Efficiency of scientific output of Venezuelan female researchers: Is parity the same as equality?

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Abstract

Gender equality policies currently in place in many countries have spurred significant progress in advancing women in the fields of science. Nonetheless, numerous of recent studies have sought to measure differences between the scientific activity of men and women. The aim of this paper is to ascertain possible differences in scientific productivity in certain scientific disciplines carried out by men versus women and to determine importance of professional standing with regard to these scientific outputs. To this end, a bibliometric analysis was conducted of the *curricula vitae* of 6015 Venezuelan researchers participating in the

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country's Researcher Promotion Program up to 2009. Findings show that the Venezuelan research system has more female than male participants, but fewer women in the highest professional echelons. Women also proved to be less productive, with performance varying significantly from field to field.

Keywords: Gender parity; Gender equality; Bibliometrics; Scientific productivity, Venezuelan researchers.

Resumen

¿Paridad equivale a igualdad? Eficiencia de la producción científica de las investigadoras venezolanas
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Las políticas de igualdad de género promovidas desde distintos países y regiones han supuesto un avance importante a la hora de facilitar la plena incorporación de la mujer en la actividad científica. Esto ha dado lugar a la realización de numerosos estudios tendentes a determinar la posible existencia de diferencias en la actividad científica realizada por hombres y mujeres. El objetivo de este trabajo se ha dirigido a conocer si existen o no diferencias de productividad en determinadas áreas científicas en función del género de los investigadores, y la relación entre la posición en la carrera profesional de hombres y mujeres y su producción científica. Para ello se ha realizado un análisis bibliométrico de los 6015 *currículums vitae* de los investigadores venezolanos incluidos en el Programa de Promoción del Investigador (PPI) hasta el año 2009. Entre los resultados hay que destacar la mayor presencia de la mujer en el sistema de investigación venezolano, una menor presencia de mujeres en las categorías profesionales superiores, una menor productividad de las mujeres, o la diferente eficiencia que muestran las mujeres en función de las áreas temáticas consideradas.

Palabras clave: Paridad de género; Igualdad de género; Bibliometría; Productividad científica; Investigadores venezolanos.

Introduction

Interest in scientific activity from the standpoint of gender has brought about numerous comparative studies attempting to determine whether gender differences exist in the characteristics of scientific activity carried out between male and female researchers. To this end, bibliometric analysis has proven to be a valuable tool, allowing researchers to analyze research activities in an objective way, examine the development of this activity, and compare results against those arising from other fields of knowledge or geographic regions.

One question that has drawn the particular interest of researchers is whether or not there are gender differences in the scientific production of researchers. In this vein, Prozesky (2006) observes that male researchers in South African universities published papers at a nearly two to one rate versus those published by the most productive female researchers. This study also showed that the most productive male researchers easily outstripped their most productive female counterparts. The researcher also observed that these trends are very similar to those found in other countries analyzed, where women researchers also published fewer scientific papers than men (Prozesky, 2008).

Studies in Spain along these same lines, specifically in the fields of Science of Materials of the Supreme Council of Scientific Investigation (CSIC) (Mauleón and Bordons, 2006), reported a scarcity of women in the highest levels of the professional career, also publishing the fewest papers included in the journals listed in the *Science Citation Index* (*SCI*/Thomson Reuters) or fewer with similar impact to those published by male scientists. A later gender study (Mauleón, Bordons y Oppenheim, 2008) focused on an examination of scientific and technological activity of researchers in the CSIC showed that the average number of papers published by male scientists in journals included in the *Web of Science* were slightly more than the average published by women across most fields; but the differences were only significant on in the field of Nutrition, where women showed higher productivity and in Science of Materials and Agricultural Science, where men were more productive.

With similar objectives, Abramo, D'Angelo and Caprasecca (2009) obtained comparable results in their analysis of gender differences in the Italian academic system; however, De Filippo, Sanz-Casado and Gómez (2009) had different findings with regard to scientific productivity, finding there was no significant difference between the scientific productivity of male and female scientists.

In this research, we are attempting to find out about gender differences in the Venezuelan research milieu. Starting in the 1990s in Venezuela, many actions were taken to encourage scientists to carry out research and publish. In 1990 the Venezuelan Research Promotion Foundation was founded to work toward such ends. This program has its origins in the 1980s when the Venezuelan Central University established a system to acknowledge its researchers (ONCTI, 2007; Marcano and Phélan , 2009). Article 2 of the decree establishing this groundwork states: "… the Foundation shall have as its objective the lending of economic assistance to cover the obligations as required and entailed in the implementation and development of the PPI program" (República de Venezuela, 1990).

The Researcher Promotion Program is one of the policies executed by the National Science and Technology Observatory (ONCTI), founded for the purpose of providing greater visibility to science and technology activities carried out by researchers residing in Venezuela. Researchers are evaluated by peers sitting on Area commissions and classified in three categories: Candidate, Researcher and Scientist Emeritus. The Researcher category consists of four levels, I, II, III and IV (Marcano and Phélan, 2009).

