Subject: [Bsc-es] ✏️Equity4ES Gazette #10 - March 2025

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Estimation of Cumulative Gender Wage Gap

Welcome to the tenth issue of the Equity4ES gazette!

In these issues, we cover the latest debates on gender equity. We bring to the table arguments in favour and against topics, policies and initiatives that are being proposed around the world to address gender gaps in the workplace, science and the public sphere.

This tenth issue aims to discuss the Gender Pay Gap within the Earth Science department. While International Women's Day may have passed, our commitment to reclaiming rights, justice, and equity continues every day.

Motivation

The **Gender Pay Gap** is the difference in working earnings between genders as a

Since the **real statistics and salary distribution are not publicly available**,

result of inequalities women face in access to work, progression and rewards [1]. In this article, rather than tackling the complex societal factors that historically hinder women's professional careers, we try to put numbers to the words. Particularly, we estimate the pay gap within the **Earth Sciences department** by focusing on the distribution of salaries.

here is an attempt to derive a **theoretical estimation** of overall possible salary distribution. In this way, the wage gap can be evaluated without empirical data.

It should be noted that we call gender pay gap to the pay gap between women and men, following the Western-centred gender binarism that drives capitalist society. However, we acknowledge the **gender spectrum**.

The Initiative

There is an initiative in **CVC** (Climate Variability Change) to start digging deeper into the salary ranges and to check if the salaries diverge between genders. The empirical statistical mean salary between genders for the salary levels **R1-R2** im CVC is within the standard error of the mean, i.e., there is **no significant difference between the salaries for the levels R1-R2**. We can argue, that there was no gender bias in the assignment of salaries of the colleagues within our group, for these levels, knowing that the range between maximum and minimum is around 18.000 € within the R2 salary level alone.

However, **this does not discard the existence of an overall wage gap**. To check that there is no pay gap within **BSC, Earth Science department, or CVC group**, the statistics should be shown for all salary levels, i.e. from **R1 to R4** or **RE1 - RE4** (R: Researcher, RE: Research Engineer).

There might be an argument for confidentiality, especially at group level, given the small number of people. Anyhow, given the lack of real data, we can estimate cumulative statistics of R1 - R4 (solely based on the BSC salary tables, and the number of workers at each level and group).

The Progressive Company

Imagine a company (The Progressive Company) with **100 women** workers that each earn **1k€** (assigned to a lower level 1 salary class) & **90 men** workers that earn in the same level 1 salary class. In addition, there are **10 men** workers, managing 10 groups and earning **2k€** (assigned to level 2 salary class).

This company might highlight, that they are highly progressive, since the number of women employees is equal to that of men, and on average, the women workers earn the same amount of money as their men counterparts at the salary level L1, where the standard mean

would not show any differences or biases. But, the higher positions in this company are only filled by men and female workers occupy only the lower class levels, which will lead to an overall pay gap of:

cumulative difference = 100k€ - 90 x 1k€ - 10 x 2k€ = -10 k€

The cumulative total for women workers of **100 k€ vs. 110 k€** for men, corresponds to a pay gap of **10k$ or 10%**.

In this example, the **cumulative** total shows a **disparity of 10%** which is also the average pay gap. As we can see, the hidden reason for disparity/injustice does not solely come from the different salaries within the same class, but rather, lies somewhere else, in the **salary class disparity**, although the payment for the same class is equal.

A similarly observed disparity might be the reason for the **Gender Pay Gap** within society. We have nearly equal numbers of women and men workers. Still, the **men workers dominate the higher salary levels and leading positions**, which leads to a cumulative total disparity at the group level.

The Imbalanced Company

Imagine another company (The Imbalanced Company) with **50 women** workers that each earn **1k€** (assigned to level 1 salary class) & **90 men** workers that earn in the same level 1 salary class. In addition, there are **10 men** workers, managing 10 groups and earning **2k€** each (assigned to level 2 salary class). This company might figure out that there is an imbalance in the number of workers among genders, but on average the women workers earn the same amount of money as their men counterparts at the salary level L1, where the standard mean would not show any differences or biases. Since there is no women worker at L2 salary level, no comparison is made. The higher positions in this company are only filled by men and women workers occupy only the lower class levels. If we calculate the cumulative salary difference, it will lead to a pay gap of:

cumulative difference = 50x1k€ - 90x1k€ - 10x2k€ = - 60k€

Hence, the cumulative total for women workers of **50 k€ vs. 110 k€** for men corresponds to a cumulative pay gap of -60 k€ which corresponds to a **nearly 50% cumulative pay gap**. On the other hand, the average pay gap in this example is only 100€ which corresponds to an **average pay gap of 5%**.

