

**Gender and Science in Developing Areas:
Has the Internet Reduced Inequality?**

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Abstract

Objective. This paper examines the impact of the Internet on the research careers of female scientists in three developing areas: Ghana, Kenya, and Kerala, India. Most empirical studies of gender and science focus on the developed world, yet theoretical accounts emphasize more extreme differences in developing areas. Limited evidence from Africa and Asia shows gender inequity is restricted to a few key dimensions, broadly related to differences in human and social capital. Specifically, women are less likely to acquire an advanced degree and more likely to experience educational and organizational “localism.” Such localism is related to constraints on physical mobility that are widely expected to diminish with the introduction of the Internet. Methods. Using longitudinal data on 1147 scientists in Ghana, Kenya, and South India, we examine gender differences in human and social capital by conducting a series of t-tests and chi-square tests. Results. We show that higher education and Internet access increased dramatically, but localism has not been reduced significantly and may be increasing. Conclusions. This finding casts doubt on the presumption that the removal of communication constraints will soon reduce career differentials resulting from the mobility constraints on women professionals.

Introduction

We examine the impact of the Internet on gender differences among scientists in Ghana, Kenya, and the State of Kerala in southwestern India. Using longitudinal data, we address the following questions: (1) Have the careers and educational experiences of women changed over time, and (2) Has the Internet alleviated the social and professional barriers that inhibit their ability to establish professional and organizational contacts?¹

A large body of literature exists on gender and science in industrialized societies (Fox, 1999; Long, 1990; Xie and Shauman, 2003). According to Xie and Schauman's recent overview, much of this literature suggests that the slow progress women have made in science is due to "career processes...influenced by multifaceted social forces" at individual, familial, and social levels (2003: 5). At the individual level, variables such as aptitude and ambition are employed to explain differential career attainment, while at broader social structural levels, such factors as parental social class, marital status, children, education, and work environment are used to explain gender differences.

Relatively little is known, however, about the careers of women scientists in the developing world. While it is generally acknowledged that women fall behind their male counterparts on such dimensions as prestige, rank, and salary, there are few empirical studies examining the processes contributing to such outcomes (Campion and Shrum,

¹ In essence, we ask whether women benefit more than men, at least for a time, in terms of both Internet access and career outcomes that result from use, simply because they are starting out further behind. To take an example from the United States, the number of households with a computer rose from 8% in 1984 to 62% in 2003, with over half (54%) reporting Internet access in the home. This overall figure includes a differential impact for women, given the change in the gender gap for use of computers from the 1980s to the 1990s. Two decades ago, there was a twenty percent deficit in the home use of computers by women, while in 2001 women had a two percent advantage (U.S. Department of Commerce, 2005).

2004; Gupta and Sharma, 2002; Kumar, 2001). Some studies indicate that those factors typically used to explain gender differences in developed countries hold little predictive power outside of highly functioning research systems (Ynalvez et al., 2005; Kumar, 2001).

Three prior studies examine these questions, drawing partly or wholly on data from the Indian subcontinent. Examining the research careers of women employed in universities and national laboratories in four Indian cities, Kumar (2001) observes that in terms of productivity and number of hours spent on research, men and women are virtually identical. Gupta and Sharma (2002) utilize qualitative interviews to locate the cause of gender differences in the patrilocality of Indian society. The system of patrilocality, they argue, limits the ability of female scientists to establish professional contacts by restricting their interactions to a minority of other female researchers, leading to less diverse and more locally oriented occupational ties.

Campion and Shrum examine gender differences in three developing areas, concluding there is negligible inequity on most indicators of career distinction such as productivity and organizational involvement (2004). However, men and women did differ on two dimensions that appear crucial to career attainment, broadly related to differences in human and social capital. First, there were significant differences in educational attainment, with fewer women possessing the doctoral degree. Second, women displayed more “localism” in their orientation to education and career. They were less likely to go abroad for higher degrees, and less likely to leave their organization for travel to meetings or other activities. In consequence, women scientists display slightly lower levels of productivity in such venues as foreign journals and book chapters.