Likewise, this program is in charge of keeping a permanent registry of scientists in the country, having built its own data capture and storage tools for the information provided in researcher curricula vitae. For research scientists, the CV also represents a record of their scientific achievements and an administrative duty to be filed with authorities. As such, they are incentivized to keep their CVs updated and available.

In the field of scientific communication, the CV is one of the few, nearly universal, sources in terms of availability and significance. As such, the CV comprises an interesting source of data for evaluating the scientific activity of researchers (Sandström, 2009). Use of CVs in this way began in the decade of the 1990s; albiet with scant research to support their use as sources of supplementary information. (Cañibano, Otamendi and Andújar, 2008; Martín-Sempere and Rey-Rocha, 2003; Gaughan and Bozeman, 2002).

The purpose of this paper is to determine whether there are gender differences in specific characteristics of scientific activity carried out by Venezuelan researchers as reflected in the CVs they submit. Some of the main questions we hope to answer are: a) Are there gender differences in productivity in each of the areas scrutinized? b) Is there a relationship between the professional seniority held by researchers and their respective scientific output?

Likewise, it is important to point out that an analysis was made only of the scientific activity of those researchers who were still active at the time data was gathered. As such, the scientific output can be compared against the

population making the inputs. This fact serves to differentiate this research from other work which associates scientific output with the entire researcher universe, whether they are responsible for said output or not (Abramo, D'Angelo and Caprasecca, 2009).

Materials and methods

To carry out this research we gathered the CV data from 2010 of Venezuelan research sceintists registered in the PPI. These data were available on the webpage of the Researchers Promotion Program (García González, 2010). The data on the researchers were grouped by gender. A total of 6015 CVs on file in the system up to 2009 were gathered. As inputs, this analysis used the number of male and female researchers participating in each of the academic disciplines in which they were classified; and as outputs, the scientific production broken down by gender, as measured by the papers published in national and international journals in each of the areas.

For the descriptive analysis, functions of the free "base package" of the R statistical software (R Development Core Team, 2010) were used. For calculating the Gini indexes, the '*ineq*' package was used (Zeileis, 2012), whose calculation function is based on the Allison formulation (1978), and is compatible with other formulations used in the field of Infometrics (Rousseau, 1998, 2000). With regard to the number of researchers and their respective published papers, contingency tables were created combining the variables of gender and scientific field.

This paper groups Venezuelan researchers into three categories: Candidate (Ca), Researcher Level I (L_1) and PPI High Level Researches (Up_L). These three grouping levels were combined with the variables of gender and academic discipline, both in terms of the number of researchers (input) and the number of publications (output).

For the purpose of exploratory and visual analysis of contingency tables, mosaic plots have been developed using the '*vcd*' package (Meyer *et al.,* 2012). A mosaic plot provides a graphic representation consisting of "tiles", each of which is proportional to the dimensions, i.e., width and height, of each of the cells (observed frequencies) recorded in the corresponding contingency table (Meyer *et al.*, 2006).

Gender efficiency is measured using the *Gender Parity Index* (GPI) (UNESCO, 1997), which serves to determine the degree of integration of women in research tasks. This index is calculated for each of the academic disciplines under study, both at the level of input and output. On one hand, the GPI is

calculated against the resources employed in the research (GPI_r), which will result from the ratio of the number of female researchers compared to the number of male researchers. Values higher than the unit indicate a higher female presence. Moreover, the GPI is calculated with regard to the gender distribution in scientific publication (GPI_p), and is gauged by the relationship between the numbers of papers published by female researchers against those published by male counterparts. Values above one (1.0) show greater output by women researchers.

The Gender Success Rate (GSR) is defined as the capacity of researchers of a given gender to enjoy success in their respective scientific field. This value is calculated by relating the GPI_i index and the GPI_p index. Values above one (1.0) show greater output by women researchers.

Results and discussion

Distributions of the number of researchers (r) and the number of publications (p) by academic discipline

The total number of Venezuelan researchers analyzed in this study is 6015. Of these, 2823 are men and 3192 are women, all registered in the PPI. *Table 1* shows the distribution by gender and scientific field, as well as the distribution by gender and academic discipline for the number of papers published as reported in the CVs of the researchers. The data are organized in descending order of the total number of researchers in each field.

