Application for Digitization Tutorial*

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Course of Study

I am a Ph.D. candidate in fourth year interested in Macroeconomics and the Economics of Artificial Intelligence (AI).

Research Interests

I am studying the effects of technological change on economic inequality, particularly the labor market implications of automation technologies such as advanced AI systems. In my dissertation, titled "**Essays in Technological Change and Economic Inequality**," I examine the distributional effects of technological change and their policy implications under the supervision of Professors Anton Korinek, Eric Young, and Eric Leeper.

In my job market paper, titled "**Factor Complementarity and the Implications of Automation for the Distribution of Labor Income**," I study how automation affects the labor income share and distribution of labor income. To answer this question, it is important to recognize that the complementarity between machines and human labor may change over time and depends on the level of technology. Also, if technology progresses at the current rate then it may be the case that fewer and fewer workers benefit as advanced machines substitute the majority of workers. To formally explore these ideas, I build a model of hierarchical production organizations with two groups of heterogeneous agents: humans and machines. The model endogenously generates Pareto income distributions, which reflects the superstar effect for the most capable workers. A key feature of the model is that it allows for an analysis of the effects of automation on the income distribution and the role of complementarity between machines and humans in these effects. Through this model, it is possible to explore the question of whether automation leads to increasing income

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concentration, which is one of the main concerns related to advanced AI systems. To the best of my knowledge, this is a novel contribution to the literature on automation and its labor market implications.

The model produces a number of results that are consistent with the experience of the US economy over the past decades. First, if machines are relatively rudimentary then automation leads to a rise in middle income and a decline in top income shares. Second, if machines are advanced then further automation leads to a rise in top income shares and declining lower income levels. The results provide an explanation for why income distribution was relatively stable with falling top income shares during the mid-20th century followed by a period of rising income inequality marked by growing top 1% income share. Moreover, the model sheds light on recent evidence that suggests labor income share has not fallen much once various measurement issues, such as equity-based compensation, are taken into account.

Currently, I am focusing on the implications of advanced AI systems that are comparable to the best humans in their ability and are capable of all or almost all tasks done by humans, such as managing an organization. One potential implication from the model is that labor income distribution may remain stable even as labor income share declines with technological progress. This is because the gains from automation are relatively evenly distributed if machines complement the majority or all of humans. However, machines may earn a significantly higher fraction of total income than before because they now benefit from the superstar effect as well. During the remaining time for my study, I plan to extend my analysis to address imminent questions about the distributional effects of such AI systems described above.

In addition to my job market paper, I have three other projects in progress. The first paper "**Pecuniary Externalities and Capital-Skill Complementarity**," co-authored with Professor Eric Young, investigates how the government should redistribute when capital substitutes routine labor but complements non-routine labor. The main idea is that, if the government can distort labor supply decisions, it may be optimal to promote automation through further capital accumulation and discourage the labor supply of routine workers. The focus of our analysis is the optimal combination of taxes that supports the redistribution policy. Our results so far shows that the government taxes routine labor supply and subsdizes savings by wealthy agents.

To establish the results, we build a quantitative model with uninsurable idiosyncratic shocks and borrowing constraints, where pecuniary externalities arise from savings and labor supply decisions. Using the model, we characterize the constrained efficient allocation where the government has access to distortionary taxes on labor and capital income, but not lump-sum transfers. Under the baseline calibration, we find that the government should indeed promote further capital accumulation and discourage routine labor supply. We view our results as highly relevant for the discussion of the policy response to automation and its macroeconomic consequences, with our focus on the roles of labor supply decision and wealth distribution in shaping the redistribution policy.

The second paper "**Micro Automation and Macro Elasticity**," co-authored with Geunyong

Park who is a job market candidate at the University of Rochester, investigates the aggregate implications of automation at the firm level. We ask what determines the changes in aggregate labor income share. There are three considerations to answer the question. First, aggregate labor consists of various skill groups of workers that differ in their substitutability for capital. Thus, it is important to recognize that a change in aggregate labor share is the sum of changes in the income shares of individual groups. Second, a change in relative factor prices not only affects factor demands but also induces technological change that reallocates tasks across factors. Third, technological change often occurs at a relatively small number of firms, and therefore firm heterogeneity is an important factor to consider when examining aggregate factor income shares.

The key factor that summarizes the forces driving changes in factor income shares is the aggregate elasticity of substitution between capital and each skill group. It is therefore necessary to develop a theoretical framework that clearly demonstrates the connection between these aggregate elasticities and their determinants. In the paper, we build a model of task automation with heterogeneous firms and workers. Based on the model, we estimate the aggregate elasticity of substitution for each skill group and decompose the changes in aggregate labor income share. The results show that the decline in the aggregate labor share is explained largely by the decline in the income share of the least skilled group. Furthermore, the decline in income shares is driven to a large extent by the most technologically advanced firms. To guide our estimation process, we derive an equation that connects the aggregate elasticity of substitution and the firm-level elasticities. Our aggregation equation is general in that, on top of firm heterogeneity, it allows for (i) multiple types of labor in the production function and (ii) both factor demand changes and technological change to affect factor income shares. To the best of our knowledge, we are the first to estimate the aggregate elasticities of substitution between capital and various skill groups with such generality.

The last paper "**Economists' Views on the Future of AI**," which is a joint work by a group of researchers including Professor Anton Korinek, is a survey of economists on the growth prospects of AI. My role is to estimate the distribution of world growth rates that captures the expectations of the survey participants. Our framework allows us to estimate the probabilities on various scenarios ranging from human extinction to growth singularity implied by the responses. Preliminary results show that, on average, the participants predict moderate growth at a rate of approximately 2-3%. Furthermore, most participants view extreme growth outcomes as unlikely. We expect that our analysis will provide insights on one important aspect of macroeconomic implications of AI, which is economic growth. Also, it will be useful for comparing economists' views on AI with those of, for example, AI researchers.