Campion and Shrum conclude that the difficulties female researchers experience in establishing their research careers stem not from deficiencies in material resources but rather from deficiencies in social resources—deficiencies ultimately traceable to constraints on the physical mobility of women (2004).

The effect of social capital, the “investment in social relations with expected returns,” on the life chances of individuals is well documented (Lin, 2001:3). Those with access to better social resources, largely defined by position in the social structure, “will obtain better outcomes in instrumental action” (Marsden and Hurlbert, 1988:1039). An actor’s location in a social network influences the resources s/he can draw on. Owing to structural and historical conditions, women receive primary socialization to become wives and mothers and are restricted primarily to networks based on kinship and family ties. Such a pattern of social ties is less diverse, providing fewer opportunities for professional advancement, and explaining why women typically attain lower statuses in their careers (Lin, 2001:789). In light of Gupta and Sharma’s (2002) results, women in developing areas may experience even greater difficulty establishing such ties, since their physical mobility and interactions with males outside of their family unit are often restricted or altogether prohibited.

Scientific careers are particularly dependent on the information and expertise that derives from social relationships. The ability of researchers to access social capital affects outcomes such as productivity, a key measure of occupational achievement (Reskin, 1978). Of course, the ramifications of possessing or not possessing social capital extend beyond productivity to affect other career outcomes such as tenure and pay, two areas in which women in developed areas continue to lag behind their male

counterparts (Fox 1995). Where women are restricted in their physical mobility owing to a culture of patrilocality, social capital is difficult to establish and maintain. As such, their career outcomes are also likely to be impacted. But if it is primarily the physical mobility of women in developing areas that impedes access to larger and more diverse social networks, new technologies offer an opportunity to surmount these social restrictions.

The development and diffusion of information and communication technologies (ICTs) has rapidly altered the practice of science in industrialized areas (Nentwich, 2003). New ICTs enable users to access a wide variety of information quickly and relatively cheaply, as well as develop and maintain contacts with other professionals. As such, the diffusion of the Internet to the developing world has the potential to alleviate the difficulties many researchers experience. Women professionals may benefit more than men, if use of the Internet removes the constraints of space and time and allows the circumvention of structural constraints imposed on their movement. Whether or not the potential benefits of ICT access are realized is contingent upon the specific context in which female scientists work (Ekdahl and Trojer, 2002).

In the following section, we describe the context for this study of science and development, our methodology, and sample. Next, we analyze gender differences in human capital as well as educational and organizational localism. We then assess the degree to which there have been changes in access to information and communication technologies. Finally, we examine whether men and women remain different in terms of their social capital and productivity. In the discussion, we cast doubt on the conventional

assumption that the diffusion of the Internet will soon allow women scientists in the developing world to circumvent international isolation.

Context and Method

The three locations chosen for this study represent varying levels of socio-economic and technological development: Kerala (high), Kenya (medium), and Ghana (low). In 2002, the dispersion of personal computers in Ghana, Kenya, and India per 1,000 people was 3.8, 6.4, and 7.2, respectively. A similar pattern emerges for the number of Internet users per 1000 (2002). India possesses the largest number of Internet users, 15.91, followed by Kenya and finally Ghana-12.7 and 7.84. Within India, we focus on the state of Kerala. Ranking high on indicators of social development but substantially lower on indicators of economic development (Franke and Chasin, 1994), the government of Kerala places a great deal of emphasis on supporting scientific research and the diffusion of ICTs within the region. With one of the larger African research systems-composed of state research institutes, universities, and non-governmental organizations-Kenya has been dogged by corruption and financial problems that have led to deterioration in the past decade. Ghana, while lagging behind Kenya in terms of scientific output, possesses higher Internet connectivity than most countries in sub-Saharan Africa. Although the three countries clearly differ, we do not disaggregate the remainder of the analysis by country since the findings do not change substantially.