When the data shown in *Table 1* are analyzed, one observes the global percentage of women is 6.13% higher than men. This data is in line with the incorporation of women in higher education in Venezuela, which moved from 43% in 1959 to 59% in 2005 (Delgado de Smith and Rojas, 2009). This feminization of Venezuelan research, especially in the field of Life Sciences, has also been reported in a recent paper by Caputo, Requena y Vargas (2012). In Spain, a similar shift has been reported, though the range is somewhat lower. In 1972, women university professors stood at 15% and by the 1990s they represented 29% of the body of university faculties (Pérez Sedeño *et al.,* 2003). Nonetheless, in terms of papers published, male researchers account for 8.35% higher global percentage. With regard to published papers by Spanish researchers, there appears to be more output by male researchers (Mauleón and Bordons, 2006). When each area is analyzed, this percentage varies from field to field; the category Other is excluded from the analysis because it groups fields with few researchers and papers published. For exam-

ple, in disciplines of Medical Sciences (Med Sci), Pediatrics (Ped), Economy (Econ), Linguistics (Ling), Law (Law), Psychology (Psych) and Ethics (Ethics), the prevalence of women tops 60%. Nonetheless, when these percentages are compared to papers published by women in these fields, we find they are inferior to said prevalence, except for the field of Psychology, where the two percentages are nearly the same, i.e., 74.5% and 74.28%, respectively.

When the same comparison is made with regard to male researchers, the areas exhibiting percentages higher than 60% are Physics (Phys), Mathematics (Math), Earth Science (Earth Sci), Philosophy (Philo), and Astronomy and Astrophysics (Astro). When these values are compared to publication rates, we find these rates to be higher, except for the case of Philosophy, which came in slightly lower at 56.32%.

Table 1. Distributions of the presence of researchers in journals by academic discipline and gender

	Number of researchers (r)					Number of papers published				
Fields	Man	Woman	Total	Man (%)	Woman (%)	Man	Woman	Total	Man (%)	Woman (%)
Life Sci	377	473	850	44.4	55.6	8062	6432	14494	55.62	44.38
Tech Sci	386	345	731	52.8	47.2	5993	5430	11423	52.46	47.54
Med Sci	226	436	662	34.1	65.9	4005	5818	9823	40.77	59.23
Agr Sci	341	289	630	54.1	45.9	6144	4186	10330	59.48	40.52
Ped	155	339	494	31.4	68.6	1796	3241	5037	35.66	64.34
Chem	240	203	443	54.2	45.8	5610	2995	8605	65.19	34.81
Econ	106	164	270	39.3	60.7	1087	1557	2644	41.11	58.89
Phys	205	43	248	82.7	17.3	3958	762	4720	83.86	16.14
Sociol	94	136	230	40.9	59.1	2096	2025	4121	50.86	49.14
Math	151	74	225	67.1	32.9	2174	881	3055	71.16	28.84
Arts	67	97	164	40.9	59.1	1384	1452	2836	48.8	51.20
Earth Sci	101	60	161	62.7	37.3	2248	979	3227	69.66	30.34
Ling	38	102	140	27.1	72.9	672	1512	2184	30.77	69.23
Hist	60	63	123	48.8	51.2	1328	1222	2550	52.08	47.92
Polit	57	60	117	48.7	51.3	1317	1003	2320	56.77	43.23
Law	35	77	112	31.2	68.8	554	891	1445	38.34	61.66
Psych	28	82	110	25.5	74.5	386	1115	1501	25.72	74.28
Philo	45	27	72	62.5	37.5	722	560	1282	56.32	43.68
Anthro	34	27	61	55.7	44.3	690	566	1256	54.94	45.06
Geo	20	21	41	48.8	51.2	259	232	491	52.75	47.25
Astro	15	5	20	75	25.0	491	110	601	81.7	18.30
Ethics	7	11	18	38.9	61.1	69	101	170	40.59	59.41
Other	35	58	93	37.6	62.4	207	286	493	41.99	58.01
Total	**2823**	**3192**	**6015**			**51252**	**43356**	**94608**		

Figure 1 is a box-plot diagram of the data appearing in *Table 1.* One can observe that the average number of female researchers is somewhat higher than male counterparts, with Life Sciences and Medical Sciences exhibiting atypical numbers of female researchers. Moreover, the average number of papers published is lower among female researchers at 1885 versus the average for male counterparts at 2228. The number of paper published in the area of Life Sciences behaves distinctly for both men and women. Additionally, these exhibit atypical behavior in the fields of Technological Sciences (Tech Sci) and Medical Sciences.

Neither of the distributions exhibit significant differences with regard to gender of researchers, as shown by the variance analysis test for the number of researchers ($F_{2,44}$=0.176, *p-value*: 0.6768) and for the number of papers published ($F_{2,44}$=0.3099, *p-value* = 0.5805).

