We are very grateful to the referee for the interesting comments and for the detailed revision.
We had taken into strong account all the provided very useful suggestions and the followings are our replies and ways to reflect your comments.

We also attach the revised version of the manuscript in a separated pdf file.

1. The CSR cost function presented in page 11: you assume that the company can decide to give a prize for the stakeholder's social responsible engagement but the CSR engagement can also have some negative impact on the cost function of the firm. Please give an example to underline your argument.

You should also clearly state your contribution as the literature on the subject is pretty massive, by discussing the results of other papers, what you barely do.
An overview of the results would be much welcome in order to have a better understanding of the results afterwards, e.g. "alienation" is an unclear concept to me.

We agree with the referee that the point was a little confusing as we have mentioned just a cost function, while, as we have corrected in the revised version of the paper, we devised a <u>*new cost-benefit model*</u> *as we think that hose in the traditional Economics textbook are not ever appropriate for the CSR companies. In fact the traditional ones does not take into account the crossed effects and the additional interactions among different stakeholders and different sectors, on which the analogies with fermions shed lights. Therefore, only the investments in CSR clearly represent an expense (i.e a cost) which couldn't be recovered, so having negative effects. When the second part of the sum in (2) is lower than the first one, despite without these investments any positive effect of CSR couldn't be possible, costs prevails and so the negative effects. According to our findings this happens when stakeholders' sensitivity and contributions in terms of effort and cooperation, even if they are boosted thanks to these investments, are not high enough.*

According to the referee's suggestions, in the final part of the Introduction we improved the short overview of our results where we also specified, to make more clear the originality of our contribution and results, that
"Our results substantially confirm those of most of the theoretical and empirical literature on the positive effects of the CSR on the companies' performance (for a survey, see Crifo and Forget, 2012). Nevertheless, referring to the existing literature and in particular to the dynamical model in Becchetti at al (2014), trough the analogies with the Mobius strip it is possible to model what effects are at work to create what those authors called Ethical Capital . In fact this kind of capital accumulation is only assumed in the theoretical model of Becchetti et al. (2014), and in general in the CSR and stakeholders theory, while a broad range of empirical literature test the positive effects of several measures of CSR on the firms' performance. Our results shed more light on what particular forces are at work , to generate that ethical capital inside the organization. Consequently, they provide useful suggestions also about the variables which should be measured at an empirical level to produce more clear and appropriate results"

We have also introduced here and specified in more detail the concept of alienation which "occurs when the worker can only express individuality through a production system, but who derives very little

satisfaction from the monotonous activity. Moreover the alienation of the worker does exists also from the other workers in a workplace which does not foster social relationships".
(for a better definition see also https://www.boundless.com/sociology/textbooks/boundless-sociology-textbook/economy-16/work-120/work-and-alienation-678-7760/).

2. I really appreciated your writing skills but I believe that you can make your paper even easier for readers by reshuffling your motivation, including more references on stakeholder theory and social networks models.

By following the referee's suggestions we added in the Introduction some more explanation underlining our motivations for the analogies used and we specify that:

