Response:

Dear editor,

We are very grateful for your constructive comments to our manuscript because they clearly improve our work. Following all the helpful suggestions from the reviewers, we believe that our manuscript has been modified significantly, resulting in a new version and the main modifications are as following:

- The title has been modified to ensure greater accuracy. The new title is: Digital gender divide and convergence in the European Union countries

- The introduction has been rewritten so that it clarifies the motivation of the paper.

- A new Section 2 (Background and context) has been added. It presents the concepts, state of affairs and contribution of our work to literature. Likewise, the new section outlines the main analytical approaches to digital gender divide and provides evidence for the suitability of the methodology employed and the variables under consideration.

- The whole paper has been revised by a native English speaker.

- The bibliographical references have been adapted to the new contents. We have added new suggested authors and updated some references.

- The new text and references are in BLUE. Please note that some paragraphs have been rewritten or eliminated.

- Finally, some specific errors detected in the annex, table 1, have also been corrected.

Please find attached a point-by-point response to reviewer's concerns. When the reviewers' comments coincide, the same answer has been provided. We have also deemed it necessary to summarize the main modifications above.

Thank you for your attention and consideration.

We are looking forward to your reply.

Sincerely,

The authors

Reviewer #1: I have enjoyed reading this article. It falls within my range of interest, and it treats a relevant and timely topic. The authors have done an important effort to provide relevant evidence on the digital divide. The paper is easy to read, well-structured and concise. However, I think there is still room for significant improvement, which I detail below.

We really appreciate your suggestions that we believe have helped us to improved our work. We believe that our manuscript has been modified significantly, resulting in a new version of which the main modifications are the following:

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Major comments:

*My main concern relates to the contribution of this paper. Most of the empirical facts presented are already well established in the existing literature. Besides that, it is based on a poor selection of data. The methodology is not a contribution either since it is quite standard. The paper can (and should) be very much improved before its publication.

We recognise that we did not explain clearly the main article's contribution in our first version. Neither was clear the lack of temporal information available about the ICT indicators when addressing the situation between men and women.

This is the reason why two basic indicators have been used, relative to recent Internet use (ICT-USE) and recent Internet purchases (ICT-PURCHASE). These are the only two sex-disaggregated indicators available for a long period of time, as required by the beta and sigma convergence analysis carried out between the years 2007-2019.

These aspects have been specified and explained in the new version of the manuscript, in the introduction and also in the section dedicated to methodology.

*Among my main suggestions to improve the paper, I would mention the use of a more comprehensive set of indicators. ICT usage (% of the population aged 16 to 74 that has used the Internet in the last three months) and ICT purchases (% of the population aged 16 to 74 that has made an online purchase in the last three months) are relevant, but do not provide a full picture of the digital divide. Several other key aspects not considered; for instance, those related to skills and digital literacy or those related to visible leadership and decision-making roles. I recommend the authors to explore other data sources (for instance, EIGE: https://eige.europa.eu/gender-equality-index/2020), to provide a meaningful and comprehensive indicator.

It is true that it is emerging a new set of indicators to explore digital skills. However, if the gender perspective is introduced, this availability is reduced to the last two or five years. This makes it difficult to study the convergence or divergence process that requires considering a long period of time (at least a decade).

Thus, the databases of the European Institute for Gender Equality (EIGE) do not incorporate female indicators on digital skills and when they do, they are only available for 2018 or 2019 (EIGE, 2020: see Annex 5. Indicators on digitalization and the world of work).

In what follows, I make a few other recommendations that may help to improve the paper:

Literature:

* The author cites a series of Spanish papers. However, the most interesting papers in this area are missing. For instance, recent articles from key authors as David Autor, Daron Acemoglu, PascualRestrepo or Ajay Agrawal, Abigail Adams-Prassl, among many others, are not included. Reports by UNESCO, EIGE, and other international sources can also help here.

* Some of the references included are outdated. For instance, (United Nations, 2005), Van Dijk and Hacker (2003) or Ramos and Rodriguez (2009). Digital economy literature evolves rapidly, given the rapid evolution of technology, and it is important to include the most recent literature.