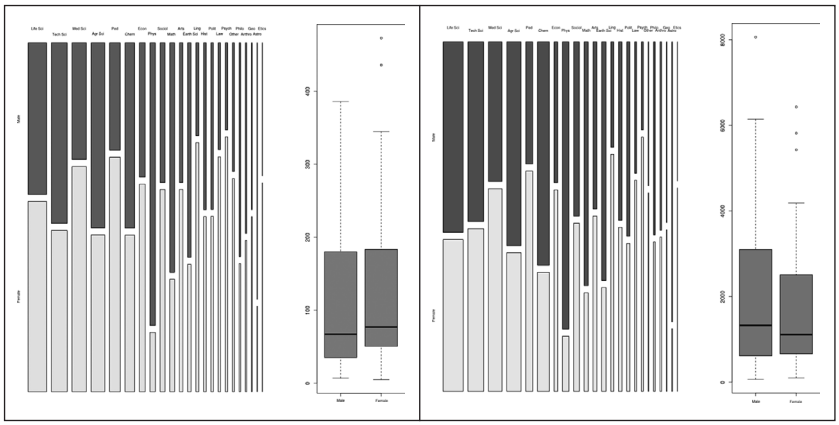

Figure 1. Mosaic plot and box-plot of distribution of researches and papers published by field and gender

The analysis of data by gender of the number of researchers and papers published against the professional grade is shown in *Table 2.* Said table shows in general terms that women researchers have a larger presence at the lower professional grade levels, such as L_1 and el Candidate (Ca), representing 22.1% and 18.57%, respectively, of the total number researchers, while male researchers are represented in the higher levels (Up_L) at 16.37% of the total. Other research has obtained similar results, showing a presence of women researchers higher than that of male counterparts in the lowest professional grade levels, and lower presence in the higher levels (Abramo, D'Angelo y Caprasecca, 2009; Mauleón y Bordons, 2006; Mauleón, Bordons y Oppenheim, 2008; Caputo, Requena y Vargas, 2012). In terms of scientific

Table 2. Number of researchers and papers published by gender and professional grade level

	Number of researcher (r)							Number of papers published						
	Men			Women				Men			Women			
Fields	Ca	L_1	Up_L	Ca	L_1	Up_L	Tot-r	Ca	L_1	Up_L	Ca	L_1	Up_L	Tot-p
Life Sci	51	144	182	118	219	136	850	307	1898	5857	493	2446	3493	14494
Tech Sci	166	144	76	126	140	79	731	683	2476	2834	544	2157	2729	11423
Med Sci	56	93	77	157	189	90	662	413	1351	2241	880	2426	2512	9823
Agr Sci	80	179	82	103	145	41	630	477	2786	2881	510	2451	1225	10330
Ped	67	54	34	157	142	40	494	294	597	905	668	1623	950	5037
Chem	41	76	123	54	78	71	443	116	884	4610	195	740	2060	8605
Econ	46	42	18	84	52	28	270	177	470	440	333	501	723	2644
Phys	31	77	97	7	21	15	248	86	717	3155	25	208	529	4720
Sociol	20	35	39	44	54	38	230	80	422	1594	187	655	1183	4121
Math	55	56	40	25	33	16	225	137	582	1455	109	345	427	3055
Arts	25	23	19	31	50	16	164	216	478	690	195	788	469	2836
Earth Sci	28	37	36	18	25	17	161	181	559	1508	92	446	441	3227
Ling	9	10	19	49	25	28	140	32	85	555	191	345	976	2184
Hist	13	16	31	17	22	24	123	121	213	994	106	320	796	2550
Polit	5	23	29	19	18	23	117	41	348	928	115	180	708	2320
Law	9	12	14	21	37	19	112	72	136	346	87	430	374	1445
Psych	9	6	13	25	35	22	110	31	61	294	93	410	612	1501
Philo	8	22	15	9	8	10	72	46	283	393	52	182	326	1282
Anthro	5	9	20	1	10	16	61	41	97	552	2	142	422	1256
Geo	6	9	5	8	9	4	41	30	80	149	33	82	117	491
Astro	2	3	10	1	1	3	20	10	49	432	0	6	104	601
Ethics	4	2	1	2	7	2	18	18	25	26	11	31	59	170
Other	23	7	5	41	9	8	93	27	106	74	51	69	166	493
Total	**759**	**1 079**	**985**	**1 117**	**1 329**	**746**	**6 015**	**3 636**	**14 703**	**32 913**	**4 972**	**16 983**	**21 401**	**94 608**

output of female researchers, this value came in higher at the highest professional levels (Up_L), at 22.6% of the papers published by women. Male researchers also boast higher scientific output at the highest level (Up_L), at 34.79% papers published by men, and at a proportion much higher than seen in women researchers.

An analysis of the presence of women researchers and their scientific output in each of the fields considered in terms of professional grade reveals that at the Candidate grade (Ca) women constitute majorities in 15 of the 22 fields, while men lead in the remaining seven, i.e., Technological Sciences (Tech Sci), Physics (Phys), Mathematics (Math), Earth Sciences (Earth Sci), Anthropology (Anthro), Astrophysics (Astro) and Ethics.

The number of publications by women at this level, however, is lower than the number of men in nine areas, including the seven already mentioned and in the Fine Arts and History (Arts).

At the next professional grade (L_1), there are fewer fields in which women are more numerous than men, since they are present in 13 of the 22 fields analyzed. In terms of papers published, the majority of fields in which women are more highly represented than men are also those in which they publish more numbers of papers, with the exception of Chemistry (Chem) where male researchers published 144 more papers than their female counterparts, despite being in a slim minority (two less researchers).

