

## Response to Referee Report 1

I would like to thank the referee for reading the paper and providing valuable comments on how the results and their exposition can be improved upon. In what follows, I will attempt to give a detailed explanation for each of the points raised by the referee.

1) The author spends too much time on standard (well-known) results. Although, those are required for a comparison with the the "patent buyout" strategy which is the main contribution, I think the paper can be made much shorter. The author should focus on his own contribution.

*I agree entirely with the referee's assessment. The paper, as it stands, is longer than needed. As the referee points out, the paper compares the result of the patent buyout strategy with the standard result. In this version, I erred on the side of caution by providing too many details of the standard model. I will cut down the exposition of the standard model, and highlight my contributions in the updated version.*

2) Basically, welfare results obtained with the "patent buyout" strategy are not surprising. The reason is that innovations are put in the public domain and goods are sold on perfectly competitive markets (the monopoly distortion is removed). If this was not the case, some clear explanations on the reasons it might be the case are necessary.

*There are two sources of welfare improvement: the first is the removal of monopoly distortions as a result of moving goods from the monopoly market to the competitive market. However, as the current version of the paper argues [section 4 (page 21)], this alone is not sufficient to generate welfare gains. This is because, moving the goods to the competitive market via patent buyout, involves a tax on goods across all sectors in the competitive markets; including goods that would have been available at marginal cost if they were imitated upon. The latter effect may, in fact, diminish welfare.*

*In addition to the point mentioned above, as the referee has correctly pointed out in comments 3 and 4, there is a reallocation of resources that leads to welfare improvement. This can be seen by considering the externalities associated with innovation. There are two sources of negative externalities. First, each innovation makes future innovation more difficult, and therefore more labor needs to be devoted to the R&D sector in the future. This would mean fewer resources toward manufacturing, and a fall in consumer expenditure. This in turn may lower future profits of firms. The second source of negative externality is associated with the fact that each successful innovation leads to a higher quality good in a particular sector which attracts consumers from other sectors. This, in turn, leads to lower profits in those sectors. The R&D firms do not consider these negative externalities and therefore may end-up over investing in R&D.*

*There is a positive externality associated with innovation as well. This is the direct benefit that consumers receive as a result of a higher quality good at the same quality adjusted price. In fact, the presence of imitation in the model serves to strengthen this effect. At the same time, RPA's lower the rate of successful imitation, leading to a weakening of this effect.*

*Given these three types of externalities, it can be inferred that if the RPA's are high enough so that the rate of imitation is low, then the two negative externalities dominate the positive externality associated with innovation and therefore there will be an overinvestment in R&D from the society's point of view. In this case, moving to a patent buyout system can lead to a higher welfare. This is because, with the patent buyout system, RPA's fall to zero. Additionally, since rate of imitation goes up, the positive externality dominates the other two negative externalities, which eliminates the overinvestment in R&D. Therefore, as the referee has pointed out in points 3 and 4, resources are reallocated from RPA's and innovation toward manufacturing. This, in turn, leads to a higher level of welfare.*

*The current version of the paper does not make this point explicit. However, this is implicitly captured in equation (35) of the model. I will reformulate this equation and present the above mentioned explanation as the basis for welfare improvement in the updated version of the paper.*

3) Even if the author tries to explain why there is no effect on long-term growth with the "patent buyout" strategy, the paper lacks economic intuitions to address the main reason of this surprising result. Changes in relative prices are insufficient. The author should assess the question of reallocation of resources between sectors and explain why there is a welfare effect and no growth effect. As it stands, it is difficult to understand the mechanisms behind the results. As a reader, we also need to understand if it is a general result or if it is specific to the model used.

*As explained in point 3, the welfare improvement as a result of the patent buyout strategy hinges on the allocation of resources away from RPA's and innovation into manufacturing. The lack of a growth effect, on the other hand, is based on the assumption that innovation becomes progressively more difficult as goods progress up the quality ladder. That is, as quality improves, more labor is required to innovate. Therefore, innovation and consequently quality growth is constrained by the growth in labor force. For example, if in the steady state quality growth exceeds the rate of growth of labor, then relatively fewer resources would be available for innovation. This necessarily implies that the rate of successful innovation will fall, and consequently rate of quality growth will also fall. Opposite will be the case if the rate of quality growth falls short of population growth. This is the case in both the standard model and the patent buyout strategy. This is captured in the model by the fact that in the steady state the variable  $x(t)$ , that captures the relative difficulty of R&D, is constant.*

*The current version of the paper does not make this point clear, but this fact is used in proving proposition 7. Therefore, as long as innovation becomes more difficult with quality improvement, the steady-state quality growth will be equal to the population growth rate ( $n$ ), and by extension the utility growth rate will be a constant proportion of  $n$ . This result also sheds some explanation for why different public policies, for example R&D subsidies and even patent buyout, lead to level effect but no growth effect.*

*Again, the current version of the paper does not make this point explicit. I will incorporate this explanation in the updated version of the paper.*

4) The author explains that the "patent buyout" strategy is welfare improving. How is it possible to implement the 1st best optimum in this case? How does the level of growth compare with the two previous cases? Answering these questions would help to clarify both the questions addressed on the problem of resources allocation and long-term growth.

*The first best optimum in this case can be considered in intuitive terms based on the discussion above. The social planner's problem would be to maximize discounted consumer utility given above equation (6) in the current version of the paper, subject to the resource constraint (given by equation 26), the time path of the variable  $x(t)$  that gives how difficult R&D becomes because of quality improvements (equation 20), and the time path of relative quality of goods in sectors with single quality leaders,  $q_L$ . The reason for including the time path of  $x(t)$ , and  $q_L$  in the social planner's problem is that the planner recognizes the two additional externalities mentioned in response to point 2, that are captured by these constraints. Given this, the social planner's allocation of resources into innovation will be less than that achieved under the conventional patent system, but greater than that achieved under the patent buyout system. This is because R&D firms under the patent buyout system do not consider the positive externality of improved quality on consumer utility. Therefore, they will underinvest in innovation compared to the social planner.*

*The growth rate in the steady state, however, will be the same under the first best solution. This is because, as explained in response 3, the rate of quality improvements is constrained by the rate of resource growth in the economy. Therefore, the growth rate will be  $n$ .*