We have added new suggested authors also updated some references, including the most updated international ones.

Methodology:

* Why if it is a paper about Europe the authors use the definition of gap by the Spanish National Institute of Statistics? The use of alternative definitions to provide robustness checks of the results are important here.

This reference has been removed, we are using in this version the definition made by the International Telecommunication Union (ITU), which defines it as: "The gender gap represents the difference between the Internet user penetration rates for males and females relative to the Internet user penetration rate for males, expressed as a percentage" (ITU, 2019: 3). It has also been pointed out that this same estimation approach is used in OECD (2020) and EIGE (2020).

* The authors should provide a better justification for use of beta and sigma convergence. Why is this method appropriate for this analysis? (Note that I'm not suggesting that they should be changed; only that the reason to use them should be properly explained).

The main objective of this work is to study whether the digital gender gap has widened or narrowed in the EU over a long period of time. We have used in the analysis the beta and sigma convergence because it has a long tradition in economics, focused on the average income of countries or regions. However, in recent years this study has also focused on other indicators related to the wellbeing of the population. In our case, it is intended to apply to the use of technology by men and women in EU countries, as well as to the gap between the two. These comments have been incorporated into the current version.

* The use of only two points in time (2007 and 2019) is a poor approximation to the measurement of convergence. The inclusion of additional years could make the analysis more relevant.

For beta convergence, we have used the first and last years of the analysis, highlighting the variation of the indicator during the analyzed period. However, they are considered every year and this is reflected in the study of sigma convergence. When considering two indicators, for men and for women in 28 countries for thirteen years, synthesising the information is complex. Hence, maps have been used, offering the most relevant data for the first and last year in an annex.

Minor comments:

* The authors link the digital economy to the fourth revolution. However, the standard is to link the digital economy to the third revolution, and the Artificial Intelligence to the Fourth Revolution.

This comment has been removed in this version,

* The paper is not especially well-written; some parts are too heavy or unclear. Some sentences are too long; for instance, on p.3: "Faced with these profound productive, labour and educational changes, the European Union has been preparing its digital transformation since the beginning of the 21st century, through different objectives embodied in the successive economic growth strategies, formulated by Lisbon and Europe 2020, in 2000 and 2010, respectively." I think the paper would benefit from the revision of a native speaker.

This paragraph has been modified and the entire wording revised to try to shorten the longest sentences. This second version has been reviewed by a native speaker.

* The introduction is too vague and not very concise. For instance, sections 1 and 2 could be easily merged to make the paper more succinct.

As mentioned, the first two sections of the previous version have been rewritten.

* The use of "digital divide" and "digital gender gap" terms is confusing.

We have also tried to avoid this dichotomy. The term "digital gender gap" appears to a greater extent precisely to differentiate it from the first, "digital divide", referring only to the global gap, for the total population without distinction of sex.

Reviewer #2:

We really appreciate your suggestions that we believe have helped us to improved our work. We believe that our manuscript has been modified significantly, resulting in a new version of which the main modifications are the following:

- The title has been modified to ensure greater accuracy. The new title is: Digital gender divide and convergence in the European Union countries

- The introduction has been rewritten so that it clarifies the motivation of the paper.

- A new Section 2 (Background and context) has been added. It presents the concepts, state of affairs and contribution of our work to literature. Likewise, the new section outlines the main analytical approaches to digital gender divide and provides evidence for the suitability of the methodology employed and the variables under consideration.

- The whole paper has been revised by a native English speaker.

- The bibliographical references have been adapted to the new contents. We have added new suggested authors and updated some references.

- The new text and references are in BLUE. Please note that some paragraphs have been rewritten or eliminated.

- Finally, some specific errors detected in the annex, table 1, have also been corrected.

1. The title of the article is not appropriate. It should be comprehensive and self-explanatory.

The title has been change to “Digital gender divide and convergence in the European Union countries”.

2. There is absence of novelty in the introduction section. It should be incorporated.

We have changed the introduction to better explain the work’s objectives and the novelty of the contribution made. The general issues related to digitization have been reduced.