With regard to the highest professional grade (Up_L), the number of fields with greater numbers of women researchers falls to eight. When fields in which women researchers publish more papers than their male counterparts are analyzed, we find that seven of these fields coincide with those fields in which they are more highly represented. In Technological Sciences (Tech Sci), despite there being more women than men, the latter publish more papers than the former.

The gender and professional grade differences observed with regard to the number of researchers shown in *Table 2* are not statistically significant, i.e., $F_{1,136} = 0.4381$, *p-value* = 0.5092) and ($F_{2,135} = 1.236$, *p-value* = 0.2939), respectively. In contrast, the differences in the number of publications are significant in term fo professional grade, i.e., $F_{2,135} = 14.84$, *p-value* < 0.05; but not for gender which came to $F_{1,136} = 0.4894$, *p-value* = 0.4854.

To determine whether the numbers of researchers and their papers published are spread equally across the diverse fields, a Gini index has been calculated for each of these distributions. Moreover, a Lorentz curve has been developed for each distribution. These results are shown in *Table 3* and *Figure 2*, respectively, on the following page.

As can be observed, the concentration levels are not excessively high. The global behavior of both the number of researchers (0.4824) and scientific output (0.4916) are very similar. It is understood that there is greater homogeneity among researchers at the highest professional grade (Up_L), and among these, the distributions are somewhat more uniform for female researchers than is the case for their masculine counterparts. As for the other two professional grades considered (Ca and L_1), these show distributions are more concentrated for numbers of papers published than for the numbers of researchers.

Table 3. . Gini Index: Distribution by area and gender

	Number of researchers (r)			Number of papers published (p)		
	Ca	L_1	UP_L	Ca	L_1	UP_L
Men	0.5207	0.5386	0.5028	0.5328	0.5704	0.5275
Women	0.5313	0.5406	0.4781	0.5521	0.5544	0.4815
Total	0.4824			0.4916		

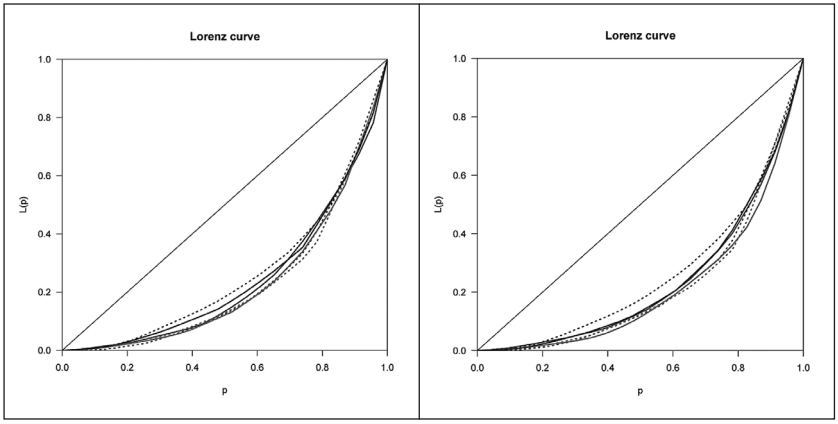

Figure 2. Lorenz curves de. Left.: by numbers of researchers. Right: by numbers of papers published. Men: Lines; Women: Dotted lines.

Gender Parity Indexes (GPI)

Table 4 shows the gender parity indices calculated for each of the professional grades and fields. Taking all of the fields together (as is the case for the *Other* category, which is not weighed since several fields are grouped therein), we can see that for the number of researchers belonging to each field,

eight of these fields (Pyschology (Psych, 2.929), Linguistics (Ling, 2.684), Law (Law, 2.200), Pediatrics (Ped, 2.187), Medical Sciences (Med Sci, 1.929), Economy (Econ, 1.547), Sociology (Sociol, 1.447) and Life Sciences (Life Sci, 1.255) female researchers are more prevalent than male researchers. In contrast, their values for professional output in these fields are lower than those for men across the board.Moreover, in two of these fields Sociology (Sociol, 0.966) and Life Sciences (Life Sci, 0.798), male researchers outperform female researchers, despite being in the minority.

From the standpoint of professional grade parity, for three grades the results vary significantly from field to field ($F_{2,66}$= 3.234, *p-value*< 0.05). In general terms, it can be said that the results obtained in this research would show that the weight of women declines as their professional grade rises.

The average of the GPI value weighed as per number of researchers in each of the fields stands at 1.317 for the entire population, somewhat higher to the real proportion of women belonging to the system (3192/2823 = 1.131). This comes about because of the strong presence of women in the fields with higher numbers of human resources devoted to research, such as Life Science (Life Sci), Medical Sciences (Med Sci) and Pediatrics (Ped). The aggregate level of the presence of women declines with the professional grade, with the highest professional grade standing below the parity mark, since the values are above 1.80 at the lowest grade (Ca), and move to 1.47 at the middle grade (L_1), and to 0.83 at the highest grade (Up_L).

