sub-populations; and finally, equivalence reliability refers to the consistency of a measure with other known competing indicators.

Table 8.1: Research Productivity Profile of Philippine Scientists

Productivity Indicators[1]	Mean	Median	Mode	SD	Skew[2]	Min	Max	Quartiles		
								25th	50th	75th
Papers written in the past 12 months	2.7	2.0	2.0	2.6	2.7	0.0	20.0	1.0	2.0	4.0
Papers at national workshops	5.7	3.0	0.0	8.5	6.0	0.0	104.0	1.0	3.0	7.0
Papers at international conferences	1.8	1.0	0.0	3.1	5.9	0.0	38.0	0.0	1.0	2.0
Papers in national and international meetings[3]	7.4	5.0	0.0	10.0	4.8	0.0	110.0	2.0	5.0	10.0
Reports (published or otherwise)	5.8	4.0	0.0	6.6	2.5	0.0	50.0	2.0	4.0	8.0
Bulletins for extension	2.5	0.0	0.0	5.7	4.3	0.0	50.0	0.0	0.0	2.0
Articles in foreign journals	1.2	0.0	0.0	2.3	3.4	0.0	18.0	0.0	0.0	2.0
Articles in national journals	1.9	1.0	0.0	3.7	4.3	0.0	30.0	0.0	1.0	2.0
Articles in national and foreign journals[4]	3.1	1.0	0.0	4.9	3.3	0.0	36.0	0.0	1.0	4.0
Chapters in books	0.7	0.0	0.0	1.8	5.7	0.0	20.0	0.0	0.0	1.0

[1] except for papers in the last 12 months, research productivity indicators cover the period since January 2000

[2] measures the extent and direction of asymmetry. A symmetric distribution such as the Gaussian curve (or the normal distribution) has a skewness of 0, and a distribution that is skewed to the left, e.g., when the mean is less than the median, has a negative skewness. A distribution that is skewed to the right, e.g., when the mean is greater than the median, has a positive skewness.

[3] total of papers at national workshops and at international conferences

[4] total of papers published in national and international journals

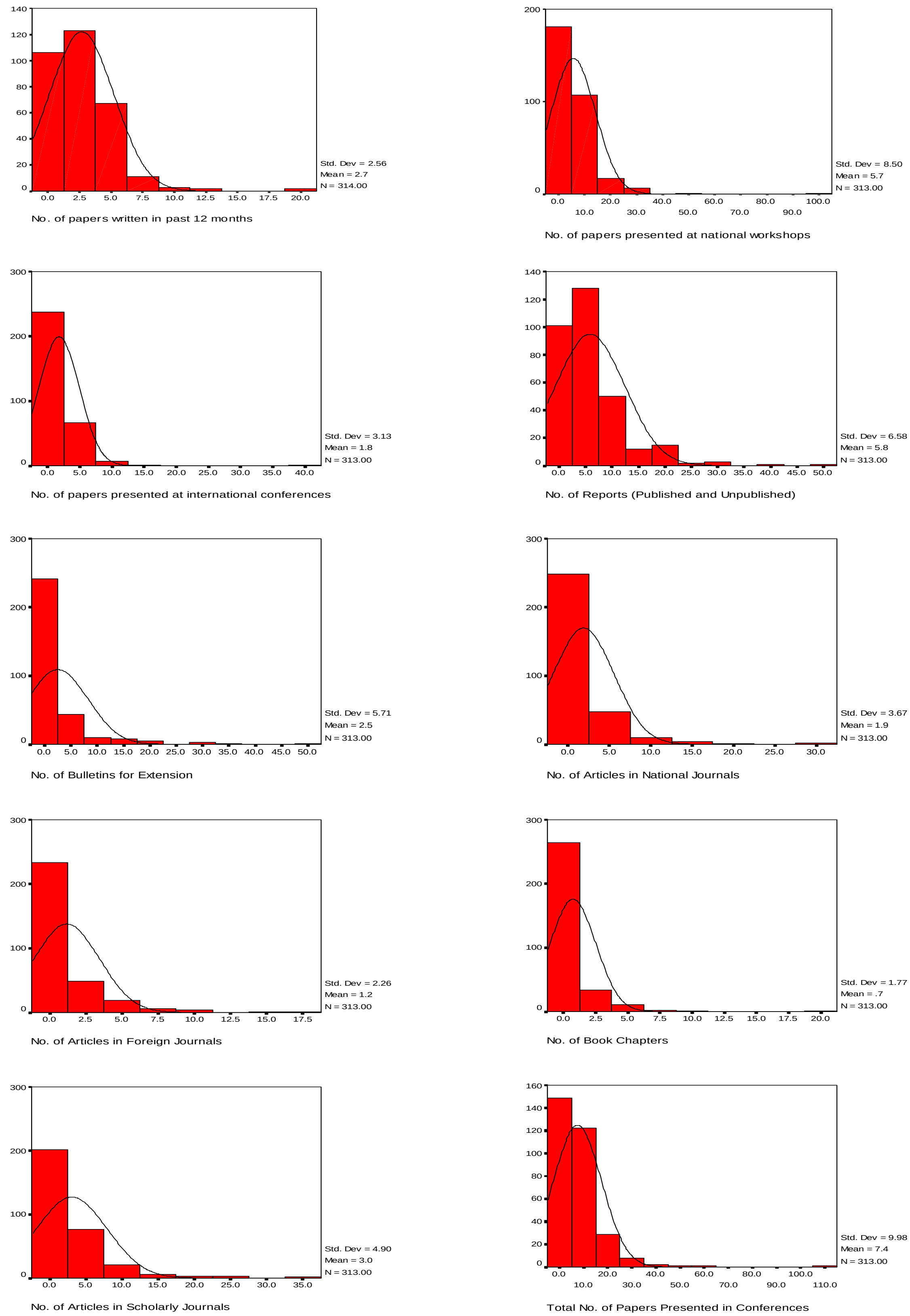

Figure 8.1: Frequency Distributions of Filipino Scientists' Research Productivity Measures

especially if these indicators accurately characterize the productive capacity of the country's premier scientific research organizations. High productivity in the last five years is indeed a minority behavior among Philippine knowledge producers. Most will not have any visible or concrete output except having written two papers in the last 12 months, which are mostly not for publication. Based on the column containing the estimates for the medians, which should give a more accurate picture given that productivity measures are positively skewed, Philippine scientists typically will have written two papers in the last 12 months, presented three papers at national workshops, presented a paper in an international conference, written four reports, written no article in bulletins for extension, will have published one article in a national journal, and will have no published article in an international journal. But again, despite these sporadic none zero indicators, it should be noted that most scientists had been unproductive in the last five years. Reasons for this dismal research productivity are lack of government funding, obsolete or derelict equipment and resources, and frequent power outages both during the day and in the evening.

From a Barjakian (2004) perspective where written papers, papers presented at national and international conferences, and published in national and international journals represent different stages in the scientific knowledge production process, the results presented in Table 8.1 imply that productivity is relatively high at earlier stages, but tends to taper away--almost to the point of zero productivity--toward the final production output, which is scholarly publication. From a foreign/domestic outlet distinction, Philippine scientists tend to have extremely low productivity in the international scientific arena. It is not clear whether Philippine submissions to international journals are systematically weeded out for reasons of differences in thematic emphasis, methodological soundness, or level of sophistication. However, there are claims that these extremely low performances in international productivity outlets reflects the counter-productive effects of having many courses to teach and the intense time demand of attempting to publish in international journals.

Together with the estimates from the column for the means, these summary statistics exemplify distinct attributes of scientific productivity in Philippine scientific research systems. First, scientists are relatively visible in domestic rather than foreign outlets. This could mean that the priorities and goals of Philippine knowledge production systems may be different from those of the international science community. For example, the problems and issues that their research addresses may be systematically different from those in the U.S. or Western Europe. Second, there seems to be evidence that Philippine scientists, although actively involved in research, are not oriented toward having their works published in scholarly journals. This observation had been alluded to by one of my informants during my exploratory visit to Los Baños in July 2004. This informant, a well-respected and distinguished professor, described the productivity situation this way: “Scientists actively engage in research, but they do not bother to have it published in scholarly journals as this takes a lot of time to do. Scientists much prefer to write and finish the terminal report for their research projects, and submit it so as to claim their honoraria. They then seek other research projects to have consultancy jobs, or write another research proposal to obtain research grants where they could again have honoraria. Publication in scholarly journals is not an attractive goal to aim for, but high consultancy fees and large honoraria are.” To obviate this practice and have the “scientific production machinery” jump-started, the university has come up with a strategy wherein researchers who are able to publish their work in ISI journals are awarded PHP 50,000; this is roughly equivalent to U.S. $1,000 in 2004.[24] If the publication is a result of a scientific collaboration, then this amount is equally divided among the authors. During my visits to the Philippines (June-July 2004, and January-February 2005), I have not had the opportunity to follow-up on how exactly this strategy actually turned out.

On average, Philippine scientists publish 3.1 articles in national and international journals combined over a five-year period. In contrast, scientists in Kerala, India, Ghana, and Kenya published an average of 7.0, 3.6, and 2.5 articles, respectively (Ynalvez et al. 2005). This trend is not as one would expect from the level of socioeconomic development of each of these locations. In terms of the per capita gross domestic product and human development index, the Philippines ranks higher that any of these three locations. Although, the correlation between scientific development and socioeconomic development is strong, it is by no means a perfect one. This may suggest that scientific productivity in terms of articles published in scholarly journals may not be the most important and solely relevant outlet among Philippine knowledge producers. Maybe the simplistic reliance on number of scholarly publications as a focal indicator of productivity does not translate into a full content-valid measure of knowledge production in the context of peripheral scientific communities like those in the Philippines. As mentioned earlier, the emphasis of the Philippine research system on applied research and the relegation of basic research to the fringes may well account for this pattern.

Productivity and Place of Graduate Education

In Table 8.2, I present the productivity profile of Philippine scientists by place of graduate education. Using a least significant difference (LSD) test after significant results from a set of analyses of variance (ANOVA), I compare the Australian, Japanese, United States, and Philippine training structures with respect to various indicators of scientific productivity. Because of the inherent positive skew of these measures, a distributional characteristic consistent with previous research using bibliographic and self-reported productivity measures (Xie and Shauman 1998), I carry out the statistical analyses by transforming the raw data into their natural logarithmic form. The dummy variable, ever received any professional awards in the last five years, is analyzed in its original form. There are no significant differences among the four places of graduation with respect to (1) number of papers written in the last 12 months, (2) number of reports written, and (3) number of bulletin articles for extension. U.S. trained scientists are prominent in national workshops, while foreign-trained scientists, whether Australia, Japan, or U.S., are significantly visible in international conferences. Domestic-trained scientists are simply not prominent, compared to their foreign-trained colleagues, in presenting papers in national and international conferences. In contrast, U.S. training translates into a productivity advantage when it comes to national and international scientific meetings.

A similar trend is observed in terms of scholarly publication in national and international outlets. Based on the statistics presented in Table 8.2, although Japanese- and U.S.-trained scientists have higher productivity, U.S. training results in a productivity advantage in national scholarly journals. Furthermore, Japanese training seems to translate into a productivity edge in foreign scientific journals. Again, domestic-trained scientists seem to be at a disadvantage when it comes to scholarly publication in general. This disadvantage is similarly observed among domestic-trained scientists when it comes to number of book chapters written and receipt of professional awards. At the face of it, domestic-trained scientists are marginalized in most internationally recognized indicators of productivity, but are able to attain parity with foreign-trained scientists on number of papers written in the last 12 months, number of articles in bulletins for extension, and number of reports written. U.S. and Japanese training seem to be an upper hand in national and international productivity, including receipt of professional awards.

Table 8.2: Mean Comparison of Philippine Scientists' Research Productivity

Productivity Indicators[1]	Place of Graduate Education								LSD Pairwise Comparisons[2]					
	Australia		Japan		United States		Philippines							
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	1-4	2-4	3-4	1-3	2-3	1-2
	[1]		[2]		[3]		[4]							
Papers written in the past 12 months	2.8	2.4	2.9	1.7	3.0	3.1	2.5	2.6						
Papers at national workshops	5.0	4.4	5.6	6.1	8.4	14.4	4.9	6.7			*			
Papers at international conferences	2.0	2.2	2.5	2.5	2.1	3.2	1.4	3.4	*	*	*			
Papers in national and international meetings[3]	7.0	5.6	8.1	6.7	10.5	15.6	6.3	8.8	*	*	*			
Reports (published or otherwise)	5.8	6.9	5.0	4.4	5.8	5.2	6.1	7.5						
Bulletins for extension	1.1	2.6	1.9	3.5	3.9	7.3	2.5	6.0						
Articles in foreign journals	1.2	2.0	2.5	3.0	1.9	3.2	0.6	1.3	*	*	*			*
Articles in national journals	1.5	2.7	2.1	2.6	3.2	4.9	1.4	3.5		*	*	*		
Articles in national and foreign journals[4]	2.8	3.3	4.6	4.1	5.1	6.7	2.0	4.3	*	*	*	*		*
Chapters in books	0.6	1.1	0.7	1.3	1.3	2.1	0.6	1.9			*	*		

[1] except for papers in the last 12 months, research productivity indicators cover the period since January 2000

[2] least significant difference (lsd) comparisons are based on the natural log transformed values of the raw data

[3] total of papers at national workshops and at international conferences

[4] total of papers published in national and international journals

Australian training exhibits a position wherein it is more advantageous than Philippine training, but less than U.S. or Japanese training.