We have changed Heading 2, now called “Background and context”. In this new section, some paragraphs have been reorganized, eliminating and adding others. The conceptual and measurement aspects of digitisation have been discussed in greater depth, also providing a brief note on the EU guidelines in this area.

3. The author(s) uses the word "Digital" in title, which is very broad term, but they have taken only ICT. It is suggested, if possible, they can use more variables.

It is true that an increasingly comprehensive set of indicators on the characteristics of digital skills is emerging. However, if the gender perspective is introduced, this availability is reduced to the last two or five years. This makes it difficult to study the convergence or divergence process that requires considering a long period of time (at least a decade).

Thus, the databases of the European Institute for Gender Equality (EIGE) do not incorporate female indicators on digital skills and when they do, they are only available for 2018 or 2019 (EIGE, 2020: see Annex 5. Indicators on digitalization and the world of work).

We recognise that we did not explain clearly the main article's contribution in our first version. Neither was clear the lack of temporal information available about the ICT indicators when addressing the situation between men and women.

This is the reason why two basic indicators have been used, relative to recent Internet use (ICT-USE) and recent Internet purchases (ICT-PURCHASE). These are the only two sex-disaggregated indicators available for a long period of time, as required by the beta and sigma convergence analysis carried out between the years 2007-2019.

These aspects have been specified and explained in the new version of the manuscript, in the introduction and also in the section dedicated to methodology.

4. The result shows digital gender gap, but the reason why there is gender gap? is less conceptualized. The author(s) needs to further conceptualize it. Why in some countries for example in Croatia and Italy there are unfavorable position for women ICT use while and in turn why in some countries for example in Ireland there is unfavorable position for men ICT use? The study results also show no gap in Denmark, Cyprus, Finland, and Latvia. Whatcould be thepossiblereasons?

In the new Section 2, we go deeper into these reasons, providing new references. For example, the European Commission (2018) points out the crucial role that prejudices and stereotypes continue to play in explaining the digital gender divide. Beliefs about women's technological or leadership capabilities or the lack of role models can create a vicious cycle that is difficult to overcome. On the other hand, in Croatia and Italy the gender equality index offered by EIGE is also below the EU average, while Ireland shows an index close to that of the most egalitarian countries. Greater equality between the two sexes, in general terms, can be expected to be more easily reflected in the digital sphere, with the participation of men and women also being more equal in the use and purchases over the Internet. The basic indicators used (ICT-USE and ICT-PURCHASE) undoubtedly condition the results obtained, although for reasons of temporary availability this circumstance cannot be overcome.

5. While using ICT-Use and ICT-Purchase indicators the general fact that women are doing more shopping as compared to men. How was this phenomenon kept in consideration while discussing the results in section 4.2? Need to highlight that either this has any significant impact or not on ICT use.

We have not been able to explain this fact properly. We would need additional information, which we have not found, to know what products are purchased in each case. Without a doubt, it is one of the limitations of the work.

6. We are now living in a digital age, but the digitization of work entails along with positive effects also many negative effects globally, like increase of unemployment especially of unskilled and semi-skilled labours. How to deal such problems also need to be examined.

The new Introduction indicates the existence of these positive and negative effects, highlighting the opportunities and risks associated with digitization that affect women to a greater extent compared to men.

We also noted the changes in labour regarding digitisation, although it is a complex subject and we did not want to look into further, so we do not divert attention from the principal subject on this paper. However, we have named some studies that allow us to broaden this question. For example, Autor (2015) has pointed out that jobs are made up of many tasks, some of which can be replaced by technology, but other tasks can complement technology.

Reviewer #3:

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- The introduction has been rewritten so that it clarifies the motivation of the paper.

- A new Section 2 (Background and context) has been added. It presents the concepts, state of affairs and contribution of our work to literature. Likewise, the new section outlines the main analytical approaches to digital gender divide and provides evidence for the suitability of the methodology employed and the variables under consideration.

- The whole paper has been revised by a native English speaker.