Face-to-face interviews were conducted with academics and scientists employed in international research centers and universities in 1994 and again during the period 2000-2002 from the primary universities and research institutions in the agricultural and

environmental sectors. In the first phase (1994) we interviewed 293 scientists (NGO respondents are excluded in the present analysis). In the second phase, we returned to a subset of these institutions in 2000 (Kerala), 2001 (Kenya), and 2002 (Ghana), interviewing a total of 908 scientists. Respondents employed in a broad range of science and engineering fields were questioned about their educational background, organizational involvement, social networks, and access to information and communication technologies. Full details of the methodology may be found in Duque et al. (2005).

To examine the questions of gender differentials and changes wrought by ICTs, we examine five key dimensions of the research career: (1) Human capital; (2) Localism; (3) Access to resources; (4) Social capital; and (5) Productivity. To measure human capital, we use two dichotomous variables. The first variable asks respondents to indicate whether or not they possess a Masters degree. The second asks them to indicate whether or not they possess the PhD. Four indicators of localism were employed. The first two focus explicitly on educational experiences. We measured years spent outside of the area for educational reasons and receipt of any degree from an institution in a developed country. The third variable asks respondents to report the number of years spent in a developed country (DC) altogether. Finally, our indicator of ‘organizational’ localism was based on a question asking respondents to report the number of days spent away from their parent organization, that is, the organization in which they are currently employed, in the past year.

Because information and communication technologies are generally viewed as the resources with the greatest potential for overcoming barriers of time and space, and hence

restrictions on women's physical mobility, our consideration of professional resources focuses on reported access to personal computers (PCs) and email. While there are many degrees of access and patterns of Internet use, we did not include other indicators in 1994 and are limited to these variables.

We measure access to social capital through a network indicator, the total number of linkages as reported in an open-ended item asking respondents to nominate those individuals whom they considered their most important professional contacts. In order to test the argument that the gender differences in scientific careers may result from restricted opportunities for women to establish non-local contacts, we distinguish between contacts with foreign and domestic researchers. Foreign researchers include all ties outside of Ghana, Kenya, and Kerala (including those outside Kerala but within India), whereas domestic contacts include only those ties with researchers in the immediate environment.

Productivity is the means by which researchers establish themselves in their field, as well as gain tenure, professional status, and salary increases. Because we are primarily concerned with the link between social capital and career outcomes, we focus on two indicators of publication output: articles in foreign journals and chapters in books. Publication in these two sources, we argue, is likely to be facilitated through contacts with other researchers. Publishing in foreign journals, for instance, may be more difficult without the input of mentors and collaborators familiar with international practices as well as the publishing process in a specific country. Chapters in books are typically opportunities that arise through the awareness of colleagues in similar areas of specialization or specific invitations to contribute.

[Table 1 about here.]

Table 1 presents the gender distribution of our sample within country of residence and sector of employment. Female respondents constitute 15% of the Ghanaian sample, 19% of the Kenyan sample, and 37% of the sample from Kerala. The percentage of women employed in national research institutes is 21%, while the percentage working in universities is 26%. Table 1 also indicates the general social and demographic characteristics of the sample. Women in the second phase are about two years younger than men, and they are more likely to be Asian (given the higher percentage of women in Kerala). Significantly fewer women than men report being married-83.6% compared to 92.0%-and they report fewer children-1.98 compared to 2.48. Interestingly, over the two phases of the survey, fewer men but more women are marrying-approximately 5% fewer men are married in the second phase compared to 3% more women. Regardless of gender, however, both men and women report fewer children in the second phase.

Results

[Table 2 about here.]

To analyze gender differences over time, a series of t-tests and chi-square tests were conducted for the main dimensions of interest. For those variables at the interval-ratio level of measurement, the t-test is employed and the F statistic is used to determine significant changes. Significant differences for variables measured at the nominal or ordinal level are tested using the Chi-square statistic. Table 2 presents the results for educational attainment for men and women in the two phases of the study. Although women were significantly less likely to possess the Ph.D. in phase one (47% compared to

63% for men) and significantly more likely to possess the Masters degree (47% compared to 32%), by phase two there was gender equity on this measure. In the phase two sample, 53% of both women and men have attained the Ph.D., while 35% of women and 38% of men possess a Masters qualification, a difference that is statistically insignificant.