The Japanese training productivity advantage in foreign publications is indeed intriguing. I had initially expected that it would be more of a U.S. training advantage, but this analysis and my qualitative interview with Japanese-trained scientists prove otherwise. A plausible explanation is the basically tight-knit relationship that develops between Japanese professors and their Filipino graduate students, which is all the more strengthened by their seemingly mutual dependence, wherein Japanese professors have many of the resources to do research, while Filipino graduate students have the basic scientific skills and proficiency to write in English, which is the dominant language of science. This instrumental relationship based on mutual need for each other appears to translate to more productive results. In contrast, U.S. and Australian professors rarely establish bonds that are as strong and tight-knit as those between Japanese professors and their Filipino graduate students. It seems that the Australian and American value and practice of being highly individualistic diminishes the likelihood of developing scientifically productive long-term relationships with their Filipino graduate students. Furthermore, there may be little that Filipino graduate students can offer to their Australian or American professors that could offset the "costs" of long-distance communication, as these professors have all that is needed for knowledge production: equipment, material resources, a large pool of graduate students, and proficiency in speaking and writing in the dominant scientific language, which is English. In other words, there appears to be no strong incentive for the emergence of a symbiotic relationship between Australian or American professors and their Filipino graduate students to the degree and extent comparable to those between Japanese professors and their Filipino graduate students.

The U.S. training productivity advantage in national scholarly outlet is expected. In the Philippine scientific research system, and as corroborated by my qualitative interviews, U.S. training is highly recognized, respected, and very prestigious among members of the Philippine scientific communities. Australian and Japanese training, although prestigious, ranks second to U.S. training. The typical reaction of people is to denigrate Australian and Japanese training as being easy to obtain and having too much emphasis on graduate studies by research, wherein graduate students are not required to take courses that entail tough examinations. In other words, the prestige of U.S. training comes from (1) the difficulty in obtaining an assistantship and/or scholarship in the U.S., (2) the difficult requirement to have high TOEFL and GRE scores over and above a very good undergraduate transcript of record, (3) the difficulty and demands of taking several courses, graduate level examinations, and a general examination, and finally (4) the dissertation defense.

Determinants of Scientific Productivity

In this section, I attempt to answer the central question: what socio-technical factors determine productivity among knowledge producers in the Philippine research system? The answer is of importance to national policy formulation, decision-making, and budgetary prioritization, which are deemed crucial to the improvement of the science and research infrastructure and manpower development. It is also important to the further understanding of knowledge production in peripheral areas, especially those that are influenced by strong scientific communities in developed areas, and the diffusion of ICTs. To answer this central question, I employ a set regression analyses of the eleven productivity indicators on contextual, personal, professional, educational, email utilization, professional network, and scientific collaboration as regressors. The focal independent variables are place of graduate education and email utilization, with professional network and scientific collaboration as focal intervening factors. The presentation and discussion of findings are grouped and proceed as follows: (1) papers written in the recent past and receipt of professional awards, (2) papers presented in scientific conferences, meetings, and workshops, (3) articles published in scholarly journals, and (4) bulletins for extension, reports, and book chapters written. These groups represent four underlying types of written productivity in applied and basic scientific communities (Neuman 2006), in domestic and foreign outlets (Duque et al. 2005; Ynalvez et al. 2005), in formal and informal modes (Barjak 2004), and short- and long-term exposure (Xie and Shauman 1998).

Recently Written Papers

In Table 8.3, I present results pertaining to the number of papers written in the last 12 months. It includes productivity pertaining to all forms of written output, published or unpublished, in the recent past. It is a less formal measure of productivity in the sense that it includes not only peer-reviewed articles, but also none reviewed papers. It can be described as one with a short-term exposure of 12 months (Barjak 2004; Xie and Shauman 1998). Typical measures of productivity have exposure periods ranging from two to five years. Other researchers have also used cumulative productivity measures or total productivity over a scientist's entire career.

For papers written in the last 12 months, I employ an ordinary least squares regression analysis on the natural logarithmic transformed values. Had these values followed a bell-shaped distribution and not one that is skewed to the right, an ordinary least-squares-regression analysis on the original data would have been employed. For these regression analyses (Table 8.3) and for those that follow (Tables 8.4 – 8.6), I sequentially build three models denoted by M1, M2, M3, and M4. The baseline model, M1, includes contextual, personal, professional, and

Table 8.3: Regression Analysis for Number of Articles in the Last 12 Months (2000-2004)

Independent Variables[1]	Papers Written in last 12 months			
	M1	M2	M3	M4
Intercept	0.00	0.00	0.00	0.00
Location (1=Los Banos, 0=Munoz)	0.11	0.10	0.12	0.12
Sector (1=research inst., 0=state univ.)	0.07	0.06	0.01	-0.01
Age (in years)	-0.04	0.01	0.02	0.02
Gender (1=male, 0=female)	0.08	0.06	0.10	0.08
Marital status (1=married, 0=not married)	0.10	0.09	0.09	0.11
Number of children	-0.09	-0.10	-0.11	-0.11
Computer in personal office (1=yes, 0=no)	0.02	-0.01	-0.02	-0.01
No. of people sharing office computer	0.05	0.06	0.06	0.08
Member of professional org (1=yes, 0=no)	0.14 *	0.11	0.09	0.08
Has a Ph.D. (1=yes, 0=no)	0.19 *	0.13	0.10	0.12
Australian trained (1=yes, 0=no)	0.03	-0.01	-0.01	0.01
Japanese trained (1=yes, 0=no)	0.01	0.02	0.02	0.02
United States trained (1=yes, 0=no)	0.00	-0.02	-0.03	-0.03
Current email user (1=yes, 0=no)	-	-0.05	-0.06	-0.05
Has ready email access (1=yes, 0=no)	-	-0.06	-0.07	-0.07
Hours in a week using email	-	0.01	0.00	0.01
Years using email	-	0.06	0.05	0.04
Email use diversity (6=diverse, 0=not diverse)	-	0.25 ***	0.21 **	0.20 **
Total number of contacts	-	-	0.18 **	0.17 *
Proportion of contacts who are male	-	-	-0.06	-0.05
Proportion of contacts who are at the core	-	-	0.09	0.05
No. of collaborative projects	-	-	-	0.00
Has collaborator in survey site (1=yes, 0=no)	-	-	-	0.05
Has collaborator other Philippine sites (1=yes, 0=no)	-	-	-	0.05
Has collaborator in Australia (1=yes, 0=no)	-	-	-	0.06
Has collaborator in Japan (1=yes, 0=no)	-	-	-	0.10
Has collaborator in United States (1=yes, 0=no)	-	-	-	0.06
Has collaborator in other foreign sites (1=yes, 0=no)	-	-	-	-0.07
Coefficient of determination (R-square)	0.10	0.16	0.19	0.22

[1] *, **, *** denote coefficients which are significant at the 5%, 1%, and 0.1% level, respectively.

educational factors as regressors. In building M2, all regressors in M1 are retained with email access and use variables added into the equation. Network variables are further incorporated into M2's regressors to come up with M3. Finally, scientific collaboration variables are added to M3 to build M4. Sequentially building the scientific production function this way allows for the assessment of direct and indirect effects of the factors in these path analytic models.

Perusing Table 8.3, it is clear that email use diversity (b=0.20) and network size (b=0.17) strongly and positively influence written productivity over the last 12 months. Having a doctorate exhibits significant effects in M1, but is marginalized when email utilization is added to M2 and network size is added to M3. There are no significant effects due to differences in training structure or place of graduate education, and due to any of the scientific collaboration variables. For written productivity in the recent past, sophisticated use of email and possessing an extensive professional network play important roles. Clearly, it is neither basic email access/use, nor intensity/extent of email use experience that matter, but advanced skills and sophisticated use of email. This means that advanced hardware-software-user interaction skills translate to increased productivity; basic hardware-software access/use, and intensity/extent of hardware-software-user interaction simply do not result in scientific productivity in the last 12 months. An implication of this finding is that the digital divide may have shifted from basic access/use to more advanced human-technology interaction skills, which might render development initiative focusing on basic access and use meaningless. Furthermore, it seems that having contacts alone is not a sufficient condition for productive science and research. What is equally important is that scientists have at their disposal a large pool of other science actors that they can consult about important matters that have to do with their research and career. It is indeed surprising, especially in a cultural system that is still predominantly agrarian and traditional, where ascribed attributes still take precedence and command deference, that contextual and personal factors appears to have no direct effects on scientific productivity.

From the results shown in Table 8.3, it is clear that recently written scientific productivity is are mainly configured by advanced hardware-software-user interaction skills. Issues of basic hardware-software access and use do not play any important role. This could well imply that what matters with respect to these measures of productivity are advanced levels of digital skills and not basic levels in terms of simple access and simple use. It is also clear that level and place of graduate education and scientific collaboration do not translate into any form of inequality among Filipino scientists with respect to recently written output.

Papers Presented in Scientific Meetings

In this section, I examine a set of productivity indicators that have not been given much attention in past and more recent literature. Productivity in terms of number of papers presented in scientific conferences and professional meetings was used by Barjak (2004) and alluded to by Xie and Shauman (1998). Barjak (2004:12) contends, “These are less well-documented and counted types of publication, and are more informal than journal articles and tend to occur at different stages of the research process.” I take the approach of Barjak and go on to introduce the distinction between those papers presented in national workshops, and those presented in international conferences, because national and international scientific events translate into two distinct and qualitatively different phenomena, reflecting the priorities of global themes versus local development goals and problem-oriented interests. Furthermore, attendance to, participation in, and presentation of papers in international conferences introduce far more pressing and exacting constraints vis-à-vis national conferences (e.g., registration fees, airfares, hotel rates, and the high dependence of peripheral scientists on travel grants and sponsorship), which essentially and naturally impose differing sources of variations. Hence, I argue that, in the study of developing world scientists, separate measures and analyses for the number of papers presented in domestic and foreign conferences yield more focused and reliable results, enabling better understanding of the knowledge production process.

Table 8.4 presents the OLS regression results for productivity in professional conferences and scientific meetings.[25] As regards prominence in national workshops and meetings, empirical results suggest that scientists who have doctoral degrees (b = 0.21), extensive email experience (b = 0.15), a large professional network (b = 0.20), and a large proportion of male contacts (b = 0.19) tend to have the upper hand. Email use diversify is initially strong in M2 and M3 but unexpectedly becomes not significant in M4. However, since the collaboration variables were not significant and arguing for a parsimonious model, then email diversity can be claimed to be an important variable. Hence, certified knowledge, extensive hardware-software-user interaction, and to a certain degree advanced hardware-software-user interaction skills, an extensive network with a high proportion of male contacts translate to more productive output in national workshops. Indeed, the Internet in general seems to function as an essential scientific tool, but in order to have it work toward productive output, users should possess extensive experience and advanced hardware-software-user interaction skills. Although network generally matters, enhanced productivity is realized when professional networks are larger and are with higher proportions of male alters. The role of a traditionally ascribed sociological status in knowledge production is interesting as it highlights how seemingly rational and objective processes like science can be strongly configured by gender differentials.