- The bibliographical references have been adapted to the new contents. We have added new suggested authors and updated some references.

- The new text and references are in BLUE. Please note that some paragraphs have been rewritten or eliminated.

- Finally, some specific errors detected in the annex, table 1, have also been corrected.

The paper offers a cross-country description of the digital gender gap in the European Union. The authors provide evidence of the existence of beta-convergence across EU Member States over the period 2007-2019 and of decreasing dispersion over the same period, both in terms of share of share of the population making use of ICT and purchasing online.

My main comments are that to me the paper does not provide sufficient insights on the context nor the mechanisms. The authors do not explain how ICT use overall and across genders compare to some benchmark. Are the values presented here high or low? And, most importantly, what is the interpretation of the results? The paper does not mention any reason or channel which might explain the result and I think this is a major issue that the authors should resolve. Finally, I think the authors should better motivate their research question.

We have changed and rewritten the introduction and Heading 2 for a better explanation of our goals and to discuss in greater depth the concept and measurement aspects of digitalisation.

Likewise, we highlight the suitability of the methodology used, which are explicitly exposed.

Please find my detailed comments below, which I hope the authors will find useful when revising their work:

<u>Introduction & lit review</u>

1. In my opinion the introduction would need to be redrafted. The introduction should state: the motivation of the paper, the contribution and the research question, the methodology applied, the summary of the results and their interpretation. Currently, none of these elements is present in the introduction, which only describes some aspects related to the digital economy in general (that I find marginal to the focus of this paper). As a matter of fact, there is no mention of gender divide in the introduction. I think a new introduction should, in particular:

   a. Incorporate section 2, which is actually much more informative than the current introduction;

   b. Clearly state what the contribution of the paper is in comparison to the existing literature;

   c. Describe what the authors actually do in the paper: I realised that the paper was about estimating beta and sigma convergence only on section 3 (page 6);

d. Present the results while framing them within the existing literature, and discussing the supporting theoretical framework.

We have changed the introduction to better explain the work objective and the novelty of the contribution made. The general issues related to digitization have been reduced.

We have changed Heading 2, now called “Background and context”. In this new section, some paragraphs have been reorganized, eliminating and adding others. The conceptual and measurement aspects of digitisation have been discussed in greater depth, also providing a brief note on the EU guidelines in this area.

We recognise that we did not explain clearly the main article’s contribution in our first version. Neither was clear the lack of temporal information available about the ICT indicators when addressing the situation between men and women.

This is the reason why two basic indicators have been used, relative to recent Internet use (ICT-USE) and recent Internet purchases (ICT-PURCHASE). These are the only two sex-disaggregated indicators available for a long period of time, as required by the beta and sigma convergence analysis carried out between the years 2007-2019.

These aspects have been specified and explained in the new version of the manuscript, in the introduction, section 2 and also in the section dedicated to methodology. Therefore:

A) The introduction has been reformulated and merged with section 2.

B) The contribution of the work is specified, focused precisely on analyzing the convergence in the digital gender gap in the EU.

C) We appreciate this comment, because it has allowed us to highlight from the beginning the importance of the study of convergence in the digital divide in this work.

D) The new section 2 highlights the contribution made, being framed in the current state of the issue, from the point of view of the existing literature on the subject and taking into account the current European context.

2. The literature mentioned in the paper is very centred around Spain, and many of the cited papers are in Spanish. I think the authors should make the effort to place their contribution in a more international setting, given that this is a journal with an international audience.

The bibliographic references have been updated and expanded, incorporating some of the most recent works by suggested authors. Likewise, we have eliminated the mentioned references, adding the most updated international references.

<u>Methodology</u>

3. From reading section 3 my understanding is that the authors claim two types of contributions: the first is the computation of the two indices of relative and absolute digital gender gap; the second one is to estimate the beta and sigma convergence. I think that the mere computation of the two indices cannot be seen as a stand-alone contribution to the literature. I suggest that the authors revise the text so that it is clear that the main result of the paper is, indeed, the estimation of the beta and sigma convergence. I would not speak of "results" when referring to the tables in the annex, as they constitute just input data that are then used in the analysis.