The **interpretation of the cumulative pay gap** is twofold:

1. Imbalance between the number of workers in the two groups

2. True imbalance in totals in payment between the two groups

Hence, to have a robust and correct analysis of the gender pay gap, **we need both metrics**, the **cumulative pay gap** and the **average pay gap per job level**. Arguments based on only one of the metrics, disguise the true nature behind those values. Showing a low standard mean gap can lead to the conclusion that there are no such differences. High cumulative pay gap without elucidating the imbalance, can lead to skewed interpretation, as the gender pay gap might stem solely from the nature of the ratios.

Methods Used

For the sake of the article format, the details of the calculation and the methods used, can be checked in the following Appendix document [2].

Additionally, in the Spreadsheet PayGapSpreadSheet you can find all the formulas used and the results shown in the tables [3].

Earth Sciences Department

The summary of the overall average salary range is shown as boxplots in Fig. 1-2 and Table 1.1 for the **CVC** group and Table 1.2 for the **ES** department. We observe a difference of **53%** for the accumulated salaries. As for the average salaries, we observe **26%** favoring men workers, by using a **Triangle Probability Distribution TPD** [4] (See the Appendix [2] and the PayGapSpreadSheet [3] for details).

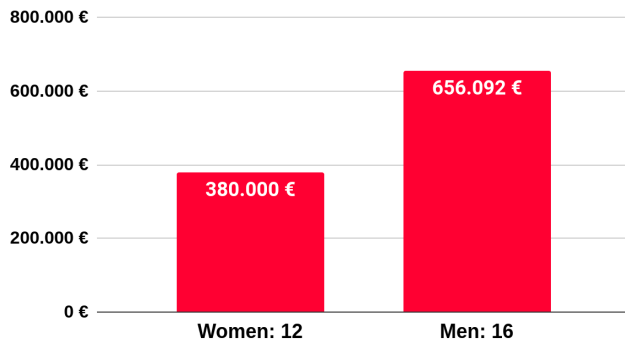**Theoretical distribution of cumulative annual salary in CVC**

Figure 1. Theoretical distribution of the cumulative salaries between genders in the CVC group.

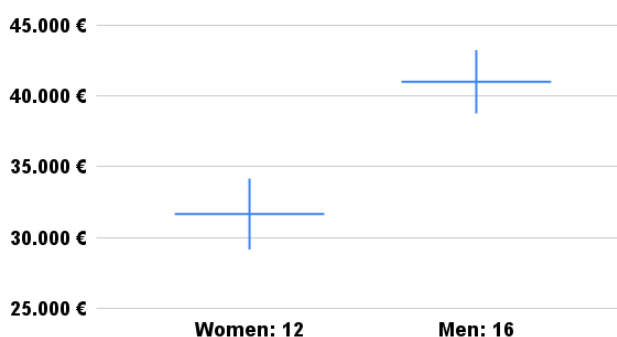**Theoretical distribution of the average salary in CVC**

Figure 2. Theoretical average salaries as whiskers with corresponding ± 1 standard error between genders in the CVC group.

Table 1.1: Statistics in CVC group. Difference in total salaries corresponds to an annual figure of **276 k€**(Conf. L :=
Confidence Level).

Gender	N	Cumulative Salary	Error	**Cum. Rel. Difference**	Average Salary	Error	**Mean. Rel. Difference**
Women	12	380.000 €	30.054 €	**-53%**	31.667 €	2.505 €	**-26%**
Men	16	656.092 €	35.865 €	**99.99% Conf. L.**	41.006 €	2.242 €	**99.0% Conf. L.**

Table 1.2: Statistics in the ES department. With **1.3 Mio. €** difference in total annual salaries between genders, due
to high gender imabalance.