In contrast, prominence in international conferences and meetings tends to be associated with having a doctorate (b = 0.25), intensive e-mail experience (b = 0.11), diverse email use (b =

Table 8.4: Regression Analysis for Number of Papers Presented in Professional Meetings (2000-2004)

Independent Variables[1]	Papers in National Workshops				Papers in International Conferences				Total Papers Presented in Conferences			
	M1	M2	M3	M4	M1	M2	M3	M4	M1	M2	M3	M4
Intercept	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Location (1=Los Banos, 0=Munoz)	-0.08	-0.13	-0.09	-0.09	-0.06	-0.07	-0.06	-0.06	-0.08	-0.11	-0.08	-0.08
Sector (1=research inst. , 0=state univ.)	0.10	0.06	0.03	0.05	0.18 **	0.16 **	0.11	0.10	0.11	0.08	0.03	0.05
Age (in years)	0.02	0.08	0.09	0.07	-0.10	-0.03	-0.03	-0.03	-0.01	0.06	0.07	0.05
Gender (1=male, 0=female)	0.07	0.04	0.01	-0.02	-0.01	-0.06	-0.02	-0.05	0.03	0.00	-0.02	-0.04
Marital status (1=married, 0=not married)	0.01	0.01	0.00	-0.01	-0.10	-0.10	-0.09	-0.06	0.00	0.00	-0.01	-0.01
Number of children	0.06	0.06	0.04	0.04	0.05	0.05	0.06	0.04	0.04	0.04	0.02	0.02
Computer in personal office (1=yes, 0=no)	0.03	0.00	-0.04	-0.04	0.05	0.00	0.00	-0.01	0.05	0.01	-0.02	-0.03
No. of people sharing office computer	0.00	0.03	0.03	0.03	0.07	0.11	0.10	0.08	0.03	0.07	0.07	0.06
Member of professional org (1=yes, 0=no)	0.13 *	0.07	0.05	0.05	0.11	0.04	0.03	0.04	0.16 **	0.09	0.07	0.07
Has a Ph.D. (1=yes, 0=no)	0.26 ***	0.20 **	0.18 *	0.21 **	0.40 ***	0.30 ***	0.27 ***	0.25 ***	0.31 ***	0.23 **	0.20 **	0.22 **
Australian trained (1=yes, 0=no)	0.08	0.00	0.02	0.01	0.15 *	0.07	0.05	0.04	0.11	0.03	0.04	0.03
Japanese trained (1=yes, 0=no)	-0.09	-0.12	-0.12	-0.10	0.03	0.01	-0.01	0.02	-0.01	-0.04	-0.04	-0.02
United States trained (1=yes, 0=no)	0.09	0.04	0.03	0.05	0.06	0.03	0.00	0.00	0.12	0.07	0.06	0.07
Current email user (1=yes, 0=no)	-	-0.03	-0.02	-0.03	-	-0.02	-0.02	-0.01	-	-0.03	-0.02	-0.02
Has ready email access (1=yes, 0=no)	-	0.08	0.06	0.06	-	0.03	0.02	0.01	-	0.08	0.06	0.06
Hours in a week using email	-	0.03	0.01	0.03	-	0.13 *	0.12 *	0.11 *	-	0.07	0.05	0.06
Years using email	-	0.16 *	0.15 *	0.15 *	-	0.08	0.08	0.07	-	0.13 *	0.12	0.12
Email use diversity (6=diverse, 0=not diverse)	-	0.22 **	0.14 *	0.11	-	0.34 ***	0.31 ***	0.28 ***	-	0.28 ***	0.21 ***	0.17 **
Total number of contacts	-	-	0.21 ***	0.20 **	-	-	0.08	0.06	-	-	0.21 ***	0.19 **
Proportion of contacts who are male	-	-	0.16 *	0.19 **	-	-	-0.05	-0.05	-	-	0.12	0.14 *
Proportion of contacts who are at the core	-	-	0.03	0.01	-	-	0.15 *	0.14 *	-	-	0.07	0.06
No. of collaborative projects	-	-	-	0.11	-	-	-	-0.05	-	-	-	0.10
Has collaborator in survey site (1=yes, 0=no)	-	-	-	-0.01	-	-	-	0.01	-	-	-	-0.02
Has collaborator other Philippine Sites (1=yes, 0=no)	-	-	-	-0.01	-	-	-	0.11	-	-	-	0.01
Has collaborator in Australia (1=yes, 0=no)	-	-	-	0.08	-	-	-	0.10	-	-	-	0.09
Has collaborator in Japan (1=yes, 0=no)	-	-	-	-0.09	-	-	-	0.04	-	-	-	-0.08
Has collaborator in United States (1=yes, 0=no)	-	-	-	-0.05	-	-	-	0.05	-	-	-	-0.02
Has collaborator in other foreign sites (1=yes, 0=no)	-	-	-	-0.03	-	-	-	0.16 **	-	-	-	0.02
Coefficient of determination (R-square)	0.15	0.23	0.29	0.31	0.22	0.37	0.39	0.43	0.19	0.30	0.36	0.38

[1] *, **, *** denote coefficients which are significant at the 5%, 1%, and 0.1% level, respectively.

0.28), a large proportion of core contacts (b = 0.14), and having a collaborator in other foreign sites (b = 0.16). Now, certified knowledge, intense hardware-software-user interaction experience, advanced hardware-software-user interaction skills, networks with higher proportions of alters from the core, and having collaborators in other foreign sites all contribute to productive output in conferences and meetings abroad. Curiously, the factors that distinguish between visibility in domestic and in foreign meetings are related to email experience and network quality. Extensive experience in terms of number of years using email, and higher proportions of male contacts enhance visibility in domestic meetings. Intensive email experience in terms of number of hours in a typical week using email, higher proportions of contacts at the core, and collaborators at some other foreign site enhance visibility at foreign meetings.

Between male and female scientists, male scientists tend to occupy higher positions and thus they tend to have more influence, power, and access to material resources in the Philippine research system. This explains why having predominantly male professional contacts in domestic scientific meetings turns into an advantage. Between domestic and core-based scientists, it is obvious that the latter have more influence, power, and access in international scientific activities than Philippine scientists so that having predominantly core-based professional contacts translates into a visibility advantage. But how do we explain the productivity advantage in national meetings resulting from extensive hardware-software-user interaction and the productivity advantage in international meetings resulting from intensive hardware-software user interaction? A possible explanation is this: intensive email use means more "continuous interaction time" for hardware-software-user interaction, while extensive e-mail means more hardware-software-user interaction time but spread thin over a period. Other things being equal, (or *ceteris paribus*) "continuous interaction time" means having gained more momentum in what one is doing. With the more exacting requirements for participation and visibility in international meetings, coupled with the limited opportunities for Internet use in the Philippine research system, it seems logical to argue that intensive use would be more firmly associated with productivity in meetings abroad.

Total number of papers in scientific meetings--domestic and foreign combined--is mainly configured by having a doctorate (b=0.22), diversity of email use (b=0.17), network size (b=0.19), and proportion of male contacts (b=0.14). With the larger sample size for Philippine-trained scientists and the predominantly domestic-presented papers (see Table 8.1), it is not surprising that the results for the combined productivity count closely resemble those of number of papers presented domestically. These results suggest that although there are commonalities among the factors influencing visibility in domestic and in foreign conferences, there are also important differences relating to hardware-software-user interaction experience and the quality of professional contacts. Compared to the combined foreign and domestic counts, the separate counts for foreign and domestic conferences seem to provide a more accurate picture of the knowledge production process. The combined productivity count, although yielding a higher coefficient of determination (0.38), clearly fails to unmask the significant effects due to different aspects of email experience and quality of professional contacts. These findings suggest that the measuring productivity in the context of peripheral scientific areas--areas whose research priorities attempts to balance local needs and foreign donor interests--should refrain from combining domestic and foreign productivity and confirm the use of a bifurcated measures of productivity.

Articles Published in Scholarly Journals

Regression results for productivity in scholarly journals are shown in Table 8.5. Number of articles published in scholarly journals has been a frequently used measure (e.g., Duque et al

2005; Lee and Bozeman 2005; Xie and Shauman 1998) of written scientific productivity, but not without any weaknesses (Barjak 2004). Consistent with Duque et al. (2005) and Ynalvez et al. (2005), I distinguish between publications in national (or domestic) journals, and those in international (foreign) journals. The distinction between these two types of journal productivity is essential because in developing areas their relationship has been shown to be weak and absent, which implies that there may be no single underlying journal productivity dimension. National and international productivity points to two distinct phenomena reflecting the priorities of careers in international science versus local development priorities, or the advantages of training in the developed world (Shrum 1997) versus local manpower development. Given the peripheral role of Philippine knowledge production in the context of a global scientific system, important research themes and relevant scientific outlets are almost always split between local needs and international themes as a consequence of the often-conflicting priorities and emphases between these two spheres. Furthermore, the review process, acceptance criteria, and prestige are not the same for local journals in the developing world and foreign journals in the developed world (Ynalvez et al. 2005:43).

Results from the last four columns of Table 8.5 show that having a doctorate (b = 0.30), diversity of email use (b = 0.15), and total numbers of contacts (b = 0.19) significantly configure total number of publications in scholarly journals. In other words, level of education and not place of education, advanced email user skills, and large professional networks all work to enhance productivity. Somehow these imply that human capital, human-technical interaction skills, and social capital are important parameters of consideration in techno-scientific knowledge production systems. Not only does this highlight the importance of education in knowledge production, but also the relevance of having superior hardware-software-user

Table 8.5: Regression Analyses for Number of Articles Published in Scholarly Journals (2000-2004)

Independent Variables[1]	Articles in National Journals				Articles in Foreign Journals				Total Articles in Journals			
	M1	M2	M3	M4	M1	M2	M3	M4	M1	M2	M3	M4
Intercept	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Location (1=Los Banos, 0=Munoz)	0.06	0.05	0.08	0.10	0.02	-0.01	-0.01	0.00	0.09	0.06	0.09	0.11
Sector (1=research inst. , 0=state univ.)	-0.02	-0.04	-0.04	-0.03	0.07	0.04	0.00	-0.02	-0.01	-0.04	-0.07	-0.07
Age (in years)	0.05	0.07	0.08	0.07	-0.07	0.00	-0.01	0.00	-0.06	-0.01	0.00	0.00
Gender (1=male, 0=female)	0.11	0.10	0.10	0.10	-0.04	-0.07	-0.05	-0.05	0.06	0.04	0.04	0.05
Marital status (1=married, 0=not married)	0.10	0.11	0.09	0.08	-0.08	-0.09	-0.07	-0.06	0.02	0.02	0.02	0.01
Number of children	-0.05	-0.05	-0.10	-0.10	-0.02	-0.03	0.00	0.00	-0.02	-0.03	-0.04	-0.04
Computer in personal office (1=yes, 0=no)	0.06	0.05	0.03	0.03	0.13 *	0.10	0.10	0.10	0.09	0.07	0.05	0.06
No. of people sharing office computer	-0.06	-0.05	-0.04	-0.04	0.01	0.03	0.03	0.04	-0.05	-0.03	-0.02	-0.01
Member of professional org (1=yes, 0=no)	0.07	0.04	0.04	0.03	0.09	0.03	0.02	0.02	0.11 *	0.07	0.05	0.05
Has a Ph.D. (1=yes, 0=no)	0.21 **	0.18 *	0.18 *	0.21 **	0.32 ***	0.25 ***	0.23 **	0.23 **	0.35 ***	0.30 ***	0.28 ***	0.30 ***
Australian trained (1=yes, 0=no)	-0.05	-0.07	-0.03	-0.03	0.11	0.04	0.01	0.02	0.05	-0.01	0.00	0.01
Japanese trained (1=yes, 0=no)	0.03	0.02	0.07	0.05	0.18 **	0.17 *	0.12	0.11	0.12	0.11	0.11	0.09
United States trained (1=yes, 0=no)	0.08	0.07	0.10	0.10	0.14 *	0.10	0.06	0.06	0.14 *	0.11	0.10	0.10
Current email user (1=yes, 0=no)	-	0.00	0.00	0.00	-	-0.03	-0.04	-0.02	-	-0.01	0.00	0.00
Has ready email access (1=yes, 0=no)	-	0.06	0.04	0.04	-	0.01	0.01	0.01	-	0.04	0.03	0.02
Hours in a week using email	-	-0.02	-0.03	-0.02	-	0.04	0.04	0.04	-	0.03	0.01	0.02
Years using email	-	0.03	0.01	0.02	-	0.13 *	0.13 *	0.14 *	-	0.10	0.09	0.10
Email use diversity (6=diverse, 0=not diverse)	-	0.11	0.07	0.06	-	0.24 ***	0.22 ***	0.23 ***	-	0.19 **	0.14 *	0.15 *
Total number of contacts	-	-	0.21 **	0.22 **	-	-	0.00	0.01	-	-	0.17 **	0.19 **
Proportion of contacts who are male	-	-	0.05	0.05	-	-	-0.03	-0.04	-	-	0.04	0.04
Proportion of contacts who are at the core	-	-	-0.11	-0.10	-	-	0.17 **	0.15 *	-	-	0.05	0.05
No. of collaborative projects	-	-	-	0.13	-	-	-	-0.06	-	-	-	0.01
Has collaborator in survey site (1=yes, 0=no)	-	-	-	-0.09	-	-	-	0.06	-	-	-	-0.03
Has collaborator other Phil Sites (1=yes, 0=no)	-	-	-	-0.04	-	-	-	0.03	-	-	-	0.01
Has collaborator in Australia (1=yes, 0=no)	-	-	-	-0.02	-	-	-	0.01	-	-	-	-0.02
Has collaborator in Japan (1=yes, 0=no)	-	-	-	-0.01	-	-	-	0.11	-	-	-	0.05
Has collaborator in United States (1=yes, 0=no)	-	-	-	-0.06	-	-	-	0.00	-	-	-	-0.06
Has collaborator in other foreign sites (1=yes, 0=no)	-	-	-	-0.09	-	-	-	0.00	-	-	-	-0.07
Coefficient of determination (R-square)	0.16	0.18	0.22	0.24	0.23	0.30	0.32	0.34	0.28	0.33	0.35	0.36

[1] *, **, *** denote coefficients which are significant at the 5%, 1%, and 0.1% level, respectively.

interaction skills and social interaction skills. The salience of academic training, human-technical interaction proficiency, and social resources as determinants of productivity runs counter to the claim of the limited translation view of science (Callon 1995) that the science actors are objective statement givers, who are not socially influenced and therefore not amenable to social analysis. Similar to finding a job or voting behavior, scientific knowledge production is subject to the oscillation and dynamics of science actors' social connections (Granovetter 1974; Xie and Shauman 1998). As to the effect of advanced email use skills on productivity, it is both direct and indirect through network size. On the basis of this, it can be said that email is an important scientific tool in that it enhances productivity indirectly by bridging non-collocated science actors and directly by expediting the knowledge production process through timely access to information.

