

WHAT MAKES A DIFFERENCE: A CROSS-COUNTRY STUDY OF INDUSTRIAL ROBOT ADOPTION

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dx.doi.org/10.18374/JABE-24-3.9

ABSTRACT

Using data of industrial robots from the International Federation of Robotics, we examine why some countries adopt industrial robots (robots) more than other countries. Our data covers 63 countries from 2010-2021. We document substantial heterogeneity in the extent to which different countries embrace robots. Countries with larger economy sizes tend to adopt more robots. In terms of labor market characteristics, we find that countries with higher employment-to-population ratios and larger proportions of populations aged 65 and above have adopted more robots, even after we account for various other independent variables. Countries that have made efforts to gain comparative advantages in science and technology, measured by the research and development expenditure as a percentage of its GDP, have also used more robots. Additionally, we observe a significant difference in robot usage across regions and income groups. Given that national culture greatly impacts our society, we conduct further analysis to find out which national culture features (using Hofstede's cultural dimensions) have significant impacts on robot adoption. We find that higher degrees of masculinity and individualism are positively related while long-term orientation and uncertainty avoidance are negatively related to robot adoption. Since our study covers a relatively long time span, as a robustness check we control the time effect, with results being qualitatively the same. To account for variations in population sizes across countries, we use an alternative measure of robot adoption, operational stock of industrial robots per million population, and get similar results. Our study sheds light on technological integration for policymakers and researchers.

Keywords: Industrial Robots, Labor Market Structure, R&D Expenditure, National Culture

1. INTRODUCTION

Following recent technological advancements, more and more robots have been adopted, making the possibility of eliminating traditional jobs ever closer. Researchers and technology innovators are considering the effect of robots on existing jobs and policies the government can make to deal with this change. Foreseeing that technology would continue to eliminate traditional jobs, the CEO of OpenAI did an experiment to give each participant \$1000 a month in free cash for five years and observed the changes in their decisions. Our study is relevant from another angle. We notice that some countries use more robots than others. For instance, for the three major countries in North America, USA, Canada, and Mexico, the operational stock of industrial robots in 2021 were 341,782 units, 32,035 units, and 45,957 units, respectively. Our goal is to examine what factors explain the differences across countries in terms of industrial robot adoption.

Existing literature on robot adoption focuses on service robots, with studies on how the characteristics of robots or customers and their interactions impact service robot adoption (Liu, Wang, and Wang, 2022; Wirtz et al., 2018). Koch, Manuyloz, and Smolka (2021) found that at the microlevel, better performing firms are more likely to adopt robots while more skill-intensive firms are less likely to do so. Regarding theoretical studies, Acemoglu and Lensman (2024) recently built a model considering both the productivity gains and the potential negative consequences from the adoption of new technology, including societal damage. In previous literature, researchers have also recognized in their models where machines replace human labors (e.g. Acemoglu, 2024; Acemoglu and Restrepo, 2018; Nelson and Phelps, 1966; Zhang, Zhang, and Mai, 2023) that automation from technological advances increase economic growth but may cause structural unemployment, with low-skilled workers facing potential hardships regarding jobs. To our best knowledge, our study is the first to apply statistical models to industrial robot adoption data to explore the factors that determine robot adoption at the macro level. We find that the economy size, labor market structure, efforts in R&D as well as region and culture characteristics all affect robot adoption.