In terms of gender and field, a slightly different comportment is observed in the distribution of scientific output of men and women registered in PPI. The aggregate, as gauged by the weighted average of the number of publications, comes to a weighted GPI of 0.951, which signals, on one hand, global parity in the number of publications, but a loss of output efficiency among women, because it is lower than the value calculated for resources. As such, with regard to female output as a function of professional grade, one observes a relationship similar to that already obtained for the number of male researchers. This female output declines from its initial professional grade (Ca), where female output is 62.4% higher than their male counterparts, to much lower output values at the highest professional grades, where the balance tips significantly toward male output (0.734). At the intermediate professional grade (L_1), the output of women researchers begins to drop off, but in general terms remains above that exhibited by men by 37.6%. This diminishing output by female researchers (as they move up in professional grade) is seen across all fields, except once again in Technological Sciences (Tech Sci), where their output increases hand-in-hand with professional advancement. The differences observed in the parity indexes of the fields

are not statistically attributable to professional grade of the researchers ($F_{2,66}$=1.805, *p-value* = 0.1725).

Table 4. GPI (Gender Parity Index) of the number of researchers and number of papers published by field and PPI rank (Researcher Promotion Program).

	Number of researcher (r)				Number of papers published (p)			
	GPI-r				GPI-p			
Fields	Ca	L_1	Up_L	Total	Ca	L_1	Up_L	Total
Life Sci	2.314	1.521	0.736	1.255	1.606	1.289	0.596	0.798
Tech Sci	0.759	0.972	1.039	0.894	0.796	0.871	0.963	0.906
Med Sci	2.804	2.032	1.156	1.929	2.131	1.796	1.121	1.453
Agr Sci	1.288	0.81	0.5	0.848	1.069	0.88	0.425	0.681
Ped	2.343	2.63	1.176	2.187	2.272	2.719	1.05	1.805
Chem	1.317	1.026	0.577	0.846	1.681	0.837	0.447	0.534
Econ	1.826	1.238	1.556	1.547	1.881	1.066	1.643	1.432
Phys	0.226	0.273	0.144	0.21	0.291	0.29	0.168	0.193
Sociol	2.2	1.543	0.974	1.447	2.338	1.552	0.742	0.966
Math	0.455	0.589	0.4	0.49	0.796	0.593	0.293	0.405
Arts	1.24	2.174	0.842	1.448	0.903	1.649	0.68	1.049
Earth Sci	0.643	0.676	0.472	0.594	0.508	0.798	0.292	0.435
Ling	5.444	2.5	1.474	2.684	5.969	4.059	1.759	2.25
Hist	1.308	1.375	0.742	1.05	0.876	1.502	0.801	0.92
Polit	3.8	0.783	0.793	1.053	2.805	0.517	0.763	0.762
Law	2.333	3.083	1.286	2.2	1.208	3.162	1.081	1.608
Psych	2.778	5.833	1.692	2.929	3	6.721	2.082	2.889
Philo	1.125	0.364	0.667	0.6	1.13	0.643	0.83	0.776
Anthro	0.2	1.111	0.8	0.794	0.049	1.464	0.764	0.82
Geo	1.333	1	0.8	1.05	1.1	1.025	0.785	0.896
Astro	0.5	0.333	0.3	0.333	0	0.122	0.241	0.224
Ethics	0.5	3.5	2	1.571	0.611	1.24	2.269	1.464
Other	1.783	1.286	1.6	1.657	1.889	0.651	2.243	2.383
Weighted average	**1.805**	**1.469**	**0.829**	**1.317**	**1.624**	**1.376**	**0.734**	**0.951**

Gender Success Rate (GSR)

Table 5 presents the Gender Success Rates for female researchers. Said table shows the ratio of output (number of papers published) to input (number of researchers) as each is gauged by its respective GPI value. The GSR value determines the observed gender performance against the expected gender performance gauged as a function of the proportion of female researchers in both outputs and inputs. In order to better understand this indicator, one must take into account that if in a given field women account for 80% against

the population of men (GSR r=0.80), one would expect scientific output, as gauged by the number of papers published and reported in CVs to be similar. If the percentage of papers published by women against those published by men is higher than expected, then the GSR value would come in higher than 1.0, and we can safely speak of the greater success of women in the field where women outperform men.

These conditions of success occur regardless of gender proportions in any given field; which is to say, there are fields with higher proportions of females who also publish more papers than the their male counterparts. These fields are marked with double asterisks (**) in *Table 5*. Despite this, male researchers are more efficient; for example, in the fields of Med Sci (GSR=0.753) and Ped (GSR=0.825). Likewise, there are fields with a higher proportion of female researchers, but which nonetheless exhibit fewer papers published than those published by men. These fields are marked with an asterisk (*) in *Table 5*. In this sense, there are fields such as Life Sciences (Life Sci), where despite the fact that women constitute the preponderance of researchers, they are less effective in terms of the number of papers published (GSR=0.636). This is the case across the three professional grades. As such, the GSR at the entry grade (Ca) of 0.694 and at the intermediate grade (L_1, of 0.847 is worthy of note; which is to say: even when women publish more papers than their male counterparts, they do so at a lower than expected proportion.