Looking at the first four columns of Table 8.5, having a doctorate (b = 0.21) and professional network size (b = 0.22) determine visibility in national (or domestic) journals. Quality of contacts, in terms of the proportion of male contacts or the proportion of core contacts, and scientific collaboration indicators do not really matter in terms of productivity in domestic outlets. Again, human capital, socio-technical interaction skills, and social resources occupy center stage with social resources and human capital exhibiting the strongest positive effects. Human capital is a necessary factor in local productivity, but so are socio-technical skills and social resources. In contrast, prominence in international scholarly outlets is associated with having a doctorate (b = 0.23), having extensive e-mail use (b = 0.14), diverse use of e-mail (b = 0.23), and a large proportion of contacts at the core (b = 0.15). With national journal productivity associated with a different set of influential factors compared to international journal productivity, this could possibly mean that there is indeed a conceptual split in the notion of scientific productivity that runs along the domestic/foreign distinction. While it is repeatedly interesting to note that human capital (level of graduate education), human-technical skills (email use diversity), and social capital (professional networks) enhance publication productivity in general, it is equally intriguing to note the productivity advantage observed among Japanese-trained scientists observed in M1 and M2.

Although the effect of Japanese training disappeared in M3 and M4, it was strong and consistent in M1 and M2. Here are some possible hypotheses for this observation, which may require further research to verify or nullify. One would be that Japanese training culture in general fosters intense affective and instrumental ties between Japanese mentors and Filipino graduate students, which serve as a focus for productive scientific interaction. Another would be the "symbiotic-relationship" hypothesis that both Japanese mentors and Filipino graduate students find themselves entrenched in a sustainable bilateral relationship wherein the former provides the material capital and monetary resources and the latter provides the labor and skills (e.g., proficiency in English) in an exchange relationship that results in productive output in international journals. It is worthy of note that productivity in international outlets is influenced by the quality of contact, but not the size or quantity of contacts. For prominence in international outlets, having a high proportion of contacts from the core precedes sheer network size. This is an important result for the sociology of science and for most readers who think that science works in an objective and rational fashion. What these findings suggest is that scientific merits alone are not sufficient to gain visibility in international scholarly publications. International contacts are necessary to gain visibility in the international scientific community.

<u>Bulletins, Reports, and Book Chapters Written</u>

Finally, the regression results for bulletins, reports, and book chapters written are presented in Table 8.6. Except perhaps for Barjak (2004), these indicators of written productivity have not been frequently used in previous studies. However, I include them in the general analysis of productivity because they represent an important dimension in written productivity that has been largely ignored, but may be relevant outlets in the developing world where scientific research systems are geared toward locally meaningful problem solving and more application of knowledge to the local context. Indirectly, this study contributes to the further elaboration of the generic concept of scientific productivity by broadening and categorizing the other dimensions of written output. In contrast to the more academically oriented articles published in scholarly journals, the productivity indicators presented in Table 8.6 are far less formal types of written productivity. Bulletins, reports and book chapters usually lack the rigorous double-blind peer-review process and are considered less academic and problem oriented.

With reference to the first four columns of Table 8.6, it is clear that significant correlates of bulletins written include having ready email access (b = 0.15) and, to some extent, email use diversity (b = 0.16 in M3). With the non-significance of all collaboration measures in M4, both enhance productivity in bulletins, with diversity of use having a stronger positive effect compared to simple access. While respondent's age exhibits significant effects in M1, it vanishes in M2, M3, and M4, where it fails to exhibit any statistically significant effect on bulletin productivity. It is worthy to note that contextual, personal, professional, educational, and professional network factors do not play prominent roles in bulletin productivity, which is obvious from the non-significant coefficients. Another interesting observation is that the regression models associated with bulletin productivity yield the lowest set of R^2 (i.e., 0.06 for M1, 0.11 for M2, 0.11 for M3, 0.13 for M4) values among all other types of productivity indicators. This means that most of the factors in the model do not really explain most of the

Table 8.6: Regression Analysis for Number of Bulletin for Extension, Reports, and Book Chapters Written (2000-2004)

Independent Variables[1]	Bulletins For Extension Written				Reports Written				Book Chapters Written			
	M1	M2	M3	M4	M1	M2	M3	M4	M1	M2	M3	M4
Intercept	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Location (1=Los Banos, 0=Munoz)	0.00	0.00	0.01	0.00	0.07	0.07	0.09	0.10	0.04	0.04	0.06	0.08
Sector (1=research inst. , 0=state univ.)	0.02	0.00	-0.02	0.00	0.14 *	0.13	0.12	0.11	-0.13	-0.14 *	-0.13	-0.13
Age (in years)	0.16 *	0.14	0.15	0.13	0.03	0.03	0.03	0.03	-0.02	-0.01	0.00	-0.01
Gender (1=male, 0=female)	0.02	0.01	0.02	0.00	0.06	0.05	0.04	0.03	0.01	0.00	-0.01	-0.03
Marital status (1=married, 0=not married)	0.00	0.00	0.00	0.00	-0.04	-0.04	-0.05	-0.04	0.01	0.01	-0.01	0.00
Number of children	0.03	0.04	0.02	0.02	0.10	0.10	0.07	0.06	-0.01	-0.01	-0.07	-0.07
Computer in personal office (1=yes, 0=no)	0.05	0.05	0.04	0.03	-0.16 *	-0.16 *	-0.18 **	-0.20 **	0.10	0.09	0.07	0.08
No. of people sharing office computer	-0.06	-0.06	-0.05	-0.07	-0.17 *	-0.17 *	-0.16 *	-0.18 **	0.08	0.09	0.11	0.11
Member of professional org (1=yes, 0=no)	0.00	-0.05	-0.06	-0.06	0.01	-0.01	-0.02	-0.02	0.10	0.09	0.09	0.08
Has a Ph.D. (1=yes, 0=no)	0.00	-0.04	-0.04	-0.04	0.23 **	0.20 **	0.20 **	0.20 *	0.17 *	0.14	0.16 *	0.19 *
Australian trained (1=yes, 0=no)	-0.09	-0.09	-0.08	-0.09	-0.10	-0.10	-0.07	-0.08	0.02	-0.01	0.05	0.05
Japanese trained (1=yes, 0=no)	0.01	0.02	0.03	0.05	-0.19 **	-0.18 *	-0.15 *	-0.18 *	-0.01	-0.02	0.05	0.04
United States trained (1=yes, 0=no)	0.04	0.07	0.07	0.08	-0.15 *	-0.15	-0.13	-0.14	0.13	0.12	0.17 *	0.17 *
Current email user (1=yes, 0=no)	-	-0.04	-0.05	-0.05	-	-0.02	-0.02	-0.01	-	0.03	0.03	0.03
Has ready email access (1=yes, 0=no)	-	0.16 *	0.15 *	0.15 *	-	0.02	0.01	-0.01	-	0.03	0.02	0.01
Hours in a week using email	-	-0.06	-0.06	-0.06	-	-0.05	-0.06	-0.06	-	0.05	0.04	0.06
Years using email	-	-0.09	-0.10	-0.11	-	-0.03	-0.04	-0.05	-	0.02	0.00	0.00
Email use diversity (6=diverse, 0=not diverse)	-	0.18 *	0.16 *	0.12	-	0.13	0.10	0.07	-	0.06	0.04	0.00
Total number of contacts	-	-	0.09	0.08	-	-	0.14 *	0.12	-	-	0.19 **	0.17 *
Proportion of contacts who are male	-	-	0.00	0.02	-	-	0.06	0.06	-	-	0.05	0.07
Proportion of contacts who are at the core	-	-	0.01	0.02	-	-	-0.05	-0.04	-	-	-0.19 **	-0.20 **
No. of collaborative projects	-	-	-	0.10	-	-	-	0.11	-	-	-	0.16
Has collaborator in survey site (1=yes, 0=no)	-	-	-	-0.03	-	-	-	-0.03	-	-	-	-0.07
Has collaborator other Philippine sites (1=yes, 0=no)	-	-	-	0.02	-	-	-	0.06	-	-	-	-0.01
Has collaborator in Australia (1=yes, 0=no)	-	-	-	0.03	-	-	-	-0.03	-	-	-	0.05
Has collaborator in Japan (1=yes, 0=no)	-	-	-	-0.10	-	-	-	0.06	-	-	-	0.01
Has collaborator in United States (1=yes, 0=no)	-	-	-	-0.01	-	-	-	0.05	-	-	-	0.03
Has collaborator in other foreign sites (1=yes, 0=no)	-	-	-	0.04	-	-	-	0.02	-	-	-	-0.09
Coefficient of determination (R-square)	0.06	0.11	0.11	0.13	0.11	0.13	0.15	0.17	0.13	0.14	0.20	0.22

[1] *, **, *** denote coefficients which are significant at the 5%, 1%, and 0.1% level, respectively.

variation in bulletin productivity. There may be some other important factors not included in the scope of this study that may be influencing productivity.

For reports written, important determining factors are having a personal computer in respondent's personal office (b = -0.20), number of people sharing a computer (b = -0.18), and having a doctorate (b = 0.20). Japanese-trained scientists appear to have significantly lower productivity with respect to all other training structures. Total number of contacts (b = 0.14 for M3) may be said to have some influence, considering that scientific collaboration variables to do not really play important roles so that M4 may be favored over M3 in terms of parsimony . Productive scientists are those who **do not** have computers in their personal offices, who have fewer people to share an office computer with, have doctorates, who are not trained in Japan (and to some extent have a large number of contacts). In general, the R^2 values (i.e., 0.11 for M1, 0.13 for M2, 0.15 for M3, and 0.17 for M4) for the regression models are again relatively low although not the lowest, which implies that there may be other factors not in the model that can better explain variation in report productivity. It is really intriguing how having a personal computer in one's personal office can lead to decreased productivity in the number of reports written and not have a general effect on other productivity measures.

What this result means when linked to the result of number of people sharing a computer is that scientists are more productive when there are fewer people sharing a personal computer that is set up in a public area. This result is counter-intuitive especially if one were to expect that having ready access to technology would, more or less, translate to increased productivity. But there is a counter argument that posits that too much privacy, especially to the point that there are no other people around in a confined setting, can make people "too comfortable" and lead them to either dozing-off or other forms of digression. But a public computer for as long a one has the privacy even though working in the presence of others, can translate to increased productivity. This is my personal experience whenever I work in my office all alone with the door closed, and when I work in the library's public computer terminal. I tend to be more productive in the latter than in the former.

With reference to the last four columns of Table 8.6, it is clear that book chapters written is mainly configured by having a doctorate (b = 0.19), being trained in the United States (b = 0.17), total number of contacts (b = 0.17), and proportion of contacts who are at the core (b = -0.20). In other words Philippine scientists who have doctoral degrees, were trained in the U.S., have many professional contacts, and have small proportions of core contacts are productive. Obviously, network size matters in a positive direction, while quality of contacts also matters but in a negative direction and this is interesting because both are almost the same magnitude but in opposite directions. What this means is: increasing the number of contacts by way of increasing number of foreign contacts does not enhance productivity. A strategy to enhance productivity is to increase network size by increasing the number of domestic professional contacts, not the number of professional contacts at the core. There is a clear productivity advantage for U.S.-trained scientists over those trained in Australia, Japan, or the Philippines. In general, the results depicted in Table 8.6 convey the message that, among the different types of productivity indicators, those that pertain to bulletins, reports, and book chapters written are those most unexplained by the regression models employed. Because the use of these indicators is relatively scarce in practice, further research is needed to assess and evaluate the particular productivity dimensions that these indicators measure.

Networks, Collaboration, and Productivity

Funding agencies and research productivity analysts have almost always assumed that collaboration leads to productivity (Lee and Bozeman 2005). Funds have been disbursed and grants have been awarded to collaborating scientists under the assumption that working together results in higher levels of production. Funds have also been channeled from the core to the periphery with the presumption that development initiatives from the core would improve production at the periphery. **But does collaboration really lead to increased productivity, especially in the context of peripheral knowledge production sites?** Empirical results indicate that after controlling for contextual, personal, professional, educational, email utilization, and professional network, scientific collaboration practically **does not** have any influence on research productivity. The results from Tables 8.3, 8.4, 8.5, and 8.6 support this generalized claim. Although results for papers presented at international conference yield a positive effect of having a collaborator in other foreign sites, its effect may be mainly localized to international conferences. Across all indicators of productivity, however, there are clear indications that level of graduate education (having a Ph.D.), advanced email utilization (diversity of use), and professional networks (total number of contacts, proportion of alters at the core, and proportion of alters who are male) strongly configure research output.