"In this paper we want to explore in more details what mechanisms are at work to make CSR convenient for a Company. To this aim we extensively from the analogies with the behavior of fermions in a Mobius strip to show the kind of interactions among stakeholders are at work to realize improvements in the Company's performance (for a complete survey on the theoretical and empirical works on the forces driving CSR measures and the effects on the firms' performance see Crifo and Forget, 2015)
The twist in the Mobius strip generates two important effects on the electrons' trajectories and the energy produced. First, unlike a cylinder, in a Mobius strip an electron move in the longitudinal direction along the ring encircles the system twice before returning to its initial position. This create flux periodicities generating more persistent current. Second, the Mobius strip cannot be pressed into a one dimensional structure and this implies the motion of electrons in the transverse direction. Therefore fermions can tunnel to their neighbours in more directions. Finally, thanks to the twist, the electrons in the last wire tunnel in the same wire on the corresponding replicated new element.
Then it is possible to notice some very important analogies between fermions moving on a Mobius strip and the effects of CSR investments. In fact, these investments, just like the twist, should make stakeholders' relationships closer and persistent, so that one stakeholders' interest become also the others' interest. This is perfectly in agreement with the stakeholder theory which suggests simultaneous attention to the legitimate interests of all appropriate stakeholders, both in the establishment of organizational structures and general policies\footnote{Stakeholder theory was firstly introduced by Freeman (1984), who argues that a business organization must ensure a minimum benefit to all stakeholders (i.e. not only to the shareholders , but also to the customers , employees , suppliers , the community within which the organization interacts) , which otherwise would leave the company , making it impossible to produce profits. This theory occupies an intermediate position between strategic management and political philosophy in that it presents a new form of sovereignty, i.e. it neutralises the sovereignty of the firm in favour of the stakeholders(Bonnafous-Boucher and Porcher, 2010) who "are persons or groups with legitimate interests in procedural and/or substantive aspects of corporate activity. Stakeholders are identified by their interests in the corporation, whether the corporation has any corresponding functional interest in them" (Donaldson and Preston, 1995). According to Jensen (2001) "managers should make decisions so as to take account of the interests of all stakeholders in a firm (including not only financial claimants, but also employees, customers, communities, governmental officials, and under some interpretations the environment, terrorists, and blackmailers)"} . In our model these desired structures and practices are just measured in general by the investments in CSR for workers and sectors, corresponding to the energy dissipation for the fermion in a Mobius strip. Nevertheless, these costs represent the appropriate incentives for different

stakeholders and in different sectors to become strightly interdependent, just as fermions tunneling to their neighbours.

These attention to the stakeholders' interests boost the consequent positive effects on companies' performance due to strength and weak ties characterized by "combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services. Any given tie may be Contagious which enters social networks and is disseminated with increasing rapidity" (Granovetter,1973). In other words, trough those investments the business company creates the social capital functionally defined as "a variety of entities with two elements in common: they all consist of some aspect of social structure, and they facilitate certain actions of actors within the structure, that is, social capital is anything that facilitates individual or collective action, generated by networks of relationships, reciprocity, trust, and social norms (Coleman, 1988). They may be seen as the incentives that boost prosocial behavior that combines heterogeneity in individual altruism and greed with concerns for social reputation or self-respect, making individuals' actions complements more than substitutes (Benabou and Tirole, 2006). In our model this prosocial behavior is measured in three crossed effects linking different stakeholders and in different sectors, but also enforcing stakeholder's attraction to the firm's mission, so that each of them can be viewed as a replicated one working both for his specific sector and for the firm's mission.
Therefore, according to this point of view, it is possible to extensively draw from the topology of the interactions among fermions on Mobius strip the most appropriate analogies with the interactions among stakeholders in a context of Corporate Social Responsibility sectors (CSR).
This is not just an exercise but it helps us to devise a new cost-benefit model, as we think those in the traditional Economics textbook are not ever appropriate for the CSR companies. In fact the traditional one does not take into account the crossed effects and the additional interactions among different stakeholders and different sectors, on which the analogies with fermions shed lights.

3. You could also add some references about social networks and social capital (Coleman, 1988; Granovetter, 1973). Part of your paper is about the diffusion of information between stakeholders so it could be related to various work on social networks. These are here probably a better reference than Giddens for example.

We agree with the referee and we introduced more references in the Introduction as pointed out in our reply to the previous comment.

4. You should properly review the model of Becchetti et al. (2014) if it provide suitable information for the paper. How do yours differ from their?
We agree with the referee and we specified our differences as pointed out in our reply to comment 1.

5. You are mentioning intra-organizational cooperation on page 3 while the beginning of the paper would let the reader think that you are talking about inter-organizational or global exchanges between individuals, doesn't matter their organization. Please clarify this point.

The referee underlined a good point. We see that the first part in the Introduction on the complexity in Economics could create be a little misunderstanding, therefore we shortened the first part so that the reader can be soon introduced into the description of the CSR context and in our Research questions.