Additionally, for fields in which women are in the minority, we never observe the circumstance of women outperforming men in terms of papers published; but there are fields in which none of the three scenarios described above occur. These cases appear in *Table 5* without asterisks. Interestingly, in this context, the field of Technological Sciences (Tech Sci), women are slightly more efficient than men (GSR=1.013), despite being in the minority (GPI-r=0.894) and less productive overall (GPI-p=0.906).

In the field of Physics (Phys), where women are in a small minority (GPI-r=0.21) and account for a low proportion of published papers (GPI-p=0.193), women exhibit gender efficiency near parity (GSR=0.919). In Chemistry (Chem) at the Candidate grade (Ca), women are more efficient than men; however, when analyzed as a whole, men turn out to be more efficient than women. In the social sciences, e.g., Economy (Econ, GSR=0.926) and Psychology (Psych, GSR=0.986), women exhibit values near gender parity, while in Sociology (Social) the index is much lower at (GSR=0.668).

Table 5. Output efficiency rate of male and female researchers by field and professional grade

	Gender Success Rate (GSR)			
Fields	Ca	L_I	Up_L	Total
Life Sci	0.694**	0.847**	0.810	0.636*
Tech Sci	1.049	0.896	0.927*	1.013
Med Sci	0.76**	0.884**	0.97**	0.753**
Agr Sci	0.83**	1.086	0.850	0.803
Ped	0.97**	1.034**	0.893**	0.825**
Chem	1.276**	0.816*	0.775	0.631
Econ	1.03**	0.861**	1.056**	0.926**
Phys	1.288	1.062	1.167	0.919
Sociol	1.063**	1.006**	0.762	0.668*
Math	1.749	1.007	0.733	0.827
Arts	0.728*	0.759**	0.808	0.724**
Earth Sci	0.790	1.180	0.619	0.732
Ling	1.096**	1.624**	1.193**	0.838**
Hist	0.67*	1.092**	1.080	0.876*
Polit	0.738**	0.660	0.962	0.724*
Law	0.518**	1.026**	0.841**	0.731**
Psych	1.08**	1.152**	1.23**	0.986**
Philo	1.004**	1.766	1.244	1.293
Anthro	0.245	1.318**	0.955	1.033
Geo	0.825**	1.025**	0.981	0.853*
Astro	0.000	0.366	0.803	0.673
Ethics	1.222	0.354**	1.135**	0.932**

(*) Fields in which female researchers are majority.
(**) Fields in which female researchers are majority who publish more papers than male counterparts.

Finally, the relational chart in *Figure 3* presents the ten most productive fields for each of the three professional grades. The abscissa axis shows the GPI-r values and the ordinate axis shows the PPI-p values for the fields selected. Additionally, two axes have been marked at GPI=1 to differentiate those fields in which women are majority and in which their output is higher or lower than that of their male counterparts. The 45° line acts as a gender success boundary: the fields above it are those in which women exhibit greater success; and those below correspond to fields in which male researchers are most successful. *Figure 3* shows women are more successful at the grade of Candidate (Ca). This is also true in the fields of Physics (Phys), Mathematics (Math), Chemistry (Chem) and Sociology (Sociol). Women at the grade of L_1 are more successful in the fields of Pediatrics (Ped), Agricultural Science (Agr Sci) and Earth Sciences (Earth Sci). With the exception of the field of Physics,

which is shown practically atop the 45° boundary, there is no field in which women are more successful than men at the highest profession grade (Up_L).

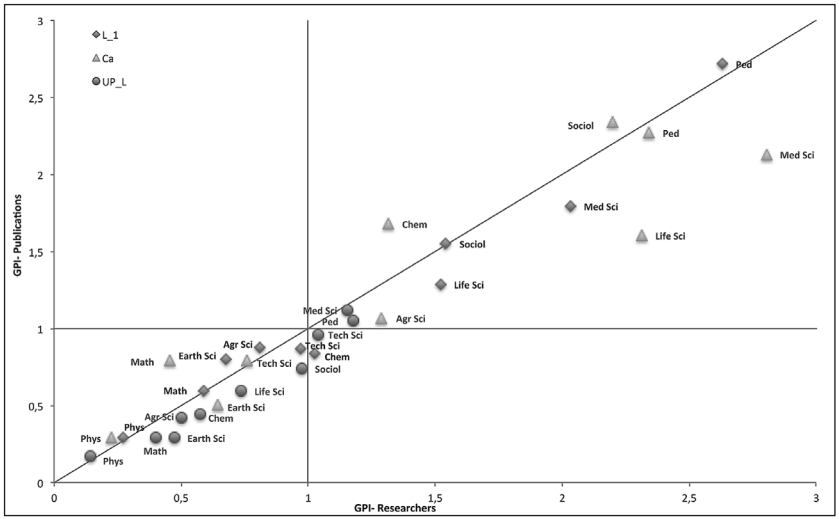

Figure 3. Relational graph. Ten most productive areas (>3.000 papers published). Three professional grades.