While professional networks somehow influence scientific collaboration, there is virtually no broad and strong influence of scientific collaboration on research productivity. It could be that involvement in scientific collaboration **generates more problems** that undermine productivity (Duque et al. 2005), so that scientists simply informally and casually consult with their professional network without really formally and officially engaging them in projects or as co-authors. Such "collaborators" usually find themselves in acknowledgment footnotes rather than in the list of authors. For example, there were instances in my career as a consulting statistician at the University of the Philippines at Los Baños, the International Rice Research Institute, and the Asian Development Bank where I was informally consulted and requested to do analysis and found my name in the acknowledgments, but not as an author. For a more intense contribution, I would find myself receiving additional gifts, some form of payment, or being treated for dinner. It appears that this strategy to get bits and pieces of necessary skills and information from many people is more sustainable than engaging in formal collaboration, which demands so much coordination and problems of having things done and submitted on time.

Summary

Measures of scientific productivity have consistently exhibited skewed distributions. These findings corroborate results from previous studies in both the developed and developing world. This provides the measures employed in this study with a basis for reliability. These productivity measures paint a scene that appears "bleak," especially if these accurately characterize the productive capacity of the country's premier scientific research organizations. Based on qualitative interviews, reasons for this dismal research productivity are lack of government funding, obsolete or derelict equipment, and frequent power outages. These results further exemplify the distinct nature of knowledge production in the Philippine scientific research system. First, scientists are relatively visible in domestic rather than foreign outlets. Second, there seems to be evidence that scientists, although actively involved in research, are not oriented toward having their works published in scholarly journals for practical reasons.

Results further indicate that after controlling for other factors, scientific collaboration **does not** have any influence on research productivity. Across all indicators of productivity, however, there are clear indications that having a doctoral degree, possessing advanced hardware-software-user interaction skills, having large networks, having more contacts at the core, and having a large proportion of alters who are male strongly configure research output. While professional networks somehow influence scientific collaboration, there is virtually no influence of collaboration behavior on productivity. **It could be that involvement in collaboration generates problems that undermine productivity so that scientists simply informally and casually activate their network without really formally and officially engaging them in projects.** Such “collaborators” usually find themselves in acknowledgment footnotes rather than in the author list. It appears that this strategy of informal consultations with network alters is more sustainable and less problematic than engaging in formal collaboration.

CHAPTER 9: SUMMARY AND CONCLUSION

This dissertation delved into the impact of new information and communication technologies in general and the Internet in particular on the knowledge production process (or science) in peripheral areas. Toward this end, concepts, methods, and perspectives at the intersection of science and technology studies, sociology of international development, and social network analysis were employed. Likewise, this research attempted to shed light on the under-researched aspects of knowledge production in peripheral areas: **the simultaneous influence of scientifically strong countries on the dynamics of Internet use and on the knowledge production process at the global periphery**. The study of the simultaneous influence of scientifically strong countries on scientifically weak countries by way of educating peripheral knowledge producers in the knowledge production sites at the core has not yet been systematically studied, and it introduces a new strand of research in post-colonial scientific influence.

More specifically, this research examined and characterized the expansion of the Internet and its impacts on the nature and dynamics of knowledge production in the Philippine scientific research system. It focused on those aspects of science that have to do with Philippine scientists' use of the Internet, their professional network, scientific collaborative behavior, and research productivity. The focus on Philippine scientific communities was mainly due to the rare opportunity about their nature and dynamics as well as their manpower development which are strongly influenced by the doctoral-degree granting institutions of three culturally, economically, scientifically, and technologically strong countries: Australia, Japan, and the United States. Consistent with the general research objective, this research essentially attempted to answer the following questions: First, does place of graduate education (i.e., whether having trained in

Australia, Japan, the United States, or the Philippines) influence Filipino scientists' Internet use behavior – their current use, ready access, intensity, extent, and diversity of use? A corollary question is: Does place of graduate education translate to yet another important dimension of the digital inequality in the knowledge production process? Second, do place of graduate education and Internet use behavior jointly but independently affect the attributes of Filipino scientists' professional network structure? Third, do place of graduate education, Internet use behavior, and professional network structure their collaborative behavior and research productivity? Fourth, how does scientific collaboration relate to research productivity? In answering this question, this research attempted to elaborate on the relationship between collaboration and productivity, by introducing professional networks into the equation. In other words, the study attempted to explore if social networks affected productivity mainly through collaboration. Or is it the case that collaboration is influenced by social networks, but does not yield to any outstanding effect on productivity in peripheral areas.

Owing to a history of diverse colonial engagements, the Philippines has relationships with a number of scientifically strong countries. This makes it a strategic research location for the study of postcolonial scientific influence. To answer the research questions mentioned in the preceding paragraph, a quantitative survey of 312 Filipino scientists in state research universities and government research institutes in Los Baños and Muñoz was conducted. The survey was carried out with the help of a team of local recruits. To ensure that quantitative results were substantiated with interpretive explanation, the quantitative survey was reinforced and supported by a preliminary face-to-face qualitative survey of 32 Filipino scientists six months earlier. Prior to the survey, the necessary and required permissions were obtained from deans, directors, and heads of my study organizations.

The PC is a prerequisite technology to connectivity, but the way it is set up and experienced in the context of scientific systems at the core are far different from those at the periphery. The results of this research strongly suggest that PCs, as construed in the Philippine research context, are rarely personal technical items typically located in places devoid of architectural privacy. These pieces of equipment are more aptly described as "public computers," that are heavily shared and normally stationed in communal work areas. This situation in PC access and use is understandable given the limited material resources in peripheral research systems. However, this situation very much precludes knowledge producers from having the necessary privacy – **personal, digital, and architectural** – that is prerequisite for knowledge production.

The Internet is both a facility for communication (email) and information retrieval (web). The utilization of both these facilities appears to have shifted from the simple notions of binary access and use to more advanced notions of intensity, extent, and diversity of hardware-software-user interaction. Results from this research have shown that digital inequality in both email and web utilization occurs at more advanced levels of computer-human interaction. Indeed, extensive and prolonged hardware-software-user interaction and advanced levels of hardware-software-user interaction appear to be the emerging dimensions of a new form of digital divide. Much of the inequality appears to stem from differences in level and place of graduate education. These findings suggest that there are salient differences among places of graduate education which indirectly provide empirical evidence in support of the extended translation view of science that emphasizes the importance of actants--human and non-human--in the knowledge production.

The results pertaining to the analysis of professional network structure suggested that Filipino scientists still prefer face-to-face interaction as their primary mode of communication.

There was no compelling evidence to support the claim that new ICTs (or Internet) will soon replace and render obsolete traditional, meaningful face-to-face interaction. What was readily obvious was that among non-face-to-face modes of communication, a reordering may be taking place. New ICTs have relegated the use of fax machines and postal mailing system to the margins. Landline phone, cellular/mobile phone, and email have taken an increasingly central role, second only to face-to-face interaction. The effect of place of graduate education is such that foreign training tends to unilaterally increase the proportion of alters at the core, with most of the networking taking place between graduates and their professors at the core. Philippine-trained scientists, who are the majority of Philippine scientists, have low levels of foreign contacts, which indicates that the majority of the scientists in the Philippine research systems are still largely isolated from the international scientific community.

Filipino scientists communicate primarily through face-to-face, and secondarily through landline telephone with a network that predominantly consists of on-site alters. For alters in other Philippine sites, cellular/mobile phone in text messaging mode is preferred. For scientific communication with foreign alters, email is the preferred mode of communication. Much of the effect of email--expressed through diverse hardware-software-user interaction skills--lies on those structural components of professional networks that have to do with network size, proportion of male alters, proportion of alters residing at the scientific core, location diversity, and multiplexity of communication means.

It is equally surprising to unravel how ascribed factors, like gender and number of children, configure the network structure of actors, who have been traditionally viewed as the epitome of objectivity, rationality, and achievement-oriented. This study has attempted to demonstrate how such ascribed attributes figure in the knowledge production process through a system of patronage. Clearly, all these lend support to the proposition of the extended translation view of science that actors, factors, and entities outside the knowledge production system affect relationships within that system. This chapter also highlights how interaction between human (scientists/users) and non-human (hardware-software) actors configure the network structure of knowledge producers.

Results from this research suggest that involvement in collaborative work is a majority behavior among Filipino knowledge producers. The popular form of collaboration is one wherein collaborators are both domestic but are situated in different locations. In other words, collaboration among Filipino knowledge producers can be described as predominantly peninsular, and are more likely to be with scientists in other Philippine sites. Although foreign collaboration is a small proportion of the total aggregate collaboration, the most frequent would be with Japanese scientists, and the least would be with U.S. scientists. This observation can be explained by qualitative reports stating that Filipino graduate students trained in Japan develop strong affective and instrumental ties with their professors as a result of close monitoring and interaction, which is rarely the case with either American or Australian professors. This highlights that contrary to the claims about a universal model of knowledge production, there are huge differences in the production processes even among the scientifically strong nations. At least for now, this puts to question the claim of the emergence of isomorphic scientific institutions.

As to the question: **Do professional networks readily translate to scientific collaborators?** The answer is both yes and no. Professional network size (or the number of alters), **but not network quality**, is directly and positively associated with number of collaborative projects; larger networks yield better chances of being involved in collaborative projects. Whether or not professional networks are comprised of foreign contacts or possess a more gender-balanced configuration does not matter much in determining collaborative patterns. For the non-numeric (or qualitative) aspects of professional networks, the answers deserve a number of qualifications.

The proportion of contacts at the scientific core determines if a respondent will have domestic collaborators, but it occurs in diametrically opposed directions depending on the location of respondent and collaborator. For **domestically collocated** respondent and collaborator, the proportion of core-based contacts enhances the likelihood of such collaboration. For **domestically non-collocated** respondent and collaborator, the proportion of core-based contacts reduces the likelihood of such collaboration. **In general, empirical evidence suggests that professional networks may be important in having scientific collaborations, but this relationship is strongly configured by network size, network quality, and the geographical location of collaborators, meaning that not all professional contacts transmute to being collaborators.** Professional networks cover a much larger domain and are typically sequentially prior to scientific collaborations. However, empirical results indicate that professional networks may not necessarily translate to scientific collaborators.

As regards scientific productivity, measures exhibited skewed distributions. These findings corroborate results from studies in both the developed and developing world, and these provide a basis for reliability. These productivity measures also paint a scene that appears bleak especially if these accurately characterize the productive capacity of the country's premier scientific research organizations. Based on qualitative interviews, reasons for this dismal research productivity are lack of government funding, obsolete or derelict equipment, and frequent power outages.

These results further exemplify the distinct nature of knowledge production in the Philippine scientific research system. First, scientists are relatively visible in domestic rather than foreign outlets. Second, there seems to be evidence that scientists, although actively involved in research, are not oriented toward having their works published in scholarly journals for practical reasons.

Results further indicate that after controlling for other factors, scientific collaboration **does not** have any influence on research productivity. Across all indicators of productivity, however, there are clear indications that having a doctoral degree, possessing advanced hardware-software-user interaction skills, large networks, having more contacts at the core, and proportion alters who are male strongly configure research output. While professional networks somehow influence scientific collaboration, there is virtually no influence of collaboration behavior on productivity. It could be that involvement in collaboration generates more problems that undermine productivity so that scientists simply informally and casually activate their network without really formally and officially engaging them in projects. Such "collaborators" usually find themselves in acknowledgment footnotes rather than in the author list. It appears that this strategy of informal consultations with network alters is more sustainable and less problematic than engaging in formal collaboration.

Overall, the findings from this research have shown that: (1) Internet utilization is a multidimensional concept, and that digital inequality has shifted to a new form of advanced hardware-software-user interaction from the traditional notion of simple hardware-software access and use. (2) The structure of professional network is affected by personal (number of children and gender), educational (level and place of graduate education), and by diverse use of email. (3) Involvement in scientific collaboration is related to network size and to diverse use of email. (4) Research productivity **is not** related to scientific collaboration. Instead, professional networks, level of education, and diverse use of email are the ones that play important roles. In essence, email use diversity (or advanced hardware-software-user interaction) has been a central factor in configuring professional network structure, involvement in scientific collaboration, and research productivity. But again, diverse use of email is mainly affected by educational factors, meaning that both advanced education and foreign education are essential to diverse email use, which in turn structures networks, collaboration, and productivity. It appears that the Internet holds great promise in being an essential tool in the knowledge production system at the global periphery. This also highlights the role of non-human entities like the Internet in knowledge production systems.

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APPENDIX A: QUALITATIVE QUESTIONNAIRE

WORLD SCIENCE INTERVIEW GUIDE

Scientists Interview Guide

Rev. July 10, 2003

Important: the *first round of interviews to be used more as a preparation for the subsequent ones, rather than as self-contained interviews. Hence the focus of these interviews should be on the CURRENT RESEARCH PROJECT (S), so as to use it as a background for the interviews to be conducted in the next phase of our study. Probe various aspects of the current project as deeply as possible, especially its 1) conception and development 2) sources of literature and data 3) implementation with special reference to collaboration and communication.*

(Details from the C.V regarding the education background of the scientist which have not come in the interview proper, could be used appropriately at the beginning of the transcription: and latter, if certain details of the C.V. are found useful may be incorporated into the transcribed text demarcating them in brackets with investigator's note.)

Name:

Sex:

Age:

Marital Status:

Ethnicity:

Institution:

Department/Discipline

Specialization:

Degrees, Locations and institutions (of all higher degrees)

Date, start time and end time of interview

Email:

1. BACKGROUND & CAREER Time 15 minutes

Focus: information and details which are not in the C.V.