6. Please give an example or an empirical result to back your results on page 16. For example, it is pretty straightforward to understand the increased motivation and productivity of workers within a firm doing CSR but there seems to be a tradeoff with your second result. This is one of your major results as motivated in bullet point 3) on page 17 so you could bring further developments on this result, for example by characterizing how you differ from the studies mentioned in the introduction. You could also refer to the large literature on intrinsic motivation and how CSR can procure a unique kind of intrinsic motivation, but you do not refer to Benabou and Tirole for example

We have put considerations about that in the Introduction, and we also add here some more hopefully clarifying statements, by asserting that:
"Our findings reveal that the convenience to invest in CSR and therefore to take care of the stakeholders' interests, produces the effects of strength ties among different workers and in different sectors, boosting social capital and their intrinsec motivation both towards the others' and towards the firm mission. Nevertheless these effects on turn are mediated by the other three following factors: 1) the workers' sensitivity; 2) the alienation; 3) the number of sectors.

Moreover at the end of the first item we added:
"Clearly this raises the problems of the right incentives not to reduce the workers' sensitivity, because as in Benabou and Tirole (2003) the wrong incentives, as donors or wages, could produce the counterproductive effect of crowding out the intrinsec motivation so lowering the value of beta.

7-8 Your result on the link between the size of the firm and the profitability of investments in CSR (page 16, point 3) is interesting and you cite only one paper motivating your argument. Could you provide more references on this case as the paper cited (Tamm et al. 2010) has not been published yet?

By the same token, you underline the fact that there might be a strategic behavior in the firm's investments depending on the number of sectors the company is facing.

To take into account both comments 7 and 8 we added more references on the problem of the mediator effect of firm size on the adoption of CSR measures, which substantially confirm that there is not a clear effect just in agreement to our results where they strongly depend on beta, that is on workers sensitivity:

"Other works on the problem of the mediator effect of firm size on the adoption of CSR measures substantially confirm that there is not a clear effect just in agreement to our results where they strongly depend on β, that is on workers sensitivity. In particular, Udayasankar(2008) arguments that in terms of visibility, resource access and operating scale, very small and very large firms are equally motivated to participate in CSR. However, the motivational bases for CSR participation are likely to be different, so that the author suggests cautions against the broad categorization of firms, without

adequate attention to the firm's size. Blomback and Wigren (2009) from examples of far-reaching CSR activities in the small business community and local initiatives by large firms, find that the distinctions suggested in the current discourse do not appear in practice are shown. The local embeddedness, corporate governance, and individual motivation are examples of issues that appear to explain a firm's CSR activities and characteristics, regardless of firm size. Other works approach to the question from an empirical point of view. For instance, Youn et al.(2015), performing a two-way fixed-effects model by firm restaurant context, find that firm size moderates the effect of positive CSR on Corporate Financial Performance(CFP), while it does not moderate the effect of negative CSR on CFP".

References added:

Krishna Udayasanka (2008), " Corporate Social Responsibility and Firm Size,Journal of Business Ethics, 83, 167-175.

Anna Blombäck, Caroline Wigren, (2009) "Challenging the importance of size as determinant for CSR activities", Management of Environmental Quality: An International Journal, Vol. 20 Iss: 3, pp.255 – 270.

Hyewon Youna, Nan Huab, Seoki Leec(2015)," Does size matter? Corporate social responsibility and firm performance in the restaurant industry", International Journal of Hospitality Management, 51, 127–134

Minor comments

• You alternatively use i) or 1) to enumerate items in the paper. Be consistent and use either i) or 1).

We amended the point and to be consistent we use only numbers to enumerate items in the paper.

• **Pages 4-5: the outline of the paper should be more straightforward to provide a clearer overview to the reader.**

We followed the referee's suggestion and we added some considerations to make more clear our results since the beginning of the paper, as specified in our reply to the comment 1.

• **Page 5: "We define a new cost function …to alienation", this set of sentences should be developed sooner in the introduction as a part of the overview of your results and should not be in the outline of the paper.**

We followed the referee's suggestion and also in this case we added some considerations to make more clear our results since the beginning of the paper, as specified in our reply to the comment 1.

• Page 9: there is a missing space "activities.According".
• Page 12: there is a missing space "in the KLD metrics,see Becchetti et al.
2016"

- Page 15: the very last sentence should finish with ‘:’ instead of ‘;’
- Page 16: there is a missing space ‘Becchetti et al.2012’
- Page 17: there are missing spaces “at work:1)” & “sectors;3)” & “shareholders)and”
- References: reference [2] writes ‘forth’ instead of ‘forthcoming’

We amended all the above minor comments and corrected all the points accordingly, in the indicated pages .