Yet during the same period that the gender gap in educational attainment was declining, women display increasing educational and organizational localism, one of the primary gender differences noted in Gupta and Sharma's qualitative study (2002). Differences in educational localism are actually wider in the second phase of the study (Table 2, line 3). In the early 1990s, 55% of men but only 34% of women received education in a developed country, a difference of 21%. Less than a decade later, in the early 2000s, 47% of men and 20% of women report education abroad, a difference of 27%. While the percentage of respondents receiving their education in a developed country has dropped for both male and female respondents, the decrease has been greater for women.

Similar trends emerge in the amount of time respondents spent abroad in developed countries. In the first wave, women averaged 1.86 years in developed areas for educational purposes and 1.81 years for general reasons, while men averaged 2.72 and 2.67 years respectively, a difference of about a year in each case. In the second time period, the number of years men spent in a developed country for educational reasons remained virtually unchanged at 2.6, while women dropped to 1.1 years, a difference of one and half years. Similarly, the gender gap in overall time abroad increased (Table 2, line 5).

From phase one to phase two, the number of days spent away from the parent organization decreased regardless of gender (Table 2, line 6). The gender gap in organizational localism has narrowed slightly but remains statistically significant. In phase one, women averaged 33 days away from their organization while men were gone 50, a difference of nearly 17 days. In phase two, women spent about 24 days away from their organization whereas men spent 35—a gender gap of eleven days. Overall, the results in Table 2 suggest that the closure of the gender gap in educational attainment has not been accompanied by any general reduction of inequity in the opportunities experienced by women to leave the confines of the organizational sphere. Are women scientists indeed becoming more locally oriented in their career development—or have information and communication technologies provided new means for the development of social capital?

[Table 3 about here.]

Table 3 provides support for the latter possibility. The latter half of the 1990s witnessed a dramatic increase in access to both personal computers and email for scientists in Kerala, Kenya, and Ghana. Changes in the latter are particularly striking. Overall, access to email increased for our sample of African and Indian scientists from 3.5 percent in 1994 to 67 percent in the early 2000s. Not only has access to these important research technologies increased, but it has done so without generating new disadvantages for women. The gender gap in the potential for rapid communication is small and statistically insignificant—two thirds of both men and women reported ready access to electronic mail capacity. Still, evidence of access does not settle the issues that are vital to understanding gender change in the developing world. Is this increase in

access associated with an increase in the development of social capital or career outcomes such as productivity?

[Figure 1 about here.]

The evidence presented in figure 1 is largely negative. From the first phase of the study to the second, the number of both external and internal contacts reported dropped. When the findings are disaggregated by gender, men report significantly larger international networks than women in both phases: 2.37 compared to 1.81 in the first phase and .83 compared to .48 in the second phase. Women, on the other hand, have more local contacts: 2.32 compared to 2.16 in the first phase and 1.90 compared to 1.37 in the second phase. To the extent that the size of one's non-local network operationalizes the relevant social capital for developing country scientists, the gender gap remains significant. Women scientists continue to exhibit localism not only in their educational and organizational environments, but also in their pattern of social relationships.

Do differences in localism have an impact on productivity? While we cannot address this question directly in a causal model, the findings in Table 3 are consistent with this conclusion. Women's productivity in international journals decreased in the late 1990s relative to men (Table 3, line 5). In fact, the small disparity in phase one becomes statistically significant in the second phase of our study, with women experiencing a much sharper drop in productivity (1.05 articles to 2.26 for men). Finally, the results on the output of published book chapters are not encouraging (Table 3, line 6). While men and women published approximately the same number of book chapters in the first phase, men reported more than two additional chapters in the second.

Discussion

We sought to examine whether changes have occurred in the research careers of women in developing areas relative to their male counterparts. The time period in question witnessed the widespread diffusion of the Internet throughout the scientific communities of the developing world, a development that has great potential for changing the status of women, given the localism identified by prior research as an important factor in gender disparity. Our results suggest reasons for both optimism and concern. The good news is that women in the second phase of our study reported possessing the Ph.D. and Masters Degree at the same rate as men, virtually eliminating the gender gap in educational attainment. Moreover, we demonstrated that a shift in access to information and communication technologies has occurred that did not favor men over women. In the first phase of the study, generally insignificant levels of access were reported, while two thirds of our sample had some form of email access by the time our second wave of data collection ended in the summer of 2002.