Education & training (degrees abroad, when did you get them, from where (country, place and university)?

Education experiences (how was it funded, how long how interests developed) any degrees from an institution abroad? Who funded? Duration, subjects studies. Major influences?

Any other trips abroad apart from training for any significant period of time for education, professional activities and/or travel? Details of 'where' and what reason.

Former positions – An over view of the career history details of he positions described in the vita.

Current position – how long, how obtained?

- What are your primary activities and responsibilities here in this institution?
- How is your time divided up between research, teaching, administration, service (extension) and other activities? (Percentage of the time used for each)
- Other involvements (e.g. public service applied work, consulting)

Besides your main affiliation, are there any other organizational affiliation?

Nature of that position, resources involved, how much time spent there?
Including non-scientific organizations – understand more about their life, religious, NGOs e.tc)

Institutional Context (Questions for chairs &senior staff)

History, Age of the organization & the respondent's unit, changes in size
Type of personnel (nationals/Experts)
Significant personnel in the history of the unit.
Changes in funding (national or international, larger programs and projects)

Procedures and processes followed in undertaking a research programme focus on the structure in which the decisions & activities are carried out in the institute?

Research environment of the institute? Freedom in selecting research theme or proposals? Support from the system, from the colleagues? Culture of research activities pursued? Funding and sanctioning procedures?

Experience and perceptions on the research activities and production of knowledge at the university (vice versa in the case of scientist the university)

2. RESEARCH (25 minutes)

 # MOST IMPORTANT CURRENT RESEARCH PROJECT

How did they start it: did it come out of any prior work; how did you get interested in this area? How did it evolve: the 'origin' stories?, the work done so far? How long it will take to complete? Who else is involved? Who are the partners, what are their roles, how do you communicate?

Specific probe on collaboration – regional, national, international? What is the division of labor? How often they are involved in the project? How do they communicate? (Likely to talk about a few professional contacts here... go into the details) Questions on how do they access the works already existing in the area? How do they find them out? The sources? Any publication yet? Where? Sources?

(By collaboration we mean joint efforts leading to publication; talking about something: being on the payroll of a project, e.t.c.) If time permits take up another project.

Seminars, meetings in the past year? Fellowships? (How did you find the information, how did you finance your travel, what did you do when you were there, whom did you meet, did you continue the contact, what was the outcome-collaboration, exchange of information, friendship, e.t.c.

Most important finished project(s)

Questions same as above with additional questions on the outcomes: what was the outcome of this project, in terms of contribution to knowledge, publication your career advancement, contacts, participation n conferences, and others? (Again likely to speak about professional contacts)

(If there is NO current project, please tell about the previous ones).

3. PROFESSIONAL CONTACTS (10 minutes)

 # Here ask about other important professional contacts that they have not mentioned in the previous section on research projects. Then discuss each person separately. Where are they, who are they affiliated with, what's the reason for their important, when did you first get to know them, how did your relationship develop? What means do you use most often to contact this person?

(Perhaps include people in this specific organization or academic department. Here include anyone you talk to, anyone you go to for advice, or anyone who comes to you for advice. In other words, just tell me those that are the most important for your own work).

4. INTERNET (15 minutes)

What the situation is now at this location.

What kinds of Internet connection are available?
How many computers, Are the connections good ones?
How much of the time the connection down? How fast is it?

Otherwise (not necessarily at this work location) what is your situation regarding the availability and accessibility of email and Internet? Type of connections; costs; location? Period of hi & lo Internet activity.

Let the questions be on the two aspects of the Internet: 1) the Web sites and search engines – the mass medium and the Emails. – Medium for personal correspondence

Email:

<u>For professional / social relationships</u>

Who are your main email partners? What do you talk to them about? How often? Describe the relationship as it exists over email.
LOCATION Are any of these people in your unit or department? How often do you talk to them? Are any outside your area? Any outside your state, or country? Is anyone abroad? Is there any difference in the pattern of responses you get from difference people on the Internet?

Has it mad any difference to your social or family life?

CURRENT use of internet (time spend sending and receiving email/where and with whom; split up this section between personal & professional & hobbies or other money-making activities)

When did you last send last email? To whom? What was it about?
How about the one before that?
How many have you sent in the last week?
Used email to contact people for research activities
Used email to send papers for publication
Started a professional relationship with someone you met on the Internet
Continued email correspondence with someone you met personally
Discussed proposals with funding agency or other wise seen any

EARLY encounters with email: what year; main motivation; when, where, and with whom;

→ TRANSCRIPTION :
briefcase. yahoo.c
worldsci2005
ref 123

who encouraged/helped you?

Web ? Kind of extra needed.
On

4

APPENDIX B: QUANTITATIVE QUESTIONNAIRE

BACKGROUND

Name of Respondent (NOT TO BE CODED): __________________________ COPY OF RESULTS: _____

1) RESPONDENT ID NUMBER: __________ (TO BE ASSIGNED LATER)

2) DATE: _______________

3) INTERVIEWER: 510 = Boots 520 = Belen 530=Tess 540 = Marcus
550 = Myra 560 = Nins 570= Helen 580 = Macrina

4) ORGANIZATION NAME ____

4B) ORGANIZATION ID NO: ____________ (see organizational list for codes)

5) SUBUNIT: Name of department or other unit of organization: ____________________________

6) TIME INTERVIEW BEGAN: __________
(*USE 24-HOUR CLOCK: FOR EXAMPLE, 1:15 PM IS 13:15*)

7) What is your official job title? ____

8) In what year did you begin your employment with this organization? ___ ___

9) In what type of organization did you work <u>before</u> you were employed by your current organization?
☐ 1=university ☐ 2=private ☐ 3=gov't research inst. ☐ 4=gov't agency
☐ 5=NGO ☐ 6=other ☐ 7=no prior employment ☐ 9=DK/NR

EDUCATION

10) Your highest degree? ☐ 1=Ph.D. ☐ 2=Master's/M.Phil. ☐ 3=BS/AB ☐ 4=Diploma ☐ 5=Othe

11) In what field? ____

12) From which <u>institution</u> and <u>country</u> was that degree received?

12A) Institution: ____

12B) Country: ☐ 1=Australia ☐ 2=Japan ☐ 3=U.S. ☐ 4=Phils. ☐ 5=Others. Specify ____________

13) In what year was that degree granted? __________

14) Have you received any of your <u>other</u> degrees from an institution in the <u>developed</u> countries?
☐ 1 = Yes ☐ 0 = No

14A) *IF YES*, Which *DEGREE, YEAR, INSTITUTION, COUNTRY*?

Degree	Year	Institution	Country
________	________	____________________	____________

15) How many years did you spend <u>outside of the Philippines</u> for higher education & training, including postdoctoral studies? _________ *years*

16) How many years have you spent abroad altogether in the <u>developed</u> countries? _________ *years*

Background Questions

17) What is your year of birth: 19__ __.

18) What was your father's main occupation?

☐ 1=Farmer/Peasant	☐ 2=Teacher/Education	☐ 3=Civil Servant
☐ 4=Nurse/Medical/Physician	☐ 5=Researcher/Professor/Scientist	☐ 6=Extension officer
☐ 7=Business/Merchant/Shopkeeper	☐ 8=Houseperson	☐ 9=Other, specify _____

19) Are you married, single, divorced, separated, or widowed?
☐ 1=married ☐ 2=single ☐ 3=divorced ☐ 4=separated ☐ 5=widowed

20a) How many children do you have? ______ 20b) If children, how many are below 21 years? _______

21) If married, what is your husband/wife's main occupation?

☐ 1=Farmer/Peasant	☐ 2=Teacher/Education	☐ 3=Civil Servant
☐ 4=Nurse/Medical/Physician	☐ 5=Researcher/Professor/Scientist	☐ 6=Extension officer
☐ 7=Business/Merchant/Shopkeeper	☐ 8=Houseperson	☐ 9=other, specify ______

TIME ALLOCATION: We'd like to know how your time is divided among research, teaching, administration, and other activities. [CLARIFICATION: WE MEAN YOUR ACTUAL TIME, NOT YOUR OFFICIAL TIME]

22) About what percentage of your professional time is spent on research? ____%

23) About what percentage of your time is spent on teaching? ____%

24) About what percentage of your time is spent on administration? ____%

25) About what percentage is spent on other activities? ____%

TOTAL = 100%

PERSONNEL: Now let's switch to some more general questions about relations with people and projects.

How many of each of the following people are you currently responsible for supervising?

26) ____ Professional scientists and engineers

27) ____ Technicians and field workers

28) ____ Doctoral students

29) ____ Postgraduate Students (MA, MS, M.Phil., etc.)

30) ____ Non-technical staff

With how many of each of the following people in your own organization do you work closely?
By this I mean those with whom you currently discuss projects on a regular basis.

31) ____ Professional scientists and engineers

32) ____ Technicians and field workers

33) ____ Doctoral students

34) ____ Postgraduate Students (MA, MS, M.Phil., etc.)

35) ____ Non-technical staff

CURRENT PROJECTS

We are interested to know something about your main research projects and activities.

36) Currently, what is your main area of research and/or professional interest? ____________________

Could you please briefly give the title of each of your most important current projects? *EXPLAIN IF NECESSAR[Y]* We'd also like to know if each one is collaborative (that is, done in cooperation with someone in another organizat[ion]) and where your collaborators are located. Please give up to a *MAXIMUM OF THREE PROJECTS ONLY.*

FIRST PROJECT (IF ANY):

____

37) Is this a collaboration? ☐ 1=Yes ☐ 0=No

37a) If YES, where are your collaborators located? (Check boxes for all that apply)
☐ 1=in Los Baños/Muñoz ☐ 2=not in Los Baños/Muñoz but in other Philippine locations
☐ 3=in Australia ☐ 4=in Japan
☐ 5=in the United States ☐ 6=in other country, please specify: ____________________

SECOND PROJECT (IF ANY):

____

38) Is this a collaboration? ☐ 1=Yes ☐ 0=No

38a) If YES, where are your collaborators located? (Check boxes for all that apply)
☐ 1=in Los Baños/Muñoz ☐ 2=not in Los Baños/Muñoz but in other Philippine locations
☐ 3=in Australia ☐ 4=in Japan
☐ 5=in the United States ☐ 6=in other country, please specify: ____________________

THIRD PROJECT (IF ANY):

____

39) Is this a collaboration? ☐ 1=Yes ☐ 0=No

39a) If YES, where are your collaborators located? (Check boxes for all that apply)
☐ 1=in Los Baños/Muñoz ☐ 2=not in Los Baños/Muñoz but in other Philippine locations
☐ 3=in Australia ☐ 4=in Japan
☐ 5=in the United States ☐ 6=in other country, please specify: ____________________

40) Total number of research projects: __________

41) Total number of research projects directed: __________

Please indicate (by putting a check mark) if each of the following is a problem for you in your current research:
1 = major problem 2 = minor problem 3 = not a problem 9=don't know/No response

	1	2	3	9
42) Contacting people when they are needed				
43) Coordinating schedules				
44) Length of time to get things done				
45) Transmitting information				
46) Getting others to see your point				
47) Security of information				
48) Resolving conflicts				
49) Decisions on a division of work				
50) Keeping others informed of your progress				
51) Too much information.				

NETWORKS

Now we are moving into the section of the interview that asks about your professional linkages. I'm now going to give you a list of organizations. First, I'm going to show you a list of international organizations, then a list of organizations in the Philippines.

GIVE RESPONDENT THE FOLDED LIST OF ORGANIZATIONS

For each of these organizations, please indicate whether you have <u>had any relations with it</u> during the past five years--say, about 2000. That is, have you had any kind of contact or dealings with it? Of course, when I say relations with an organization I include <u>relations with the people</u> who are members of that organization. Just make a mark in the first column. Please add any organizations or university departments we have left out.

PROMPT AT THE END OF EACH LIST
Are there any other organizations or departments of this type you've had contact with? We should add them at the end of each list because we didn't have room to list them all.

TAKE BACK THE FOLDED LISTS AND UNFOLD THEM. GIVE THE RESPONDENT THE CARD WITH NINE "**TYPES OF RELATIONS**" AND ASK HIM TO REFER TO IT AS YOU READ BACK THE NAMES OF THE ORGANIZATIONS THAT HE HAS MARKED. FILL OUT THE LAST COLUMN YOURSELF AS THE RESPONDENT CALLS OUT THE ANSWERS FROM THE LIST OF TYPES OF RELATIONS

AFTER RESPONDENT HAS FINISHED LOOKING AT EACH LIST:
Now please refer to this card listing 9 types of relations. I'll read back to you the names of those organizations you have had some contact with and you tell me what kind of contact it involved--that is, what kinds of contact it was (collaborative project, personal friend, exchange of information, and so forth). So for (NAME OF ORG) what kind of relation was that? Just look at the list and tell me what it was.

CLARIFICATION: RECEIVING FUNDS FROM AN ORGANIZATION INDIRECTLY ALSO COUNTS.

