Reply to Referee Report 1

“ The Macroeconomic Consequences of Artificial Intelligence: A Theoretical Framework”

Dear Referee,

Thank you for your useful feedback and comments. Below, we provide our response to your comments. Your original comment is presented in blue italic below, while our replies are typed in black.

Overview

This article aims to improve the neoclassical production function and task-based model. The authors Huang, Hu and Dong, from now on referred to as HHD, claim that they improve the neoclassical production function by adding the elasticity of substitution between labor and artificial intelligence, and by considering the difference in impact when artificial intelligence is complementary or a substitute to traditional labor. The task-based model is also explored and finally the authors look at how the long-term economic growth rate is affected by artificial intelligence.

This is a good summary of this paper. Thank you very much.

Assessment

The topic of this paper, i.e. how artificial intelligence affects the economy, is very relevant. This paper provides some nice intuition behind how artificial intelligence affect wages, employment and economic growth. However, this paper brings very few new insights to the academic literature

on artificial intelligence, as most of the work is a simplified replication of previously published models.

Our work is based on previous research which has been detailed in the paper:"Based on the previous work (Acemoglu, 2018a-f, 2019; Aghion, 2017, Autor, 2013; Prettner, 2017), we for the first time introduce the elasticity of substitution, differentiate between complementary artificial intelligence and alternative artificial intelligence to study the impacts on the economy, and present a general framework in theory." We did use some same methods as the above scholars. Our work is on the shoulders of giants, and the contribution may be a little smaller. However, we realized that it is not enough to only distinguish between complementary and alternative artificial intelligence. We decided to make a lot of changes , and we will elaborate on how to modify it later.

The authors claim that one contribution of this paper is the introduction of the elasticity of substation between labor and artificial intelligence capital into the neoclassical production function and task-based model. This is however already a feature in several previous papers, with the latest contribution being in Lankisch, Prettner and Prskawetza (2019), from now on LPP (2019) and Prettner (2019). Most of section 2.1 follows LPP's (2019) reasoning and modelling, see their section 3. A simple model of automation and wage inequality. The only difference between LLP (2019) and this article is that HHD makes LLP's model

marginally simpler by assuming that there is only one type of labor instead of two types like LLP. This would be equivalent to assuming β=1 in LLP eq. (1). HHD's results in the main part of section 2 on the neoclassical production function are thus identical to LLP's if one assumes that β=1.

The same applies to the discussion on the growth rate in section 4, this is also largely a replication of LLP (2019) result section with a simplification regarding the number of types of labor.

Thus, most of the section on the neoclassical production function is a slightly simplified replication of previous published work.

Thank you for this assessment.

First, we quote LLP (2019) in the reference. Second, LLP(2019) eq. (1) is $Y=[(1-\beta)L_s^{\gamma}+\beta(P+L_u)^{\gamma}]^{\frac{1-\alpha}{\gamma}}K^{\alpha}$,when $\beta=1$, eq. (1) becomes $Y=K^{\alpha}(P+L_u)^{1-\alpha}$. The production function in our paper is $Y=K^{\alpha}(L^{\frac{\sigma-1}{\sigma}}+P^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma(1-\alpha)}{\sigma-1}}$, It is obvious that the two production functions are different, and the case of the LLP (2019) equation (1) $\beta=1$ is a special case in our paper, which is alternative artificial intelligence. It is worth noting that we for the first time introduce the elasticity of substitution, differentiate between complementary and alternative artificial intelligence, while LLP (2019) does not.

Of course, we realize that it is not enough to only distinguish between complementary and alternative artificial intelligence. We will make more innovations in the new version.

We realize that artificial intelligence can enhance not only the efficiency of capital production, but also the productivity of workers, while artificial intelligence actually has a strong spillover effect on other industries. We are prepared to modify our model from this perspective and to distinguish between complementary and alternative artificial intelligence simultaneously.

The production function of the enterprise is

$$Y = [A_K f(A_I)K]^{\alpha}\{[(A_L g(A_I)L)^{\frac{\sigma-1}{\sigma}} + (A_P h(A_I)P)^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}}\}^{1-\alpha}$$

where K is traditional capital, L is labor, and P is artificial intelligence capital. σ is the elasticity of substitution between labor and artificial intelligence capital, and $\sigma \geq 0$. When $0 < \sigma < 1$, artificial intelligence capital is complementary to labor, when $\sigma > 1$, labor and artificial intelligence capital substitute each other. A_K is the efficiency of traditional capital production. A_L is the productivity of workers. A_P is the production efficiency of artificial intelligence capital. A_I is artificial intelligence technology. $f(A_I) = e^{m_1 A_I}$ represents the spillover effect of artificial intelligence technology on traditional production methods. $g(A_I) = e^{m_2 A_I}$ indicates the enhanced effect of artificial intelligence technology on labor productivity. $h(A_I) = e^{m_3 A_I}$ indicates the enhanced effect of artificial intelligence technology on capital production efficiency, At the same time, $f(A_I), g(A_I), h(A_I)$ indicate that artificial intelligence technology has improved its production efficiency through self-learning.

$f(A_I), g(A_I), h(A_I)$ take the form of exponential function to show that artificial intelligence technology can greatly improve the productivity of laborers and capital, and has a strong spillover effect, which is the difference between artificial intelligence technology and previous technological changes.

Furthermore, we are going to analyze the situation of wages, capital prices, and labor shares with the change of artificial intelligence technology under the static model, and then introduce consumption in the dynamic model, considering the economic growth rate and other issues. In addition, in the new version we will analyze the impact of government taxation policies on economic growth and social welfare.

With regards to the section "The develop of artificial intelligence and the creation of new tasks", as this is also a simplification of Acemoglu and Restrepo's work, the academic contribution of this section is also rather limited.

Thank you for this assessment. We use the following production function $Y = K^{\alpha}[\int_{N-1}^{I}(A_p(i)p(i))^{\frac{\sigma-1}{\sigma}}di + \int_{I}^{N}(A_I(i)l(i))^{\frac{\sigma-1}{\sigma}}di]^{\frac{\sigma(1-\alpha)}{\sigma-1}}$, mainly to connect the neoclassical production function with the Task-based Model, which simplifies the complex operations of the Task-based Model. This production function combines the advantages of both models. It is worth mentioning that we can use this form of production function to analyze some specific problems, such as the impact of artificial intelligence on

income inequality and population aging. In addition, from (16), not only can you get Proposition 4, but you can also get Propositions 1-3, which cannot be found in Acemoglu's paper.

In all, we will further improve this production function in the new version.

References

Lankisch, Clemens & Prettner, Klaus & Prskawetz, Alexia, 2019. "How can robots affect wage inequality?," Economic Modelling, Elsevier, vol. 81(C), pages 161-169.

Prettner, Klaus, 2019. "A Note On The Implications Of Automation For Economic Growth And The Labor Share," Macroeconomic Dynamics, Cambridge University Press, vol. 23(03), pages 1294-1301, April.

Thanks for listing these two important references, we have already cited LLP (2019), and we will also list them in the new edition of the reference. We strive to make bigger innovations in the new version.