Conclusions

In general terms, research in the Venezuelan scientific system under the auspices of the Researcher Promotion Program is characterized by having larger numbers of women than men in research activity; however, in aggregate terms the scientific activity of men, gauged by papers published, is higher than that of women. When both distributions are broken down by field, no significant gender differences are observed (*p-value* > 0.05). From the standpoint of numbers of researchers in the five largest research fields, those of Life Sciences (Life Sci, 55.6%), Medical Sciences (Med Sci, 65.9%) and Pediatrics (Ped, 68.6%) exhibit a strong female population. We also must stress the larger proportion of women in social science fields with lower scientific research output, i.e., Economy (Econ, 60.7%), Linguistics (Ling, 72.9%), Law (Law, 68.8%) and Psychology (Psych, 74.5%).

This preponderance of female researchers is also evident in papers published in these fields, with the exception of Life Sciences (Life Sci), where women publish fewer papers than men. In general terms, however, the women's share of scientific output in these fields is lower than the share expected in terms of their respective populations. Caputo, Requena and Vargas (2012)

come to a similar conclusion with regard to Life Sciences (Life Sci), when they assert: "…Venezuelan female biologists are less productive than their male counterparts." This is a first indicator of the lower success of women in the Venezuelan scientific system, which could be caused by the greater difficulties faced by women who are trying to carry out scientific research. Moreover, this phenomenon has been observed in other countries (ETAN, 2000; Pérez Sedeño *et al.,* 2003).

When the data analyzed is broken down by professional grade and gender, we observe fewer from the global standpoint women than men in the highest professional grade (Up_L). When looking at numbers of researchers in the three professional grades of each field, we see that the differences are not statistically significant ($p > 0.05$); however, in view of the number of papers published these differences are significant ($p < 0.01$). In light of the fact that women at the highest professional grade are less productive than men at this grade, we can assert that this outcome is not caused by advancement, but rather by some other cause, insofar as these causes have already been examined in other research, such as research into the effects of age (Fox, 1983), child rearing (Prpić, 2002) or of observed gender differences in the degree of specialization in some fields (Leahey, 2006).

When parity indices are examined, we obtain results consistent with the aforementioned results. These measurements allows us to compare the degree of parity between both inputs (number of researchers) and outputs (number of papers published). Taken as a whole and as weighted averages, women make up a majority of researchers in the Venezuelan scientific system by a margin of 32% over men; however, their productivity is almost 5% less than that of their male counterparts. These differences are even more unambiguous at the highest professional grade (Up_L), where the average value of the number of women is 17% less than that of men and where women publish 27% less papers than their male counterparts. Even though the differences observed in the three professional grades are significant, one might say that they are not conclusive; since the value obtained ($p = 0.046$) is quite close to the critical value. When the number of papers published in the three professional grades is examined, the differences between men and women are not significant ($p > 0.05$).

In global terms, the calculation of the success rate of Venezuelan female scientists shows that women are slightly more successful than their male counterparts in three fields: Philosophy (Philo), Anthropology (Anthro) and Technological Sciences (Tech Sci). When the success rate is examined across the three professional grades, it is clear that parity is not linked to efficiency, because in parity situations favorable to women, their efficiency may be

greater or lesser than that of men in any of the professional grades. For example, across all of the professional grades of Life Sciences (Life Sci), despite women being in the majority and exhibiting higher outputs rates than men, it is lower than expected, which indicates that men, even with lower numbers, are more efficient than women in terms of scientific output.

Where parity does not favor women in terms of numbers of researchers and scientific output, they may well be more efficient than men. This is the case observed across the professional grades in the field of Physics (Phys) and at the Candidate level (Ca) in the field of Mathematics (Math).

In all of the fields where the women are majority and their scientific output is inferior, we find that female efficiency is also inferior to that of men. This occurs only in a few cases, such as in the professional grade L_1 in the field of Chemistry (Chem) and in the professional grade Up_L in the field of Technological Sciences (Tech Sci).

The results of this study allow us to state that the women constituting a majority in the scientific milieu has not helped them improve their productivity. In this sense, policies aimed at increasing the number of women in research positions are insufficient, because, as these results suggest, parity policies alone do not necessarily imply equal opportunities, though such policies are doubtless important to achieving such ends. As indicated in the ETAN Report (2000), many social, economic and political factors could explain the results observed in this study regarding the scientific careers of women. These factors are not easily addressed in the relatively short time that has transpired since actions have been implemented to correct this injustice.

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