Indeed, the contribution of the work focuses on the study of beta and sigma convergence. However, we understand that the descriptive study of the indicators carried out previously is also necessary. The use of the term "results" has been omitted in that case.

4. The last paragraph of Section 3 ("We not only examine …") is unclear.

It has been modified. This second version has been reviewed by a native speaker.

Analysis

5. What is the reason why the year 2007 is chosen as reference? It cannot be the first year that the selected countries were all in the EU because Croatia only entered in 2013. I thinkthisshould be clarified.

The first information available for all 28 countries was in 2017, including Croatia, despite their subsequent incorporation into the EU.

6. Cyprus is not in the maps. It really should be, and the authors should find a solution for this.

As explained in the text, Cyprus did not appear on the maps, we do not know the reason, but the software we used to elaborate the map did not show it. We have chosen to indicate, as a footnote on each map, the colour of a country that corresponds to the color of Cyprus.

Map 1: The color of Cyprus matches Malta.

Map 2: The color of Cyprus matches Croatia for women and Italy for men.

Map 3: The color of Cyprus matches Denmark.

Map 4: The color of Cyprus matches Finland.

7. In between the description of map 1 (ICT use in 2019) and graph 1 (convergence over 2007-2019) I would have expected a comment on within-country differences. That is, are the 2019 levels a major improvement wrt 2007? Is this driven by certain age groups, for instance? Can the authors find comparable figures, e.g., in the USA or other countries? This comment applies to all parts of section 4.

This comment has been addressed. We have carried out a more detailed analysis of the evolution, since the temporal information by age groups is not available for the period. We have not found detailed information by country either.

You may be correct in what you suggest, but we cannot verify it and we have not found any reference that indicates so. It is generally acceptable that access to ICT technologies is normally lower for older than for younger people, although age patterns are similar in all countries. The differences in the use of new technologies based on gender seem quite small and may indeed hide discrepancies by age groups. In the United States, men's and women's Internet usage rates were statistically identical. However, users tend to be in the younger age groups, while men are in the older age groups.

8. Graphs 1 and 2 seem to show a clear distinction between EU-15 and EU-8 + EU-2 countries, the former group being on the south-east quadrant and the latter in the north-west quadrant. Could this be related to the fact that EU-8 and EU-2 countries in the years following 2007 received quite a lot of investments from the EU? Can the authors comment on this? Perhaps they could try to understand whether convergence is more marked for former objective 1 regions?

As mentioned in the work, it seems to be a certain correlation between per capita income and the digital indicators used. This indirectly accounts for this important issue, as the funds allocated to these regions (generally within the poorest countries) have been able to favour convergence.

9. The sigma convergence in graphs 3 and 6 is also not discussed.

Comments have been expanded.

10. How do the results relate to other indicators of economic development such as the female employment rate (and its evolution)? This would help understanding why it is useful to look at ICT use and not just any other measure. I feel that the paper is missing a lot of story-telling, in this respect.

No connection has been found with the female unemployment rate, but it seems to be a connection between the gender equality index and some of its dimensions, especially knowledge. This topic could be explored in the future.

Minor

1. Pleaselabel figures consistently (and notmaps and graphsseparately).

Maps and charts have been numbered consecutively as Figures 1 to 10.

2. On page 9, the authors state that "Regarding Internet usage, there are hardly any differences between the proportion of men and women in the EU-28 in 2019 (map 3)". It does not seem so from the map. I think the scale should be adjusted. What are "low" and "high" in map 3?

The scale has been specified.

3. Footnote 5 is redundant. I suggest dropping it.

It has been removed.

4. I understand that the authors must be Spanish or work for a Spanish institution. Spain is mentioned many times throughout the paper (e.g., 3 times in the conclusions only) for no apparent reason. I would drop those mentions, they do not add anything to the paper.

It has been modified, removing the comments on Spain on several occasions.

5. I think the caption of the tables in the Annex should read "ICT indicators…", not "TIC indicators…".

It has been modified.