CLARIFICATION: YOU NEED NOT HAVE HAD RELATIONS WITH THE MAIN HEADQUARTERS OF THE ORGANIZATION--*ANY* PERSON OR ANY BRANCH OF THE ORGANIZATION WILL COUNT AS A RELATION.

PROFESSIONAL CONTACTS

Now I'd like to ask about a few specific people, the people who have similar interests or work on the same kinds of things that you do. I only want to exclude other people in this specific organization or academic department. Here include anyone you talk to, anyone you go to for advice, or anyone who comes to you for advice. In other words, just tell me those that are the most important for your own work.

(A) Just give me the short names or initials (no need for full names) of the people, with their organization & location.

LOCATION CODES:

1 = in Los Baños/Muñoz **2 = not in Los Baños/Muñoz but in other Philippine locations**
3 = in Australia **4 = in Japan**
5 = in the United States **6 = in other country, please specify: ____________________________**

(B) What means do you use most often to contact this person? (Circle all that apply)

MEANS CODES:

1=Face-to-face 2=land line 3=fax 4=letter 5=Email 6=mobile phone

PC ORGID	NAME	GENDER 0=Female 1=Male	ORGANIZATION NAME & CITY	LOCATION	MEANS
		0 1			
		0 1			
		0 1			
		0 1			
		0 1			
		0 1			
		0 1			
		0 1			
		0 1			
		0 1			
		0 1			
		0 1			

PROFESSIONAL ACTIVITIES

Thanks very much. That's more than half of the survey and the hard part is over! I have a few questions now concerning the resources that you have access to and some questions on your professional activities.

Do you have ready access to the following? (CHECK BOXES TO RECORD RESPONSES)

52) A telephone	☐ 1=Yes	☐ 0=No
53) A typewriter	☐ 1=Yes	☐ 0=No
54) A computer	☐ 1=Yes	☐ 0=No
55) A printer	☐ 1=Yes	☐ 0=No
56) A fax machine	☐ 1=Yes	☐ 0=No
57) Electronic mail capacity (email)	☐ 1=Yes	☐ 0=No
58) Secretarial assistance	☐ 1=Yes	☐ 0=No
59) A mobile phone	☐ 1=Yes	☐ 0=No

The following questions about your professional activities refer to the last five years (that is, since about 2000). Most of these are just either Yes or No.

60) Have you been a member of any professional associations?	☐ 1=Yes	☐ 0=No
61) Have you served on the editorial board of a journal?	☐ 1=Yes	☐ 0=No
62) Have you held office in a professional organization?	☐ 1=Yes	☐ 0=No
64) Have you been an advisor to the extension service?	☐ 1=Yes	☐ 0=No
65) Have you been a member of a government committee or advisory group?	☐ 1=Yes	☐ 0=No
66) Have you served as a consultant within your professional field?	☐ 1=Yes	☐ 0=No
67) Have you been to any training courses during this period?	☐ 1=Yes	☐ 0=No
68) Have you been an advisor to an NGO?	☐ 1=Yes	☐ 0=No
69) Are you a member of any NGO?	☐ 1=Yes	☐ 0=No
70) Have you reviewed a manuscript for a professional journal or book publisher?	☐ 1=Yes	☐ 0=No

72) How many journals do you subscribe to personally? __________

73) As a professional, approximately how many hours in a typical week do *you spend working*? __________

74) About how many hours of this would you say you *spend on research*? __________

MEETINGS & TRAVELS

75) Since 2000, how many professional meetings have you attended? __________

INCLUDE GOVERNMENT-SPONSORED AND PROFESSIONAL SOCIETY MEETINGS BUT NOT MEETINGS WITHIN YOUR OWN OFFICE)

76) Again since 2000, how many meetings have you attended *outside the Philippines but within Asia*? __________

77) Again since 2000, how many meetings have you attended *outside Asia*? __________

78) Approximately how many days during the past year have you spent *away from your organization* on professional activities? PLEASE INCLUDE TIME AT PROFESSIONAL MEETINGS. ______ days

Thinking of the following five means of communication, how would you *rank their importance* for your own professional work, where

1 is most important and 5 is least important.

79) _____ Postal Mail

80) _____ Phone

81) _____ Fax

82) _____ Email / Web

83) _____ Face-to-face

PRODUCTIVITY

84) In the past 12 months, how many research papers have you written by yourself or in collaboration with others (Published or unpublished)? _________

Now for the last five years, we would like to know about the period since 2000. We are interested in the number of publications, reports, and so forth. (INCLUDE THE YEAR 2000.)
How many?

85) Papers at local or national workshops: ______

86) Papers at international conferences: ______

87) Reports (published or otherwise): ______

88) Bulletins for extension: ______

89) Articles in foreign journals: ______

90) Articles in national journals: ______

91) Chapters in books: ______

92) Since 2000, have you received any professional awards? □ 1=Yes □ 0=No

NEEDS OF THE PHILIPPINE RESEARCH SYSTEM

Now I'm going to read you a list of some things people say are important for the Philippine research system. I'd like your opinion of how important each one of them is.

	1=Very Important	*2=somewhat important*	*3=not so important*	*4=not at all important*	*9=DK/NR*
93) Increasing salaries & improving conditions for researchers	1	2	3	4	9
94) Hiring more technicians & support staff	1	2	3	4	9
95) Building new facilities	1	2	3	4	9
96) Improving links with international research organizations	1	2	3	4	9
97) Maintaining the physical infrastructure	1	2	3	4	9
98) Providing funds for travel	1	2	3	4	9
99) Improving communication with policy makers	1	2	3	4	9
100) Providing operating funds for field & lab work	1	2	3	4	9
101) Creating electronic communication networks within Phils.	1	2	3	4	9
102) Creating international electronic communication networks	1	2	3	4	9
103) Expanding & improving libraries	1	2	3	4	9
104) Improving communication between researchers & extension	1	2	3	4	9

Thinking of the following six things, how would you rank their importance for improving the Philippine research system? Give a number from 1 to 6, where 1 is most important and 6 is least important--don't use any number more than once.

105) Salaries: ____

106) Management: ____

107) Setting research plans & priorities: ____

108) Operating budget: ____

109) Communication budget (including travel): ____

110) Training budget: ____

COMPUTERS

In this section we'd like to ask a few questions about computers and the Internet. By the "Internet" we mean all types of electronic connectivity, including both email and the World Wide Web.

111) Do you have a computer at work? ☐ 1=Yes ☐ 0=No ***IF NO, SKIP TO 116***
CLARIFICATION: THIS INCLUDES LAPTOP IF S/HE USES IT AT WORK

112) IF YES, in what year was it first available: __________

113) IF YES, Where is it located? ☐ 1=personal office ☐ 2=shared office ☐ 3=common computer room

114) IF YES, How many people use this computer, including yourself? __________

115) IF YES, Is this computer connected to the Internet? ☐ 1=Yes ☐ 0=No

116) Do you have a computer at home? ☐ 1=Yes ☐ 0=No ***IF NO, SKIP TO 120***
CLARIFICATION: THIS INCLUDES LAPTOP IF S/HE USES IT AT HOME

117) IF YES, in what year did you first acquire a home computer? ____

118) IF YES, How many people use this computer, including yourself? ____

119) IF YES, Is this computer connected to the Internet? ☐ 1=Yes ☐ 0=No

120) In a typical week, about how many hours do you use a computer for your job (whether at home or at work)?
0=Not at all 1= Less than one hour 2= Between one & five hours 3= Between five & ten hours
4= Between ten & twenty hours 5 = Over twenty hours per week 9=DK/NR

121) How often do you use a computer for fun/play?
1=Frequently 2=Occasionally 3=Seldom 4=Never 9=DK/NR

122A) How comfortable do you feel using computers in general?
1=Very comfortable
2=Somewhat comfortable
3=Slightly comfortable
4=Not at all comfortable
9=DK/NR

122B) Some people are relatively sophisticated in their use of computers—writing programs and configuring hardware. Others use computers in more basic ways, typing documents or entering data, for example. Would you characterize your use as?

☐ 1= sophisticated
☐ 2= somewhat sophisticated
☐ 3= more than basic, but not sophisticated
☐ 4= basic
☐ 9 =DK/NR

EMAIL

123) Have you ever used email? ☐ 1=Yes ☐ 0=No ***IF "NO" SKIP TO QUESTION 142***
WHEN WE SAY "USED EMAIL" WE INCLUDE SOMEONE ELSE USING IT FOR YOU

124) Are you currently using email? ☐ 1=Yes ☐ 0=No

125) When was the last time you sent an email? ☐ 1=Yesterday or today, ☐ 2=Within the past week, ☐ 3=Within the past month, ☐ 4=Within the past six months, ☐ 5=Longer than 6 months, ☐ 9=DK/NR

126) In what year did you first use email? __________

127) Within the past year, have you been <u>unable to access</u> your email account for at least one week? ☐ 1=Yes ☐ 0=No

127a) IF YES, What was the primary reason? ☐1=technical ☐ 2=financial ☐ 3=other ☐ 9=DK/NR

128) If you wanted to send someone an email, which of the following would you be most likely to do?
- ☐ 1=Use an Internet connection at home
- ☐ 2=Use an Internet connection at work
- ☐ 3=Use a public terminal (library or Internet cafe)
- ☐ 4=Use someone else's Internet connection at home or at work
- ☐ 5=Ask someone to send it for you (assistant, secretary, friend)
- ☐ 9=DK/NR

For these next questions, think about your <u>typical week</u>:

129) How many email messages do you send?
1=Less than one each week 2=Between one & six in a week
3=Usually one or two daily 4=More than two daily 9=DK/NR

130) How many of these are related to your research?
1=Less than one each week 2=Between one & six in a week
3=Usually one or two daily 4=More than two daily 9=DK/NR

131) How many email messages do you receive?
1=Less than one each week 2=Between one & six in a week
3=Usually one or two daily 4=More than two daily 9=DK/NR

132) All in all, about how many hours in a typical week do you spend sending and receiving email messages?
0=Not at all 1= Less than one hour 2= Between one & five hours 3= Between five & ten hours
4= Between ten & twenty hours 5 = Over twenty hours per week 9=DK/NR

Have you ever done the following on email?

133) ☐ 1=Yes ☐ 0=No Been a member of a discussion group concerned with science & technology issues
134) ☐ 1=Yes ☐ 0=No Sent a message to a discussion group concerned with science & technology issues
135) ☐ 1=Yes ☐ 0=No Discussed research with a colleague in the Philippines
136) ☐ 1=Yes ☐ 0=No Discussed research with a colleague in Asia but outside the Philippines
137) ☐ 1=Yes ☐ 0=No Discussed research with someone in the U.S., Europe or other developed country
138) ☐ 1=Yes ☐ 0=No Started a professional relationship with someone you met on the Internet
139) ☐ 1=Yes ☐ 0=No Continued email correspondence with someone you met personally
140) ☐ 1=Yes ☐ 0=No Discussed proposals with funding agency
141) ☐ 1=Yes ☐ 0=No Submitted and/or reviewed manuscripts for journals

WEB USE

142) Have you ever used any web browser? ☐ 1=Yes ☐ 0=No ***IF "NO" SKIP TO QUESTION 166***

143) When was the last time you browsed the Web? ☐ 1=Yesterday or today ☐ 2=Within the past week
☐ 3=Within the past month ☐ 4=Within the past six months ☐ 5=Longer than 6 months ☐ 9=DK/NR

144) In what year did you first use the Web? __________

145) All in all, about how many hours in a typical week do you spend using the Web?
0=Not at all 1= Less than one hour 2= Between one & five hours 3= Between five & ten hours
4= Between ten & twenty hours 5 = Over twenty hours per week 9=DK/NR

145A) How many hours are spent using the Web for your job?
0=Not at all 1= Less than one hour 2= Between one & five hours 3= Between five & ten hours
4= Between ten & twenty hours 5 = Over twenty hours per week 9=DK/NR

How frequently do you access the web from the following places?
(1=daily, 2=weekly, 3=monthly, 4=less than once a month, 5=never, 9=DK/NR)

147) From home	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
148) From work	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
149) From a free public terminal (e.g., library)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
150) From a cybercafe	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
151) From a friend's	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9

152) How comfortable do you feel using the Internet? ☐ 1=Very comfortable ☐ 2=somewhat comfortable
☐ 3=Slightly comfortable ☐ 4=Not at all comfortable ☐ 9=DK/NR

Which of the following have you done on line?

153)	☐1=Yes	☐ 0=No	ordered a product or service for your research
154)	☐1=Yes	☐ 0=No	created a web page
155)	☐1=Yes	☐ 0=No	conducted an information search
156)	☐1=Yes	☐ 0=No	used an electronic journal
157)	☐1=Yes	☐ 0=No	acquired or used scientific data
158)	☐1=Yes	☐ 0=No	collaborated on a scientific project
159)	☐1=Yes	☐ 0=No	found and examined reference materials
160)	☐1=Yes	☐ 0=No	accessed research reports or scientific papers
161)	☐1=Yes	☐ 0=No	participated in online chat groups
162)	☐1=Yes	☐ 0=No	used online job listings
163)	☐1=Yes	☐ 0=No	used online maps
163a)	☐1=Yes	☐ 0=No	downloaded any software
163b)	☐1=Yes	☐ 0=No	published any papers

164) All in all, how would you assess the influence of the Internet on your professional activities?
☐ 1=Improved matters greatly ☐ 2=Improved matters somewhat ☐ 3=Has had no effect
☐ 4=Impaired matters somewhat ☐ 5=Impaired matters greatly ☐ 9=DK/NR

165) All in all, what effect would you say the Internet <u>will</u> have on your professional activities?
☐ 1=Improve matters greatly ☐ 2=Improve matters somewhat ☐ 3=Will have no effect
☐ 4=Impaired matters somewhat ☐ 5=Impaired matters greatly ☐ 9=DK/NR

What are the biggest problems you've found in your experience of the Internet (email and the World Wide Web)?