But over the same period of time the gender gap in educational and organizational localism became more pronounced. Women are less likely than before to spend time abroad for education and less likely to leave their parent organization for travel. This increase in educational and organizational localism would not be a matter of concern if the necessity for travel has diminished owing to increased access to information and communication technologies. If most scientists have the capability to interact at a distance with colleagues in both the national and international scientific community—an assumption often made by researchers in the U.S.—one would also expect that the

number of professional contacts would increase, as well as the productivity of both women and men. Indeed, the widespread policy expectation has been that the diffusion of the Internet will eventually yield career gains for women, enabling them to circumvent restrictions on their mobility.

Our analysis is not consistent with such assumptions. Instead, women continue to be disadvantaged in the size of their professional networks outside the local context. Their lower productivity in foreign journals and chapters in books may be one consequence of this deficit in social capital. Men may be more successful in publishing in such venues as a result of their educational and travel experiences in foreign countries. To the extent that productivity in foreign journals and book chapters are contingent on professional relationships, the changes reported here should counteract any tendency to focus exclusively on advances in human capital.

Based on these findings, it appears that the Internet has not yet improved the size of women's external networks and their productivity, our career outcome measure, has actually decreased relative to their male counterparts. Whether or not the shift to Internet-based science translates into occupational benefits for women in the long term remains to be seen, since the diffusion of ICTs and shifts in usage patterns are very much in progress. The findings here do call into question the notion that ICTs, as they have been designed, are appropriate for use in all areas. The research institutions examined here have different needs from the countries in which the technologies were developed. As such, future studies must continue to investigate where this trend leads. Otherwise the danger exists that the current ICT centered policies implemented by development institutions will persist in overlooking more suitable practices.

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Table 1. Sample Characteristics by Survey Year

Variable	1994			2000		
	Male	Female	N	Male	Female	N
<i>Country</i>						
1. Ghana	83%	17%	70	85%	15%	298
2. Kenya	77%	23%	70	81%	19%	310
3. Kerala	63%	37%	89	63%	37%	303
<i>Sector</i>						
4. National Research Institutes	71%	29%	154	79%	21%	422
5. Universities	79%	21%	82	74%	26%	489
<i>Demographic</i>						
6. Age	42.41	40.63	236	44.8*	42.89	905
7. %Asian	31.6*	50.8	235	27.2**	53.0	905
8. %African	68.4*	49.2	235	72.2**	46.5	905
9. % Married	96.6**	80.6	236	92.0**	83.6	904
10. Number of Children	2.84**	2.03	233	2.48**	1.98	862

** p<.01; * p<.05

Table 2. Educational attainment and localism by gender and survey phase

Variable	1994			2000		
	Male	Female	N	Male	Female	N
1. % PhD	62.6*	46.8	236	52.7	53.0	908
2. % Master's Degree	32.2*	46.8	236	37.8	34.6	908
3. % Educated in developed countries	54.6*	33.9	236	47.0**	19.8	865
4. Number of years outside of survey location for education	2.72*	1.86	233	2.6**	1.1	782
5. Number of years spent in developed countries	2.67*	1.81	232	3.0**	1.4	796
6. Number of days spent away from own organization in the past year	49.90*	33.08	225	34.53*	23.73	786

** p<.01; * p<.05

Table 3. Access to resources, social capital and productivity by gender and time period

Variable	1994			2000		
	Male	Female	N	Male	Female	N
1. % reporting access to personal computers	62.7	55.0	229	77.5	72.1	903
2. % reporting access to email	3.0	5.0	229	67.8	65.1	901
3. Reported number of external contacts	2.37	1.81	227	.83**	.48	840
4. Reported number of local contacts	2.16	2.32	227	1.37**	1.90	840
5. Articles in international journals	2.33	1.30	227	2.26**	1.05	750
6. Chapters in books	.42	.40	228	2.74	.57	698

**p<.01; * p<.05

Figure 1. External and internal professional contacts by year.