Gender	N	Cumulative Salary	Error	**Cum. Rel. Difference**	Average Salary	Error	**Mean. Rel. Difference**
Women	66	2.244.166 €	143.825 €	**-46%**	34.003 €	2.179 €	**-4%**
Men	101	3.575.130 €	173.282 €	**99.99% Conf. L.**	35.397 €	1.716 €	**38% Conf. L.**

With cumulative totals of **380k€** (women) vs. **656k€** (men), the difference is around **276 k€ annually,** which is roughly a cumulative pay gap of **53%**, adjusted for the means of **9.3 k€** or 26% pay gap for CVC group annually (Table 1.1).

Similar calculation has been performed for the entire **ES department** (Table 1.2), given the number of workers split by gender. Here we observe a **46% cumulative wage gap** for the ES department corresponding to **4% average wage gap**.

Table 2: Summary of the statistics for different groups (Conf. L := Confidence Level).

	Total	Ratio Men:Women	**Cum. Rel. Diff.**	Conf. L.	Signific.?	**Mean. Rel. Diff.**	Conf. L.	Signific.?
CVC	28	1,33	**-53%**	99,99%	HIGHLY	**-26%**	99,0%	HIGHLY
ES	167	1,53	**-46%**	99,99%	HIGHLY	**-4%**	38,4%	NOT

Conclusions

We can conclude from our analysis that the cumulative **salary gap can be due to (1) total population imbalance (2) difference within each salary class.** Hence, not assessing all salary classes is an incomplete analysis. Addressing the estimated wage gap is a piece of valuable information to be raised in different groups.

While our approximation provides valuable insights, we decided to check the **BSC salary registry** available through the workers council to compare its content against our assumptions. At the date of writing this article, only the 2022 data was accessible. In this registry **only average pay gaps are provided** and cumulative differences are not considered. Focusing on **Earth Sciences Department** data, we can verify that the number of men is higher than that of women (60:40 ratio) and therefore we could expect a higher cumulative pay gap than the average shown in the registry.

We highlight the **vertical segregation**, with less than 20% of people at R3-4/RE3 -4 being women. The data points to the stagnation of **women's careers that accumulate at R2/RE2** positions without accessing higher responsibilities. This is most concerning since the lowest positions are highly men-dominated too, suggesting a possible gender imbalance in applications and/or biases in hiring processes, with no indication of improving the ratios within the department long term.

With respect to the **salary supplements** we denounce the lack of transparency in their allocation. The report shows great gender disparities in the "responsibility" and "productivity" complements with approximately an 85% gap for the former. As there are no public written policies to determine the requisites for receiving them, they are highly susceptible to bias.

The first step to tackle this problem is to **publicly report this disparity within BSC**, in a way that is widely and easily accessible, and take concrete action to eliminate the gender pay gap in the future. Some **applicable policies** are:

- **Hiring** policy that prioritises gender balance in each category, especially those of higher responsibility.
- **Transparent internal promotion** and salary improvement path. Clearly specifying milestones such as years of experience and individual achievements would be beneficial to address this issue.
- **Fostering career development** with proactive preparation of women who might qualify for leadership positions.
- **Gender perspective in the project proposal** process, both in terms of content and balanced participation, increasing the number of women colleagues leading projects as PI (Principal Investigator).

References

[1] Wikipedia - GenderPayGap
[2] Appendix: Description of the methods & derivation used for the wage gap calculation: Link
[3] Application of the methods in an excel table: Link
[4] GUM - Guide to the Expression of the Uncertainty in Measurements: BIPM
[6] Methods for the Determination of the Measurement Uncertainty Using GUM – Part 1 (German) - page 75 - Link

Public Mailbox

As part of the Equity4ES initiatives, we have opened a **public mailbox** to collect **anonymous testimonials** and experiences regarding gender issues in the workplace. We would like to share these testimonies publicly to raise awareness of these issues amongst our colleagues. Other aspects such as suggestions, ideas and feedback are also welcomed.

Public Mailbox

Agenda

- **Monthly meetings** the **3rd Friday** of every month at **3 PM**. We usually meet in room 0-1-13 and also online.

Make sure to also follow us on Twitter:

Our mailing address is: **equity4es@bsc.es**

Bsc-es mailing list -- bsc-es@bsc.es