1=major problem 2=minor problem, 3=Not a problem

	Major	Minor	Not	DK/NR
166) Too much time to connect	1	2	3	9
167) Too much time waiting for a page to appear	1	2	3	9
168) Not being able to find desired information	1	2	3	9
169) Costs too much	1	2	3	9
170) Links to pages that are no longer there	1	2	3	9
171) Not enough valuable scientific information	1	2	3	9
172) Getting disconnected	1	2	3	9
173) Too many useless sites	1	2	3	9
174) Sites that require registration	1	2	3	9
175) Sites that require payment for use	1	2	3	9

ATTITUDES

In this last section, I'm going to read some typical statements used in surveys of scientists--some of these we asked when we did the survey in 1994. I'd like to know if you
1=agree strongly 2=agree somewhat 3=disagree somewhat 4=disagree strongly
9=DK / NR

176) People in my field mostly work on their research by themselves or in a small research group.
1 2 3 4 9

177) My research is the most important interest in my professional life.
1 2 3 4 9

178) Security on the Internet is a big problem.
1 2 3 4 9

179) People in my field of research compete with each other more than they collaborate.
1 2 3 4 9

180) I sometimes worry that other scientists might publish the same results before I do.
1 2 3 4 9

181) People in my field of research generally agree about the most important research issues.
1 2 3 4 9

182) In the past few years, there have been a lot of changes in my field of research.
1 2 3 4 9

183) It is likely I could find a similar or better position if I left my current position.
1 2 3 4 9

184) Other aspects of my work are more important interests than my research.
1 2 3 4 9

185) Scientists in my area generally collaborate with others to do their research.
1 2 3 4 9

186) My research has often been delayed by information or decisions needed at another organization.
1 2 3 4 9

187) Since getting on the Internet, I have become more connected with researchers in my area.
1 2 3 4 9

188) I have a lot of freedom to select my own research problems.
1 2 3 4 9

189) It is just as easy for women to get ahead in a research career as for men.
1 2 3 4 9

190) I am free to publish the results or reports of my research without asking permission.
1 2 3 4 9

191) The research system would be better if there were more women researchers.
1 2 3 4 9

192) Environmental problems in the Third World have been exaggerated by industrial countries and donor agencies.
1 2 3 4 9

193) Environmental issues are a rich-country obsession that the Philippines cannot afford.
1 2 3 4 9

196) The research system in the Philippines has considered the environmental costs of production for many years.
1 2 3 4 9

S1) Locally trained scientists rely on the Internet less than foreign trained scientists.
1 2 3 4 9

S2) The Internet has not yet made much difference in how I do research.
1 2 3 4 9

S3) The Internet has made a difference in how I teach.
1 2 3 4 9

S4) Reliable scientific information is difficult to get online.
1 2 3 4 9

S5) The Internet tends to promote diffusion of ideas from the developed world to the developing world.
1 2 3 4 9

S6) The Internet is an obsession of first world countries which third world countries cannot afford.
1 2 3 4 9

S7) The Internet is mainly a means to promote Western culture.
1 2 3 4 9

S8) The Internet promotes appreciation and understanding of cultural heritage.
1 2 3 4 9

S9) Women scientists have as much access to the Internet as men.
1 2 3 4 9

S10) Women scientists benefit more from the Internet than men.
1 2 3 4 9

S11) The Internet promotes masculine values and orientations.
1 2 3 4 9

S12) Male scientists are more skilled at using the Internet than female scientists.
1 2 3 4 9

LAST QUESTION:

197) Fnally, could you tell us about any *specific changes that have occurred in your professional life* as a result of the Internet?

INTERVIEWER OBSERVATIONS

ANSWER THESE QUESTIONS YOURSELF AFTER LEAVING

198) Time interview ended: ______

199a) R's ethnicity: □ 1=Asian □ 4=Indian □ 5=Coloured □ 6=White □ 7=Chinese □ 8=Filipino □ 9=Latino □ 10=other, specify ______

199b) R's religion: □ 1=Catholic □ 2=Protestant □ 3=Iglesia ni Kristo □ 4=Jehovah's Witness □ 5=Muslim □ 6=others, specify __________

200) R's sex: □ 1=Male □ 2=Female

Did you see any of the following in Rt's office or the room where the interview took place?

201) A telephone	□ 1=Yes	□ 0=No
202) A typewriter	□ 1=Yes	□ 0=No
203) A computer	□ 1=Yes	□ 0=No
204) A fax machine	□ 1=Yes	□ 0=No
205) A printer	□ 1=Yes	□ 0=No

206) Was there any evidence of computer use, such as the computer switched on before or during the interview?
□ 1=Yes □ 0=No

207) Did R have difficulty hearing the questions or understanding the questionnaire?
□ 1=Hearing □ 2=Understanding □ 3=Both □ 4=No problems

208) What was R's <u>initial attitude</u> about being interviewed?
□ 1=very interested □ 2=somewhat interested □ 3=indifferent
□ 4=somewhat reluctant □ 5= very reluctant □ 6=hard to tell

209) What was R's attitude about giving the communication network information?
□ 1=volunteered information easily □ 2=somewhat reluctant, but did not object
□ 3=somewhat suspicious at first, but later cooperated □ 4=refused to give information
□ 5=didn't refuse but I thought s/he held back

210) Was anyone else present during the interview? □ 1=Yes □ 0=No

212) Aside from what R said in answer to the specific questions, is it your impression that R leads a very busy and active professional life; that R is about average; or that R doesn't have much to do?
□ 1=leads active life □ 2=leads average life □ 3=inactive

213) How open and forthcoming do you think R was about (his/her) feelings?
□ 1=very open □ 2=held back somewhat □ 3=held back a great deal

214) Did you observe any signs of tension or stress in R's behavior? □ 1=Yes □ 0=No

215) In what condition was R's office & equipment?
□ 1=relatively new □ 2=OK but nothing special □ 3=a bit worn down □ 4=very poor shape

216) In what condition was R's building?
□ 1=relatively new □ 2=OK but nothing special □ 3=a bit worn down □ 4=very poor shape

217) How much activity (e.g. cars and/or people) was there in and around the place where the interview was conducted?
□ 1=a great deal □ 2=some □ 3=almost none

218) Was the interview held in a?
□ 1=private office □ 2=shared office

219) Where did the interview take place?
□ 1=R's Office □ 2=Lab □ 3=Other, specify _____________

APPENDIX C: LETTER OF PERMISSION TO CONDUCT SURVEYS

LOUISIANA STATE UNIVERSITY
AND AGRICULTURAL AND MECHANICAL COLLEGE
Department of Sociology

December 14, 2004

Dear ______________________________:

RE: Request to Conduct Interviews with Scientists in January 2005

I am a graduate student at Louisiana State University Department of Sociology with area of concentration at the intersection of science and technology studies, international development, social network analysis, and diffusion of innovations. I obtained my B.Sc. and M.A. degree from UPLB. My dissertation, which is funded by the US National Science Foundation (NSF), focuses on the impacts of information and communication technologies (ICTs) on the patterns of scientific communication and collaboration, professional networks, and Internet adoption behavior of scientists in developing countries. I am particularly interested in studying research systems in the Philippines for two reasons: First, the Philippines, being home to the green revolution, is a strategic location for studying the impacts of ICTs on scientific knowledge production. Second, because of its historically rich colonial engagements, the Philippines offers a rare opportunity to study the joint influence of the strong scientific centers of Australia, Japan, and the United States on the nature, orientation, practice, and dynamics of science in the Philippines.

My dissertation is an offshoot of the *World Science Project* awarded by NSF to my graduate supervisor, Prof. Wesley Shrum. This project has conducted quantitative and qualitative surveys and published reports covering other locations in Kerala, India; Kenya, and Ghana. All of our previous questionnaires and reports are available at our project website at http://worldsci.net/global. In addition, the project is also organizing a 'satellite summit' at the next World Summit on the Information Society in Tunisia (13-15 November 2005). The title of the event is "Past, Present and Future of Research in the Information Society" (http://worldsci.net).

In this regard, I would like to kindly request for (i) a list of all academic and/or research scientists (with doctorate degrees), which will serve as my sampling frame, and (ii) obtain permission to conduct face-to-face interviews this January 2005 with selected scientists in organizational units under your supervision. Please rest assured that data and information would be obtained with the consent of the participating individuals, and with complete confidentiality. My interviews will focus on the extent of scientists' utilization of the Internet, as well as their website visits, and email linkages.

Thank you for considering my request.

Respectfully yours,

Marcus Antonius Ynalvez

Noted:

Wesley M. Shrum
Professor and World Science Coordinator
Dept. of Sociology,
Louisiana State University

Approved:

William B. Bankston
Professor and Chairman
Dept. of Sociology
Louisiana State University

126 Stubbs Hall • Baton Rouge • Louisiana • 70803-5411 • 225/578-1645 • Fax 225/578-5102

APPENDIX D: LETTER OF PERMISSION TO REPRINT

Ynalvez, Marcus A.

From: Dick Kraaij [Kraaij@brill.nl]
Sent: Wednesday, November 01, 2006 7:54 AM
To: Ynalvez, Marcus A.
Cc: Patterson, Rubin; shrum@lsu.edu; maynalvez@yahoo.com
Subject: RE: Consent To Publish - Urgent Request

Dear Mr Ynalvez, dear Marcus,

This is OK with us. You have our permission. I will check with one of my collegues if we need to send you a formal letter (if so, it will be a PDF by e-mail). I won't be able to do this before Tuesday next week, but in the meantime you may proceed. Please note that you are to mention the source of the original publication, which is *Perspectives on Global Development and Technology*, Volume 5 No. 4 (2006), pp. 277-302. Copyright 2006 by Koninklijke Brill NV, Leiden, Boston.

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From: Ynalvez, Marcus A. [mailto:mynalvez@tamiu.edu]
Sent: woensdag 1 november 2006 14:32
To: Dick Kraaij
Cc: Patterson, Rubin; shrum@lsu.edu; maynalvez@yahoo.com
Subject: Consent To Publish - Urgent Request

Dick Kraaij
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Dear Editor Kraaij:

This is to request for permission to publish, reprint or include parts of my forthcoming article in Perspectives on Global Development and Technology (PGDT 5.4) entitled "International Training and the Digital Divide: Computer and Email Use in the Philippines," by Marcus Ynalvez and Wesley Shrum.

This article is a chapter in my dissertation manuscript, which I will be submitting to the Louisiana State University Graduate School this Friday (03 Nov) for me to receive the degree in December 2006. In this connection, I would like to please request your office to grant me the necessary permission pertaining to the inclusion of parts/sections of the PGDT article in my dissertation.

I would appreciate it very much if you could grant me this request and if possible to email me a scanned copy of your response in PDF format so that I may be able to meet my Friday deadline. I earnestly apologize for having this request in short notice.

Thank you very much.

Sincerely yours,

Marcus Antonius Ynalvez
Dept. of Behavioral, Applied Sciences, and Criminal Justice
Texas A&M International University
Laredo, TX 78041 U.S.A.

VITA

Marcus Antonius Ynalvez is married to Ruby Agno, and they have two children--Ma. Leslie Ammabel (fondly called Les and Sukam), and Marcus Amiel (fondly called Bokoy and Boonie). Marcus, together with his family, came to the United States in August 2001 to pursue his doctoral degree at Louisiana State University. He received his Bachelor of Science degree in statistics and his Master of Arts degree in sociology from the University of the Philippines at Los Baños. Prior to his graduate studies in the U.S., he worked at the University of the Philippines at Los Baños Computer Center, the International Rice Research Institute, and the Asian Development Bank. In 2004, a National Science Foundation Dissertation Enhancement Grant allowed him to conduct surveys in the Philippine scientific communities in Los Baños, Laguna and Muñoz, Nueva Ecija.

While at Louisiana State University in Baton Rouge, Marcus taught courses in introductory statistics and social research methods. He received awards for excellence in teaching from the Department of Sociology, and the College of Arts and Sciences. At present, Marcus is visiting assistant professor of sociology at Texas A&M International University in Laredo. He is currently teaching courses in introductory sociology, social research methods, and graduate sociological theory. Marcus plans to carry out further research in the scientific cultures of the Confucian states of China, Japan, Singapore, Taiwan, and South Korea.

His most important dream is to see Les and Boonie successful in life, as contributing members of society, tolerant of and compassionate to others, and respectful of the Almighty God.