

Macroeconomic Implication of Automation: Theory and Evidence

Abstract

This thesis investigates the macroeconomic implications of automation from three complementary perspectives: the labor share, environmental outcomes, and inequality across gender and skills. In the first chapter, we study whether human capital accumulation can mitigate the adverse effects of automation on the global labor share. We develop an automation- and human-capital-augmented growth model in which we first treat human capital as exogenous and then endogenize human capital formation. The analysis shows that automation exerts downward pressure on the labor share, but this effect can be partially offset through greater investment in human capital. Using data on industrial robot adoption and years of schooling, we find that fully stabilizing the labor share would require unrealistically large and persistent increases in educational investment. The results highlight the value of human capital as a policy instrument in the age of automation, while also showing that education alone cannot counteract its long-run distributional consequences.

The second chapter examines the environmental dimension of automation by analyzing its impact on aggregate emissions of CO₂ and NO₂ in a growth framework that incorporates robots as a production factor. The model predicts that the use of industrial robots raises aggregate emissions and delays the timing of the emissions peak relative to a robot-free economy. These predictions are evaluated empirically using a balanced international panel dataset. The estimates indicate that countries with greater demand for industrial robots experienced faster growth in GDP per capita alongside higher average growth in CO₂ emissions per capita. Although the direct contribution of automation to emissions is modest in magnitude, it is statistically significant and consistent with the theoretical mechanism in which automation slows the arrival of the Environmental Kuznets Curve turning point.

The third chapter explores how automation shapes inequality between men and women and between high- and low-skilled workers in the United States. We construct an R&D-based growth model in which automation substitutes for routine workers and complements high-skilled workers, while education choices endogenize skill and gender differences. The model predicts that automation increases demand for high-skilled labor and raises female participation in innovation, but it also widens inequality both within gender groups and across skill levels. Policy experiments show that redistributive transfers financed by robot taxation compress inequality but reduce innovation and growth, whereas education subsidies expand the skilled workforce and stimulate growth at the cost of greater inequality.

Together, the three essays provide a unified perspective on how automation reshapes labor markets, environmental dynamics, and social inequalities, offering guidance for policies that seek to balance innovation, equity, and sustainability in an increasingly automated economy.